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PROCEEDINGS

of the American Academy of Forensic Sciences

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Contents

Financial Disclosure Index 1

Special Sessions 4

Breakfast Seminars 9

Academy-Wide Luncheons 12

Workshops & Workshorts 13

Scientific Sessions

- Criminalistics 23
- Engineering Sciences 95
- General 122
- Jurisprudence 147
- Odontology 159
- Pathology/Biology 187
- Physical Anthropology 239
- Psychiatry & Behavioral Science 282
- Questioned Documents 294
- Toxicology 300
- Last Word 324

Presenting Author Index 327

Key Word Index 331

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Special Sessions

SS1 Multidisciplinary Symposium on the Uses of Forensic Science -Multidisciplinary and Jurisdictional Interfacing After a Critical Incident: After an Event Occurs, Such as "9/11" How Do Local Agencies and Jurisdictions Work and Interact Together?

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This Multidisciplinary Symposium is designed as an interactive forum bringing together various jurisdictions and experts involved with handling a critical incident. All presenters are involved in critical incident planning and response, and many have "9/11" experience.

Generally, a critical incident consists of two parallel ongoing investigations. These are the criminal investigation and the identification of human remains. A critical incident event may be coordinated by national agencies, regional agencies, or a combination of the two depending on the overall event. The session will be divided into two aspects reflecting both the criminal investigation and the identification of human remains. The session will further be divided to cover national and regional perspectives of these topics.

The presentations and round table discussions will feature a variety of forensic and associated experts. Questions to be answered during the presentation are: Who are these experts? What do they do? How do they coordinate? How do local agencies or governmental bodies interact with all of these experts? and, How can agencies better prepare for a critical incident in the future?

Jurisdictions, Critical Incidents, Forensic Experts

SS2 Young Forensic Scientists Forum - Emerging as a Young Forensic Scientist

C. Ken Williams, MS, New Jersey State Police Department, South Regional Laboratory, 1101 South Whitehorse Pike, Hammonton, NJ; Amy C. Price, BS, Virginia Division of Forensic Science, 6600 Northside HS Road, 2nd Floor, Roanoke, VA, Claire E. Shepard, MS, 3630 Camp Circle, Crime Scene Unit, Decatur, GA; Sheila M. Estacio, BA*, Office of the Chief Medical Examiner - NYC Office, Department of Forensic Biology, 520 First Avenue, New York, NY; Edward G. Bernstine, MS, PhD*, State Police Crime Laboratory, 702 South Westfield Street, Feeding Hills, MA 01030; Charles H. Dold, JD, MBA*, 13145 92nd Avenue, NE, Kirkland, WA; David L. Exline, MSFS, Chemicon, Inc, 7301 Penn Avenue, Pittsburgh, PA; Eric W. Greenberg, BA, MFS*, 935 Pennsylvania Avenue, NW, Washington, DC; Christopher M. Gojcz, BS*, 28 Atwood Avenue, Pawtucket, RI; Carol Henderson, JD*, Shepard Broad Law Center, Nova Southeastern University, 3305 College Avenue, Ft. Lauderdale, FL; Graham R. Jones, PhD*, Medical Examiner's Office 7007-116 Street Northwest, Edmonton, AB, Canada; Kenneth E. Melson, JD*, United State's Attorney's Office, 2100 Jamieson Avenue, Alexandria, VA; Kathleen J. Reichs, PhD*, UNC-Charlotte, Department of Sociology & Anthropology, Charlotte, NC; Marie Samples, MS*, Office of the Chief Medical Examiner, Department of Forensic Biology, 520 First Avenue, New York, NY; Helena Soomer, DDS*, Department of Forensic Medicine, University of Helsinki, P.O. Box 40, Helsinki, Finland*

The role of the Young Forensic Scientist has changed drastically over the past few years. The many "forensic science" television shows have caused the public to expect answers in minutes and for laboratories to work miracles. The sensationalism creates its share of backlogs, but it is not the only factor in the changing role. Recent terrorist attacks, and the threat of future ones, have also impacted the future of the young scientist. The pressures placed on forensic science by the public and the constantly growing caseloads have created a need for young forensic scientists to quickly make the transition from school to employment and then to expert. The best preparation for the transition is to be informed of the situation. Focusing on the factors involving both the aspiring and the emerging forensic scientist, the full day program consists of presentations by established members of the forensic science community as well as those that are new to field. The day session concludes with a mock trial that is designed to prepare the attendees for courtroom testimony through demonstration. An evening session has been added to provide a more concentrated focus on those attendees looking to enter the field. Registrants are encouraged to bring copies of their resumés in order to have them fine-tuned during an interview and resumé workshop. The informal atmosphere and the experiences of the new and established members of the field create an environment that fosters questions and discussion.

The program should appeal to individuals with a strong desire to enter the field of forensic science as well as those with a few years of experience and looking to get ahead. The combination of lecture, demonstration and handouts will help to accomplish this goal. Realizing that the knowledge and experience level will vary greatly, the program is designed to touch upon many topics, ranging from the procedure in which one must follow to make a presentation at an Academy meeting to fine-tuning your resumé for that very first job search. Emerging Forensic Scientists will share their tales of landing that first job in the field and their involvement with the World Trade Center Disaster. Established members of the field will also be in attendance to share their experiences and to help answer any questions that

the attendees may have during our afternoon Open-Forum Discussion. The legal aspects of forensic science will be addressed and put to the test during the afternoon Expert Witness Demonstration. This should give the attendees an idea of what to expect before they take the stand.

The objectives of the Young Forensic Scientists Special Session are as follows:

- to understand the membership process of the American Academy of Forensic Sciences
- to understand the pressures facing the young forensic scientist
- to understand the process of publishing papers, making presentations, and authoring books
- to understand what employers want to see in a resumé and during an interview
- to understand the role that the law plays in forensic science
- to understand the role of the Expert Witness

And finally…

- to understand the Role of the Young Forensic Scientist in the Fight Against Terrorism!

Emerging Forensic Scientists, Career Preparation, Expert Witness Testimony

SS3 Forensic Scientific Investigations: The Role of Independent Forensic Scientists in the Investigation of Fatalities Associated With International Conflicts: Differentiation of "Massacre" From War Zone Deaths (Combatants and Civilians)

Michael M. Baden, MD, Forensic Science Unit, New York State Police, Building 22, State Campus, Albany, NY; Henry C. Lee, PhD*, Connecticut Forensic Laboratory, Connecticut State Police, 278 Colony Street, Meriden, CT; Cyril H. Wecht, MD, JD*, Allegheny County, 542 Fourth Avenue, Pittsburgh, PA*

This session is intended to inform and educate the forensic community about the problems, pitfalls, and significance of investigating deaths occurring in conflicts involving different ethnic, racial, and nationality groups.

Firsthand experiences related by the presenters will provide background information and knowledge for future utilization and broader application.

In every instance of an alleged massacre since World War II, forensic scientists have been called upon to conduct examinations of dead bodies, gravesites, and other physical circumstances and factors to assist in the determination of how those multiple deaths occurred. Cambodia, Bosnia-Herzogovina, and various countries in Africa are examples that readily come to mind. Such forensic examinations are not designed or intended to supplant other investigative efforts, nor are they to be construed as the sole determiner of such an inquiry. However, an investigation conducted by highly competent and experienced forensic scientists is obviously quite different from a non-scientific inquiry conducted by political, military, and other groups of organizational personnel.

Without the input of forensic scientists of this caliber, it is difficult to understand how an assessment of the cause and manner of death (i.e., intentional homicide/massacre vs. accidental/war combat) could be ascertained. As a matter of fact, without such input, conclusions arrived at solely by military, governmental, and political investigators would be subject to doubt, criticism, and perpetual challenge.

Individuals with international reputations based upon education, experience, and proven performance should be selected for these kinds of extremely sensitive, dramatic, and critical investigations. To the fullest extent possible, the forensic scientists who are willing to become involved in this kind of endeavor should not have a political agenda of their own to pursue. It should be kept in mind that longstanding reputations could be jeopardized if the investigation is not conducted in a thorough, competent, and objective fashion. There would be much to lose for professionally active and reputable forensic scientists by the promulgation of a spurious report with false conclusions and unsubstantiated opinions.

These kinds of incidents are always complex, controversial, and frequently quite critical from a regional and international political perspective. Cessation of military conflict or lingering hostilities may depend upon the findings of such a proposed team of independent, highly regarded forensic scientists. Accordingly, it is imperative that this kind of approach be implemented in every situation of this kind. From the standpoint of the forensic scientists involved in such an investigation, no endeavor could be more professionally significant and important.

Massacre, Forensic Scientific Investigation, Military War Deaths

FS1 The Council on Forensic Science Education, COFSE

Lawrence Kobilinsky, PhD, John Jay College of Criminal Justice, 899 Tenth Avenue, New York, NY*

Forensic science is a unique scientific discipline requiring its practitioners to have, in addition to technical skills and knowledge, also critical, analytical thinking skills, communication skills and an ethical awareness of the role of the scientist in the criminal justice system. A complete educational program, therefore, should create forensic science professionals. The Council on Forensic Science Education (COFSE) was formed more than two decades ago by a group of forensic science educators who were dedicated to achieving the following objectives: 1) to encourage the exchange of ideas and information regarding academic programs in the laboratory based forensic sciences and the discussion of problems of common interest; 2) to work collectively toward the coordination and upgrading of academic forensic science programs; 3) to promote constructive integration of formal academic training with postgraduate preparation for professional practice; 4) to foster friendship, cooperation and synergism among academic forensic scientists, practicing professionals, and laboratory management; 5) to encourage research and the advancement of knowledge benefiting forensic science; and, 6) to pursue other objectives appropriate to the advancement of forensic science education.

Membership is open to any person of professional competency, integrity, and good moral character who is actively engaged in forensic science education. Members of the Council are employed by various public and private educational institutions and are in all academic ranks. Some are college administrators and have responsibility for running forensic science programs. Although some are part time, most are full time educators. Some have experience as crime laboratory directors. Some have spent their careers working with undergraduates while others work exclusively with graduate students, and some members work with both.

Recently there has been a marked increase in the number of forensic science programs at colleges and universities. Many programs have been established despite very limited resources, insufficient personnel, lab space, and support for these programs. Students completing these programs expect to find employment in crime labs but are surprised to learn that lab management is not impressed by the curriculum. COFSE has been working to develop academic standards for both undergraduate and graduate education. COFSE has also been discussing accreditation of forensic science educational programs. A web site has been established and is under development. Plans are underway to link this site with the Academy's home page.

Forensic Science Education, COFSE, Council

FS2 Technical Working Group on Education and Training in Forensic Science: Academic Program Guidelines

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After this presentation, the audience will have an overview of process and results of the professional continuing education guidelines generated by the Technical Working Group on Forensic Science Education and Training.

Based upon the recommendations of the forensic science community in the National Institute of Justice 1999 publication, Forensic Science Review of Status and Needs, the educational and training needs "…of the forensic community are immense. Training of newcomers to the field, as well as providing continuing education for seasoned professionals, is vital to ensuring that crime laboratories deliver the best possible service to the criminal justice system. Forensic scientists must stay up to date as new technology, equipment, methods, and techniques are developed. While training programs exist in a variety of forms, there is need to broaden their scope and build on existing resources." (Forensic Science Review of Status and Needs, executive summary, page 4, emphasis added).

The Technical Working Group on Education and Training in Forensic Science (TWGED) is a multidisciplinary group of experts from the United States and Canada formed to respond to this need. Each member represents his or her respective agency or practice in forensic science and is involved in the education and/or training of forensic scientists, either as students or professionals. The members of TWGED represent academia, operational forensic science laboratories, professional forensic science organizations, and the legal system.

At the outset, it must be stressed that the work product of TWGED is guidelines and recommendations, not standards or requirements. These guidelines address qualifications for a career in forensic science, undergraduate curriculum in forensic science, and graduate education in forensic science. These topics will be addressed in a companion paper at this meeting. This paper addresses the professional training and continuing education guidelines drafted by TWGED.

Training is the formal, structured process through which an individual progresses from a current level of scientific knowledge and expertise to the level of competency required to conduct specific forensic analyses. Continuing professional development is the mechanism through which an individual remains current or advances to a higher level of expertise, specialization, or responsibility. All forensic scientists have an ongoing obligation to remain current in their field through the process of continuing education and other developmental activities. Similarly, laboratory management and its parent agency have an ongoing responsibility to provide support and opportunities for this continuing professional development.

In order for any training or continuing professional development to be recognized, it must be properly documented. The model criteria for training consist of entry requirements, program structure and content, assessment mechanisms, and documentation.

Entry requirements should include specified minimum academic and experiential requirements consistent with recognized, peer-defined standards (e.g., SWGs, ASCLD/LAB, ABC). Applicants must be aware that ongoing background security clearances and random drug testing may be required. Program structure should include the following written components: learning objectives, instructor qualifications, student requirements, detailed syllabus, performance goals, periodic assessments, and competency testing. Program content should be designed to include both discipline-specific and core elements. Core elements are essential topics that lay the foundation for entry into professional practice regardless of the specialty area and include standards of conduct, safety, policy issues, legal issues, and communication. Discipline-specific elements guided by recognized peer-defined standards should be incorporated, as appropriate, including history of the discipline, relevant literature, methodologies and validation studies, instrumentation, statistics (where appropriate), knowledge of related fields, and testimony. The trainee's progress should be assessed at appropriate intervals.

Continuing professional development encompasses competency maintenance, skill enhancement, and other aspects of professional activities. It is important that continuing professional development be structured, measurable, and documented. Courses taken for continuing professional development should include the following predefined structural components: Learning objectives, instructor qualifications, detailed syllabus or program description, assessment, and documentation. Assessment mechanisms for continuing professional development include: Oral exams or reports, written exams or reports, peer-reviewed publications, instructor or presenter evaluation, laboratory practicals and exercises, and observation of technical performance.

The agency must keep a permanent, official record of employee continuing professional development activities. The employee is encouraged to keep a personal copy of his/her record. The agency record must include a detailed description of the activity, its structural elements, and performance documentation, such as academic credit, continuing education credit, certificates, and/or proceedings' abstracts.

Training and continuing professional development based on the model criteria may be implemented in a variety of ways to maximize opportunities, minimize costs, and ensure high standards of professional practice. Examples of implementation include instructor-led courses, professional conference/seminars, distributed learning, apprenticeships, residencies, internships, teaching and presentations by trainee/employee, and independent learning.

TWGED recommended that the forensic laboratory establish a process to oversee, coordinate, and document all training and continuing professional development. Training and continuing professional development programs should be externally audited on a periodic basis.

TWGED also recommended that continuing education and training courses include qualified instructors, written course syllabus/outlines, written course objectives, instructor/course evaluations, mechanism for student assessment, documentation of student performance, and quantifiable elements such as continuing education units, academic credits, number of hours, or points. It was recommended that a clearinghouse of training-related opportunities be maintained.

Resources are needed to properly support training and continuing professional development. Qualified forensic scientists and supervisors should be afforded time in addition to their regular duties to mentor trainees and/or for their own continuing professional development. It should be recognized that case productivity will be affected by this reallocation of laboratory resources.

Agencies may partner to develop and provide intensive formal discipline-specific programs for trainees. These programs can relieve an operational forensic science laboratory of the in-house mentoring needed for an individual to be able to conduct casework. This partnering model may also be extended to continuing professional development, with agencies working together to develop and provide standardized training curricula and materials for use across multiple agencies. Although these partnerships significantly reduce costs, funding for student attendance will be needed.

It is recommended that between 1% and 3% of the total forensic science laboratory budget be allocated for training and continuing professional development. The professionalism expected of forensic science staff mandates that appropriate resources for training and development are provided by the parent agency. Forensic science is a labor-intensive undertaking, in which the quality, experience, and technical currency of personnel performing the work are paramount. Neglect of on-going training and professional development of staff leads to organizational failure to meet service goals and quality requirements of stakeholder agencies.

Education, Training, Forensic Science

FS3 Technical Working Group on Education and Training in Forensic Science, the TWG Process, and Academic Program Guidelines

Anjali Swienton, MFS, JD, National Institute of Justice, 810 7th Street, NW, Washington, DC; Max M. Houck, BS, MA*, West Virginia University, West Virginia University, Morgantown, WV; Christopher Turner*, National Institute of Justice, 810 7th Street, NW, Washington, DC; and Michael Yura, PhD*, West Virginia University, West Virginia University, Morgantown, WV; Lisa Forman*, National Institute of Justice, 810 7th Street, NW, Washington, DC*

The goals of this research project are to present to the forensic community how NIJ's consensus TWG process was used by forensic science educators and practitioners to draft model curricula for academic institutions offering degree programs in forensic science.

The National Institute of Justice 1999 publication, Forensic Science Review of Status and Needs, identified the educational and training needs of the forensic community as "immense." Participants in the development of that document targeted the education and training of the nation's forensic scientists as critically lacking and detrimental to the criminal justice needs of the country.

The Technical Working Group on Education and Training in Forensic Science (TWGED) is a multidisciplinary group of experts from the United States and Canada formed to respond to this need. Each member represents his or her respective agency or practice in forensic science and is involved in the education and/or training of forensic scientists, either as students or professionals. The members of TWGED represent academia, operational forensic science laboratories, professional forensic science organizations, and the legal system.

The work product of TWGED is put forth as guidelines and recommendations which are not intended as standards or requirements. These guidelines address qualifications for a career in forensic science, undergraduate curriculum in forensic science, graduate education in forensic science, and training and continuing education that the group as a whole selected through a consensus process. This last topic will be addressed in a companion paper at this meeting.

Because of the role that forensic science plays in the criminal justice system, personal honesty, integrity, and scientific objectivity are paramount. Forensic scientists also need to have a strong foundation in the natural sciences. For example, new hires in forensic science laboratories performing analyses of drugs, DNA, trace, and toxicological evidence typically will have a degree in chemistry, biochemistry, biology, or forensic science from an accredited institution. Although forensic scientists involved in the recognition and comparison of patterns, such as latent prints, firearms, and questioned documents, historically may not have been required to complete a college level degree, the trend in the field is to strengthen the academic requirements for these disciplines and require a baccalaureate degree, preferably in a science.

A model career path for a forensic scientist begins with formal education and continues with training, post-graduate education, certification, and professional membership. The career path contains elements, which address most of the components of this flow chart, to guide students, laboratory managers, agency personnel, and the public in understanding how credentialing can positively impact the overall effectiveness of forensic science practice.

The undergraduate forensic science major offered at an academic institution should provide a strong and credible science foundation emphasizing the scientific method and problem-solving skills for use in both classroom and laboratory settings. Graduates of an undergraduate forensic science program should also have acquired knowledge, skills, and abilities, which include scientific writing, public speaking, laboratory safety practices, computer software application skills, and laboratory skills.

It is likely that an increasing number of forensic scientists will seek graduate level education in the forensic or natural sciences to facilitate career advancement. A fundamental background in the natural sciences is central to the graduate education of a forensic scientist who conducts examinations of physical evidence in the laboratory setting. A program of forensic science education at the graduate level must do more than educate students in theoretical concepts. A graduate education for forensic scientists is expected to provide the student with critical thinking ability, problem-solving skills, and advanced, discipline-specific knowledge.

This presentation will focus on the Technical Working Group process for consensus building and the identification of educational elements in model curricula.

Consensus, Education, Training

FS4 Forensic Education Programs Accreditation Committee (FEPAC) of the AAFS

José R Almirall, PhD, Department of Chemistry and International Forensic Research Institute, Florida International University, University Park, Miami, FL; and James Hurley, MS, American Academy of Forensic Sciences, P.O. Box 669, Colorado Springs, CO*

The goals of this research project are to present the mission, organizational structure, and activities of the accreditation body of forensic science academic programs.

AAFS past-President Mary Fran Ernst established the Forensic Education Programs Accreditation Committee (FEPAC) as an ad hoc committee in November of 2001 and named the membership to include 5 educators, 4 lab directors, one director of training for a large organization, a member representing the NIJ, a consultant on accreditation issues and an AAFS staff member.

The mission statement of the FEPAC follows: The mission of the FEPAC is to maintain and enhance the quality of forensic science education through a formal evaluation and recognition of college level academic programs. The primary function of the committee is to develop and maintain standards and administer an accreditation program that recognizes and distinguishes high quality undergraduate and graduate forensic science programs.

It is the intention of the committee to meet once a year at the AAFS Annual Meeting to conduct the business of the committee. Some of the work of the committee (through task groups, and program evaluations) would take place through correspondence with the AAFS staff member coordinating the correspondence.

Liaison appointments to the Council of Forensic Science Educators, the American Board of Criminalistics, and ASCLD have also been established.

Additional volunteer AAFS members under the guidance of and direction from the FEPAC members may carry out the on-site evaluations of academic programs. Familiarity with the guidelines by which programs are evaluated is a requirement for this responsibility.

It is the intention of the committee to use the product of the West Virginia University/National Institute of Justice funded Technical Working Group on Education (TWGED) as the basis of the standard for the accreditation of academic programs. The committee also decided not to include the evaluation of continuing education programs and other non-academic institutions at the present time. The committee will pursue recognition from the U.S. Department of Education (DoED) as an accreditation body and has hired a consultant to guide the AAFS through this process.

The aim of this presentation is to provide an update of the FEPAC activities in 2002 and to describe the proposed activities for 2003 and beyond. The committee aims to conduct a pilot accreditation program in 2003 and a full accreditation program (first 12 academic programs) in 2004 for vote at the February. 2005 meeting.

Forensic Science Education, FEPAC, AAFS

FS5 Young Forensic Scientists Forum (YFSF)

Sheila M. Estacio, BA, Special Session Co-Chairman, Young Forensic Scientists Forum, NYC OCME, Department of Forensic Biology, 520 First Avenue, New York, NY*

During this presentation the attendee will learn about the history of the YFSF, how to become involved and become a member, the purpose of the Special Session, and how to use and contribute to resources such as the YFSF website and YFSF newsletter.

The Young Forensic Scientists Forum (YFSF) was formed in 1995 with the purpose of providing a welcoming environment for new and young (less than 5 years in the field) forensic scientists and those interested in pursuing careers in forensic science.

Objectives of the YFSF are follow:

- To provide information about educational, internship, research, and job opportunities in the field of forensic science;
- To introduce new and young forensic scientists to their colleagues and to potential mentors, and to provide networking opportunities;
- To assist in attaining and upgrading membership in the American Academy of Forensic Sciences and to provide links to other forensic science organizations; and,
- To educate members about grant and scholarship opportunities as well as competitions targeted for young forensic scientists, such as the Emerging Forensic Scientist Award sponsored by the Forensic Sciences Foundation.

Those who attend the YFSF Special Session at the Annual Meeting of the American Academy of Forensic Sciences will have the opportunity to hear speakers in the field of forensic science discuss their careers, to learn how to establish a career in forensic science through education and hands-on experience, and to observe expert testimony in a mock trial.

Dr. Steven Batterman, the founder of the YFSF, stated that emerging forensic scientists are "the future of forensic science." The central purpose as an organization recognized by the American Academy of Forensic Sciences is to enrich the education and experience of those who have recently entered the field and to encourage students and those who are changing fields in their pursuit of careers in forensic science.

Young Forensic Scientists Forum, Forensic Science Education, Career Planning

Breakfast Seminars

BS1 Mass Disaster in Chicago

Edmund R. Donoghue, MD, Eupil Choi, MD*, and Barry D. Lifschultz, MD*, Office of the Medical Examiner of Cook County, 2121 West Harrison Street, Chicago, IL*

The objective of this breakfast seminar is to review actual mass disasters occurring in Chicago, and to discover what may be learned from these events to prepare for future disasters.

In the history of Chicago, many disasters have been presented as fires. On October 8, 1871, following a three-month drought, the Great Chicago Fire broke out in a barn on the city's West Side and quickly blew across the Chicago River into the downtown area. Firefighters were hampered by dispatch problems, high winds, and lack of water. When the fire was put out 24 hours later, 300 lives had been lost, 18,000 buildings destroyed, and 100,000 people left homeless.

Chicago's most deadly fire occurred on December 30, 1903, when fire broke out on the stage of the newly opened Iroquois Theater. The conflagration killed more than 600 of the 1,900 patrons who had come to see the musical "Mr. Blue Beard" starring comedian Eddie Foy. A defective spotlight ignited a velvet curtain and fire quickly spread to highly flammable canvas scenery backdrops stored above the stage. An asbestos fire curtain, designed to prevent the spread of an on-stage fire, became stuck before reaching the fully down position leaving a gap that exposed the audience to flames and smoke. Lack of ushers, locked exit gates, and inward opening exit doors contributed to the disaster.

Another tragic fire happened on December 1, 1958, when 92 school children and three nuns perished at Our Lady of the Angels Grammar School. The fire started in a trash bin in the basement and quickly spread up the rear stairwell to the second floor. Smoke and flames filled the second floor corridor, trapping the children and nuns in their classroom. Many who survived jumped from high second floor windows before firefighters arrived. The fire was later found to be the arson work of a sixth grader who wanted a little time out of class. The Chicago Municipal Code was amended to require fire doors, enclosed stairwells, automatic sprinkler systems, and automatic internal fire alarm systems linked directly to the fire department in all schools.

Chicago's largest mass disaster occurred on July 24, 1915, when the excursion steamer Eastland, on its way to a picnic for Western Electric employees, capsized in the Chicago River killing more than 800 of the 2,500 persons on board. The steamer, known to be top heavy with a tendency to list, had a water ballast system that made it dangerously unstable. A temporary mortuary was established at the 2nd Regiment Armory with a nursery to watch children while parents looked for the bodies of family and friends. An outraged public blamed not only the boat's owners but also the Federal Steamboat Inspection Service.

The largest aviation disaster in the history of the United States took place at O'Hare International Airport on May 25,1979, when an American Airlines DC-10, fully loaded with gasoline, dropped an engine on the runway during its takeoff roll. The airplane attained an altitude of about 400 feet, began to roll, and struck ground a half-mile from the end of the runway killing 273 persons. The cause of the accident was a defect in the design of the engine pylon that made it vulnerable to damage during maintenance.

In an unusual natural disaster in the summer of 1995, 733 residents of Chicago died as a result of excessive heat and humidity when the temperature reached 106^{O}F and the heat index 119^{O}F. Controversy arising about how deaths were determined to be heat-related led to the development of criteria for the determination of heat-related death.

Fire, Aircraft Accident, Mass Disaster

BS2 Terrorism Prevention, Sherlock Holmes, and Forensic Applications

Saul B. Wilen, MD, International Horizons Unlimited, 4 207 Gardendale, #105, San Antonio, TX*

At the completion of this presentation the attendee will understand forensic processes in terms of terrorism prevention and will be able to appreciate the skills, data tools, and systems available to make the transition from law enforcement/crime solving to prevention. Sherlock Holmes will serve as your guide.

Sir Arthur Conan Doyle, through *The Adventures of Sherlock Holmes*, created a super-sleuth capable of applying forensic processes and skills to solving perplexing crimes of his day. However, these skills (trained observation, inferential relationships, deductive reasoning, critical thinking, information integration and analysis, and problem solving) are as vital today as they were then. Technological advances have further enhanced the sensitivity and scope of these skills.

In the last adventure, *The Final Problem*, Sherlock Holmes reveals to Dr. Watson the identity of his contemporary personification of evil. "For years past I have continually been conscious of some power behind the malefactor, some deep organizing power which for ever stands in the way of the law, and throws its shield over the wrong-doer…For years I have endeavored to break through the veil…and…it led me, after a thousand cunning windings, to ex-Professor Moriarty…He is the Napoleon of crime…He sits motionless, like a spider in the center of a web, but the web has a thousand radiations…his agents are numerous and splendidly organized…the central power which uses the agent is never caught — never so much as suspected…This was the organization which I devoted my whole energy to exposing and breaking up."

Were Holmes functioning today, he might view terrorists and their threats as radically different from those of the past. By applying inferential relationships and deductive reasoning he might see these changes not only as representing a shift in methods and tactics, but more significantly as a shift in their primary intent. He would infer that the terrorists were no longer primarily interested in spreading an ideological or geo-political message, but as radical fundamentalists, believing "their cause is just, God is on their side, and any and all actions are justified." Holmes would further deduce that terrorists have raised the stakes and no longer expect to survive their murderous attacks. This fatalistic mentality has made previously unthinkable acts possible. He would tell Dr. Watson that these acts clearly result in fear, create economic vulnerability, and divert resources. Finally, Holmes would conclude that the disruption of American security, daily activities, and economic stability are the ultimate goals of the terrorists.

Prevention in forensic efforts today remains the major deficiency that it was in the processes applied by Sherlock Holmes. Prevention is defined as those actions instituted to defeat a threat before any impact can occur. All other categories (protection, preparedness, intervention, response/reaction) relate to efforts after a threat is manifested and/or ongoing. Prevention strategies, tools, and weapons are based on four pillars: information horizontally integrated in real-time and readily capable of data trend delineation; effective communication; educational strategies applied at all levels; and resources management. These come together to define a prevention weapon that can be used in terrorism prevention and applied universally to other situations. The thinking processes of law enforcement are based primarily on solving crime once it has occurred. A logical transition and re-orientation is necessary to bring prevention concepts into the routine functions of forensic science to be applied to terrorism prevention.

In his letter to Dr. Watson at the conclusion of *The Final Problem*, Sherlock Holmes pens, "I write these few lines through the courtesy of Mr.

Moriarty, who awaits my convenience for the final discussion of those questions which lie between us…I am pleased to think that I shall be able to free society from any further effects of his presence." This presents a first glimpse into Holmes' thinking process transition toward prevention.

Terrorist threats are real. America is extremely vulnerable and no system is exempt. Prevention is the critical element offering the best strategy for defeating terrorism.

Forensic Processes, Terrorism Prevention, Inferential Relationships

BS3 Let's Go to the Videotape II: Crimes, Movies, and the Law

Haskell M. Pitluck, JD, 573 Lake Avenue, Crystal Lake, IL; Linda B. Kenney, JD*, Law Offices of Linda B. Kenney, Red Bank, NJ; James E. Starrs, LLM*, The George Washington University, 720 20th Street NW, Washington, DC*

It is the objective of this seminar to provide an overview of significant movies that have teaching value to lawyers and expert witnesses.

This is the sequel to last year's breakfast entitled "Movies and the Law." This year, the breakfast will focus on the "Crime" aspect of movies and the law. It is the objective of this breakfast seminar to provide a closer view of some movies that teach both lawyers and expert witnesses the value of spending their money on a Friday night and eating popcorn in front of the big screen. The audience will be able to learn that the presenters are "Loose Cannons," only one of whom is "Legally Blonde." They may ask the famed detective Agatha Christie to "Ride a Pale Horse" to the home of "Dolores Claiborne" and learn the ins and outs of important, accurate forensic detection both on-screen and off. Last year the audience learned that a "Witness for the Prosecution" who visits "Chicago" may not fool the system. "High Crimes" will be presented along with the traditional American breakfast of eggs, bacon, and an Oscar.

Movies, Forensic, Crime Scene

BS4 Is There Evil Beyond Crime? Defining Depravity for Criminal and Civil Courts

Michael Welner, MD, The Forensic Panel, 224 West 30th Street, #806, New York, NY*

At the conclusion of this seminar, the participant will be familiar with the most updated reliability and validity studies in the effort to define depravity in criminal and damages cases.

The rulings and writings of the U.S. Supreme Court have invited the standardization of factors relied upon by juries to pass sentencing in criminal cases. While criminal codes in many states contain aggravating factors for sentencing such as heinous, atrocious, and cruel, wanton, vile, or outrageous, these terms have heretofore been arbitrarily defined. Higher court decisions have demonstrated courts' awkwardness with terms regularly used in court to essentially designate the wickedness of a crime.

Likewise in civil cases, verdicts that deem actions "outrageous," in employment, personal injury, and malpractice cases, may escalate damages. But what is "outrageous?" And, can evil in everyday life be standardized for use in civil cases?

In an effort to bring rigor to these designations, the author has developed the Depravity Scale. This device assesses the history of the defendant's actions before, during, and after the criminal offense and incorporates his mental state and feelings as reflected by available history and evidence. The instrument therefore provides a measure to distinguish crimes qualitatively, independent of the background of the offender, and other collateral issues that sometimes influence or bias juries.

Confronting the challenge of defining the different expressions of "evil" for fair use in criminal matters ranging from capital cases to parole, the Depravity Scale project has unearthed many surprising results. First introduced as a poster at the 2001 AAFS Annual Meeting, the research effort has undertaken extensive research to standardize the definition of evil for use in courts.

The Depravity Scale research has now identified, with statistical reliability, aspects of intent, actions, and attitudes that jurors and judges in criminal cases can focus on in making these determinations. The author will review the very specific criteria arrived at for inclusion in the final version of the Depravity Scale.

As this presentation further details, the Depravity Scale is heavily reliant upon forensic science evidence. Those sources of evidence are reviewed for the benefit of crime scene technicians, forensic pathologists, forensic psychiatrists and psychologists, and others who gather and present evidence to courts that may later be used in sentencing.

The author also presents the research to date on the Depravity Scale being adapted for use in civil cases. Participants will learn of examples of cases in which "evil" impacts property and other material considerations, and of the methodology employed in arriving at specific criteria now being validated for use in civil courts in questions of "outrageousness."

The forensic scientists and investigators in attendance will learn of the evidence they need to be especially mindful of in confronting questions of depravity in future courts. Attorneys and law professionals will learn of the recommended applications of the Depravity Scale, clarifying how the instrument will be used to inform juries without supplanting the trier of fact.

Civil Law, Evil, Criminal Law

BS5 Les Timbres de la Mort and Other Philatelic Crimes

James E. Starrs, LLM, The George Washington University, 720 20th Street NW, Washington, DC*

Participants attending this seminar will learn the significance of philatelic products in the investigation and in the commission of crimes.

Crimes can be topical, just like stamps. This presentation will demonstrate how apt this double entendre is.

Criminal conduct may be timely and current, and in that sense it may be topical, such as in the investigations of child abuse, serial murder, and the like. Criminal conduct may also be, in the terminology of philately, topical because it relates to stamps and other philatelic products.

Philately features in crimes and investigations of crimes in many diverse ways and in a wide array of crimes. In penal institutions, stamps are notoriously well known as a means of importing drugs, such as LSD, into a correctional facility. Ted Kaczinski, a former college professor who the world came to know as the Unabomber, made efforts to distract his pursuers by sending pubic hairs he retrieved from public restrooms with his mailings. Although normally careful about not licking stamps, he slipped up when he left his saliva on a package he sent to Mr. Thomas J. Mosser, an advertising executive.

Stamps have found their place in wartime as a medium for those who are bent on espionage. Stamps have been known to be the hiding place of clandestine microfilms. The microdots implanted in stamps may be a form of covert intelligence transferred through stamps cryptographically from and to espionage agents.

The transmittal of anthrax bacterium through the mail is the single most topical of all current instances of the misuse of philatelic products. In this case envelopes were transmitted through the mail as an instrument for the perpetration of criminal deeds.

Stamps may be of such rarity and consequent value that they may be the direct impetus for criminal activity. The 2-cent Hawaiian Missionary stamp is often miscited as the genesis for the murder of Gaston Leroux, the author of the *Phantom of the Opera*. Evidence will be presented to dispel

this longstanding myth. Other valuable stamps have been the object of forgeries and other criminal behavior.

Little is it recognized that the infamous Ponzi scheme originated with Charles A. Ponzi, a stamp collector, who developed his scam from the International Reply Coupons authorized by the Universal Postal Union in 1907. Much more will be said on this subject.

The literature of fiction is replete with tales of stamps that have had a Wilkie Collins Moonstone-effect on criminal activity. Ellery Queen's *The Adventure of the One Penny Black* is one of this genre. Robert Graves *The Antigua Stamps* is another. The Sean McGrady series of whodunits featuring Postal Inspector Eamon Wearie canvases a multitude of hard-fisted and drama-driven criminal investigations involving a congeries of crimes featuring philatelic products.

Stamps, Terrorism, Philately

BS6 Murder & Mayhem Via the Home Computer

Carrie Whitcomb, MSFS, National Center for Forensic Science, P.O. Box 162367, Orlando, FL*

By attending this seminar, participants will learn examples of methodology on how traditional crimes are occurring from the keyboard, and how it extends all the way to murder.

Computers are becoming increasingly integrated with a variety of crimes. These crimes range from auction fraud to murder. This breakfast seminar will share detailed case examples of how traditional crimes have extended into the virtual world. Some of the stories read as though from a fiction novel as they include love, manipulation, and murder.

As such crimes may not be filed under any "computer crime" statute, it is extremely difficult to acquire a statistic regarding the frequency of such crimes. This seminar will provide insights into the methodology of these crimes and how traditional forensics must often work hand in hand with computer forensics to solve the case.

Digital Evidence, Cybercrime, Computer Forensics

BS7 SWAT Teams: Their Organization, Tactics, and Weapon Systems— Why This is Important to You as a Forensic Scientist

Donald F. Burbrink II, BS, Louisville Division of Police, 633 West Jefferson Street, Louisville, KY*

The goals of this presentation are to inform the forensic community about the roles, weapons, and methods of SWAT teams in law enforcement, and to aid forensic scientists in their investigation of SWAT-related incidents.

This breakfast seminar will begin with a history of the origin of SWAT teams throughout the country and their evolution into the teams utilized today. There will be information about the different types of teams (Full Time, Part Time and COMPACT), with a discussion of their missions and function. Time will be spent on the selection process, standards, and training needs of SWAT teams. Information about the various types of SWAT team call outs and the different tactics used will be discussed. The organization, position assignments, and functions of various members at call-outs will be discussed, including the use of snipers, perimeter teams, and arrest teams. These functions will be illustrated with video footage. Discussion will include the interaction and integration of SWAT with other teams such as Hostage Negotiation teams.

Protective gear for SWAT team members will be displayed and compared with regular bullet-resistant vests worn by patrol officers.

The basic weapon systems of SWAT teams will be explained with both "lethal" and "less than lethal" munitions discussed and illustrated. There will be illustrations and displays of the various weapon systems and their usage. Different types of ammunition and their indications will be discussed. Regarding lethal force, a basic guideline of appropriate use of lethal force will be discussed, along with the difference between SWAT teams and regular officers.

Less than lethal munitions will be highlighted and displayed. These less than lethal munitions instruments include pepper balls, tasers, sock rounds, fire hoses, canine, and a variety of noxious chemicals.

There will be illustrations of various weapon systems and their use in SWAT situations. Pattern injuries caused by these weapons will be shown. Since these weapons are not used during mainstream policing, a discussion of their intended use will explain when and how forensic scientists may see these weapons and their effects and wounding patterns.

Understanding the role of SWAT teams in the world of policing today will better aid the forensic scientist in determining the events in SWAT related incidents. The forensic scientist will be better equipped to understand and interpret pattern injuries created by less than lethal weapons. Understanding the tactics and assignments of SWAT personnel in a tactical situation will improve scene assessment and investigation. Seeing the weapon systems and understanding their indications and usage will improve the understanding of pattern injuries. Using a variety of illustrative aids including video, photos, and actual displays, this seminar will culminate a better understanding of what SWAT teams do, and will thus improve the forensic scientist's ability to investigate SWAT-involved incidents.

SWAT, Police, Pattern Injuries

BS8 Tom Krauss Memorial Bite Mark Breakfast: Bite Mark Evidence in a DNA World — Where Do We Stand?

Richard R. Souviron, DDS, Miami-Dade County Medical Examiner's Office, 336 Alhambra Circle, Coral Gables, FL*

The goal of this seminar is to demonstrate the fundamental difference between bite mark and DNA evidence.

The advent of DNA analysis has impacted many aspects of forensic science, but recently it has had a profound effect on a number of cases where bite mark evidence was also present.

The role which DNA evidence plays in cases that include bite mark evidence is contingent on the nature of the evidence and whether it has a common origin.

Ordinarily, the concept of independent analysis would preclude one form of forensic evidence from taking precedence over another. However, that concept has been called into question in several recent cases that included both bite mark and DNA evidence. Although these two forms of evidence are fundamentally different in many ways, they seem to be competing with one another despite their differences. These differences will be explored as a basis for discussion of circumstances in which DNA evidence may appropriately influence bite mark evidence. In addition, there will also be discussion of circumstances in which they should remain independent of one another.

In considering whether DNA evidence should exert any influence over bite mark evidence when they coexist, the fundamental differences between the two must be taken into account. More importantly, several basic factors will be crucial in determining what role bite mark and DNA evidence will play with each other when they coincide in a case. For example, is the same anatomic site used as a source for both DNA and bite mark evidence? If not, the possibility that these pieces of evidence are independent of one another is higher.

In many ways, basic fundamentals of crime scene analysis should control the interplay between bite mark and DNA evidence. There should not be an assumption that one form of evidence supercedes the other because it is statistically based. These two forms of evidence should be looked at as pieces of a puzzle that sometimes intertwine.

Bite Mark, Independent Analysis, DNA

Academy-Wide Luncheons

L1 Lessons From DNA Exonerations: Impact on the Forensic Community

Peter J. Neufeld, JD, Cochran, Neufeld & Scheck, LLP, 99 Hudson Street, 8th Floor, New York, NY*

Peter Neufeld, co-author of *Actual Innocence: Five Days to Execution, and Other Dispatches From the Wrongly Convicted*, co-founded and directs The Innocence Project at the Benjamin N. Cardozo School of Law. The Project currently represents hundreds of inmates seeking post-conviction release through DNA testing. In its ten years of existence, The Innocence Project has been responsible in whole or in part for exonerating more than sixty of the one-hundred and fourteen men to be cleared through post-conviction DNA testing.

In the last two years, The Innocence Project has been transformed from a clinical program with the single focus of exonerating the wrongfully convicted into a leadership role in the burgeoning "civil rights" movement to identify and address the systemic causes of wrongful convictions.

Mr. Neufeld has litigated and taught extensively in both the "hard" and behavioral forensic sciences. He has lectured before legal and scientific organizations and bar associations and has taught continuing legal education programs for bench and bar in twenty-five states as well as abroad, on the subjects of forensic science, expert witnesses, and cross examination. He also taught trial advocacy at Fordham University Law School for several years.

In 1995, Mr. Neufeld was appointed by Governor Cuomo, re-appointed by Governor Pataki, and continues to serve on the New York State Commission on Forensic Science, with responsibility for regulating all state and local crime laboratories.

Innocence Project, DNA Testing, Wrongful Convictions

L2 Reconstruction of a Traffic Accident: The Lady Diana Case

Jacques Hebrard, BA, Institute de Recherche Criminelle de la Gendarmeire Nationale, 1 bd Theophile-Sueur, Rosny sous Bois, France*

In the early morning hours of August 31, 1997, a Mercedes 280S sedan driven by Mr. Henri Paul, second in charge of security of the Ritz Hotel, crashed into the 13th pillar of a tunnel located along the Seine River in the center of Paris under the Pont de l'Alma. A bodyguard employed by Ritz hotel owner Mr. Mohamed Al Fayed, Trevor Reese-Jones, was sitting in the front, passenger-side of the car and in the back seat were Lady Diana, the Princess of Wales, and Mr. Dodi Al Fayed. During the ensuing two-hour period, paramedics made every effort to rescue the victims of the accident, in particular, Lady Diana and Mr. Reese-Jones.

This presentation will discuss in detail the investigation of this fatal accident by the Central Bureau of Accidents (CBA in France) and experts from the Forensic Science Institute of the French Gendarmerie (IRCGN).

Traffic Accident, Accident Reconstruction, Lady Diana

Workshops & Workshorts

W1 Evidence in History

James L. Hayes, BA, Hayes & Associates, Inc., 102 Main Street, Park Ridge, IL*

Upon completion of this workshop, the participant should be able to identify forensic document resources within the Newberry Library; highlight historical facts and information as it pertains to document examination; and, acquire a resource of literature for document examination, research, and publication. In addition, the participant will gain a historical overview of calligraphy, review the application of calligraphy as it relates to pen strokes, and evaluate the form and style of calligraphy.

The preservation of documents and how they serve as evidence is paramount to a document examiner's field. Come and explore the Newberry Library and uncover resources available for research and publication. Let leaders in the field provide a historical overview and access to their expertise.

This workshop, divided into two sessions, will feature a tour followed by a discussion of the history of the Newberry Library. The Newberry Library is known throughout the world as one of the finest rare book, map, and manuscript collections. These collections are of particular interest to document examiners. Attendees will receive a guided tour of the facility and Dr. Paul Gael will highlight the first-rate research facilities, historical manuscripts, and special collections used by scholars the world over doing research most notably in history and the humanities.

A master penman and calligraphic artist will discuss the form and style of the pen stroke in the second session of this two-part workshop. An interactive question and answer session is encouraged as the artist discusses this ancient and beautiful art form.

Historical Manuscripts, Newberry Library, Calligraphy

W2 Extracting DNA Profiles From Challenging Sample Materials

James W. Schumm, PhD, The Bode Technology Group, 7364 Steel Mill Drive, Springfield, VA; Mitchell M. Holland, PhD*, The Bode Technology Group, 7364 Steel Mill Drive, Springfield, VA; Kerri A. Dugan, PhD*, FBI, Counter-Terrorism and Forensic Science Research, FBI Academy, Building 12, Quantico, VA; Mechthild K. Prinz, PhD*, Office of the Chief Medical Examiner, Department of Forensic Biology, New York, 520 First Avenue, New York, NY; Dragan Primorac, PhD*, University of Split, School of Medicine, Department of Pediatrics, Laboratory for Clinical and Forensic Genetics, Spinciceva, Croatia; Patricia Loudon, PhD*, Armed Forces DNA Identification Laboratory (AFDIL), Office of the Armed Forces Medical Examiner, 18700 Walker's Choice Road, #226, Montgomery Village, MD; Edward M. Golenberg, PhD*, Wayne State University, Department of Biological Sciences, Detroit, MI; John Ballantyne, PhD*, Department of Chemistry, University of Central Florida, Department of Chemistry, P.O. Box 162366, Orlando, FL; Robert A. Bever, PhD*, The Bode Technology Group, 7364 Steel Mill Drive, Springfield, VA; Walther Parson, PhD*, Institute of Legal Medicine, University of Innsbruck, Institute of Legal Medicine, Muellestr, 44, Innsbruck; Alexandra L. Lowe, MSc*, The Forensic Science Service, Trident Court, Solihull Parkway, Birmingham Business Park, Solihull, United Kingdom; Jonathan Hoyle, BS*, Gene Codes Corporation, 775 Technology Drive, Suite 110A, Ann Arbor, MI; Heather Miller Coyle, PhD*, Connecticut State Police, DNA Unit/Forensic Biology, 278 Colony, Meriden, CT; and James M. Robertson, PhD*, Research Biologist, Counter-Terrorism and Forensic Science Research Unit, FBI Academy, Quantico, VA*

Upon completion of this workshop, the participant will have an understanding of several approaches available to develop DNA profiles from challenging casework materials, will be able to better practice DNA extraction methods with casework samples including human bone and other tissues, and will be able to identify new resources and techniques to support DNA analysis of challenging casework materials.

This workshop is designed for anyone who performs casework or has an interest in this topic. By emphasizing work with difficult samples, individuals will learn useful new techniques in determining DNA profiles. Methods amenable to both STR and mitochondrial DNA analysis employing laboratory equipment commonly available in today's forensic laboratories will be emphasized. Participants will be exposed to practical aspects of both published and currently unpublished advances. In addition to focusing on traditional challenges, discussion of improving interpretation from statistical methods and the special challenges of using plant materials and studying ancient DNA will be addressed.

The program will include an international array of experts describing their latest improvements in extraction of DNA from human bones and bone fragments. Extreme cases include the study of charred and moist bones, bones exposed to acid and burial, as well as ancient remains from fossil DNA. Evaluation of extracted materials using both genomic and mitochondrial DNA analysis will be described.

A second goal of the workshop will be description of extraction methods for other human tissues, adaptation to robotic environments, and modifications required for DNA isolation from plant species, now sometimes used in DNA forensic analysis.

New reagent systems are being developed specifically for use with casework samples of limited quality and/or amount. Two new methods compatible with existing laboratory instrumentation will be described.

Short Tandem Repeat, Mitochondria, Casework Samples

W3 The Disaster Mortuary Operational Response Team (DMORT) Model for Managing Mass Fatality Incidents

Frank P. Saul, PhD, USPHS DMORT V, Lucas County Coroner's Office, 2595 Arlington Avenue, Toledo, OH; Paul S. Sledzik, MS*, USPHS DMORT III, NMHM, Armed Forces Institute of Pathology, Washington, DC; Frank A. Ciaccio, MPA*, National Transportation Safety Board, 490 L'Enfant Plaza, East Southwest, Washington, DC; Frank Shank, BS*, USPHS DMORT V, 6 Ridgewood Circle, Perrysburg, OH; James McGivney, DMD*, 66 Grasso Plaza, St. Louis, MO; Paul Messner, JD*, Federal Bureau of Investigation, Room 305, 1240 East 9th Street, Cleveland, OH; Dennis E. McGowan, CPM*, Fulton County Medical Examiner's Office, 1700 South Crestview Drive, Snellville, GA; Joyce deJong, DO*, Sparrow Hospital, 1215 East Michigan Avenue, Lansing, MI; Julie Mather Saul, BA*, Forensic Anthropology Laboratory, Lucas County Coroner's Office, 2595 Arlington Avenue, Toledo, OH; Allan J. Warnick, DDS*, Wayne and Oakland Counties Medical Examiner's Office, 31632 Schoolcraft Road, Livonia, MI; John P. Kenney, DDS, MS*, Identification Services, Dupage County Coroner's Office, 101 South Washington Street, Park Ridge, IL; Robert W. Sibert, MS, MA*, FBI, Forensic Analysis Section, 935 Pennsylvania Avenue,*

Northwest, Washington, DC; and David Boyer, MFS, Department of Defense DNA Registry, Armed Forces Institute of Pathology, 1413 Research Boulevard, Building 101, Rockville, MD,*

Upon completion of this workshop, coroner/medical examiner participants should be able to assess and manage response to mass fatality incidents (MFIs) within their jurisdiction and utilize available external resources as needed; forensic specialist participants should be able to organize and integrate their response as members of a multidisciplinary team; and, all participants should be able to recognize the increasing importance of forensic science in victim identification and other aspects of MFIs while planning for a future that may include incidents involving weapons of mass destruction (WMD).

During the past decade, the management of mass fatality incidents (MFIs) has undergone dramatic changes based in particular on the evolving roles of the forensic anthropologist, odontologist, pathologist, and other scientists in obtaining positive identification of the victims. In addition, recent incidents and the potential for future terrorist activities have led to an increased focus on appropriate evidence collection and crime scene preservation. Fortunately, the U.S. Public Health Service Disaster Mortuary Response Teams (DMORTs) provide trained and experienced forensic and other specialists to assist local jurisdictions. The local coroners/medical examiners remain in charge of the victim's remains.

This multidisciplinary model will be exemplified through presentations and discussions by specialists who will share the knowledge gained from participating in the aftermath of the events of 9/11/01, air and train crashes, bombings, and natural disasters. Actual (or equivalent) specimens, radiographs, and other materials, including the most current DMORT computer programs, will be available for examination and/or demonstration.

Although this program is based primarily upon the DMORT model, it should provide participants with basic principles and information that will be of use in planning and carrying out MFI management in general.

Forensic Identification Procedures, Multidisciplinary Teams, Mass Fatality Incidents

W4 Advocacy for the Novice: How to Work for the Forensic Sciences

JCU Downs, MD, Alabama Department of Forensic Science, P.O. 3510, Auburn, AL; Barry A.J. Fisher, MS, MBA*, Scientific Services Bureau, LA County Sheriff, 2020 West Beverly Boulevard, Los Angeles, CA; Beth Lavach*, ELS and Associates, 9322 Old Burke Lake Road, Burke, VA; and Joseph P. Polski, International Association for Identification, 2535 Pilot Knob Road, Suite 117, Mendota Heights, MN*

Upon completion of this workshop, participants should be able to effectively lobby budget-makers at the local, state, and federal levels.

This workshop will present a primer on how to lobby at the local, state, and federal level. Participants will receive instruction in increasing funding for forensic laboratories and medical examiners.

This workshop will address the history of the efforts to secure additional funding for the forensic sciences. Through an interactive approach, techniques that have proven successful or unsuccessful in lobbying will be demonstrated and discussed. The content will cover local, state, and federal lobbying efforts and effective communication skills. Public relations skills and concise message driven delivery are stressed. The attendee should leave the workshop with a better understanding of the ethics of lobbying; consensus building; and who, what, when, where, how, and why to lobby public officials responsible for agency budgeting.

Federal Funding, Lobby, Advocacy

W5 New Concepts in Neuroimaging and Pathology of Child Abuse

Jeffrey M. Jentzen, MD, Milwaukee County Medical Examiner's Office, 933 West Highland Avenue, Milwaukee, WI; and Robert G. Wells, MD*, Radiology Department, Children's Hospital of Wisconsin, 900 West Wisconsin Avenue, Milwaukee, WI*

Upon completion of this workshop, participants will be familiar with the newer concepts of pathological and neuroimaging patterns of head injuries in children that may provide insight into the mechanism of injury and predictability of accidental vs. non-accidental trauma.

This workshop will discuss the issues relating to the predictability of intentional vs. non-intentional head injuries in children based on characteristic neuroimaging and pathological findings. The authors will discuss the development of a prediction model for diagnosis of intentional head trauma by correlating combinations of clinical, pathological, and imaging variables by logistic regression analysis. The prediction model is based on information obtained by review of large case series to investigate the correlation among CT imaging, intracranial trauma, and retinal hemorrhages in infants and young children.

The authors will draw upon their work involving the retrospective review of all intracranial hemorrhages detected on CT in children less than 3 years of age at a metropolitan children's hospital radiology department and more than 620 fatal cases of children examined in a medical examiner's office over a ten-year period.

In addition, the workshop will discuss new concepts of head trauma such as the development of hygromas as a sign of acute head injury, characteristics of retinal hemorrhages, and the use of immunoperioxidase studies as an adjunct in the pathological examination of head injuries in children. The workshop will provide a review of the pertinent literature as well as visual diagnostic tools for the pathologist, radiologist, and other healthcare clinicians involved in the investigation of childhood injuries.

Head Injury, Child Abuse, Retinal Hemorrhage

W6 Murder by Poison & Poisoners Throughout History

John H. Trestrail III, RPh, DeVos Children's Hospital Regional Poison Center, 1840 Wealthy, SE, Grand Rapids, MI; and James E. Starrs, LLM*, George Washington University, 720 20th Street, Northwest, Washington, DC*

Upon completion of this workshop, participants should be able to describe some of the psychological characteristics of the homicide poisoner, describe those instances in a death investigation when suspicion should be aroused, briefly describe the toxic mechanisms of the more commonly used homicidal poisons, and discuss poisoner trial strategy for either the prosecution or defense.

"Murder by Poison" is a discussion of the various factors which come into play in the forensic investigation of criminal poisoning: the poison, the poisoner, the victim, the crime scene, proving the poisoning crime, poisoning homicide epidemiology, and putting the poisoner on trial. "Poisoners Throughout History" is a discussion of homicidal poisoning from the days of early man down to the present, with case discussion of real poisoners drawn from criminal history.

Criminal Investigation, Poison, Murder

W7 Death Dealing Caregivers

Fredric Rieders, PhD, Forensics Mentors Institute of the Fredric Rieders Family Renaissance Foundation, 2300 Stratford Avenue, Willow Grove, PA; Michael F. Rieders, PhD*, National Medical Services, Inc., 3701 Welsh Road, Willow Grove, PA; Michael M. Baden, MD*, Forensic Sciences Unit, New York State Police, Forensic Investigation Center, Building 30, 1220 Washington Avenue, Albany, NY; and Kevin D. Ballard, MD, PhD*, Analytical Toxicology and Research & Development, National Medical Services, Inc., 3701 Welsh Road, Willow Grove, PA.*

The goals of this workshop are to heighten alertness to the names, toxic effects, routes, and potential of certain hospital-pharmacy sourced drugs as a means of deliberate killing of patients; to facilitate recognition of general aspects of such deaths which can serve to raise suspicion of poisoning as the cause of death; to understand the necessity of immediate and thorough collection and preservation of evidence, including specimens, medications, and paraphernalia in the vicinity of such deaths; to understand the importance of retention, preservation, and security of available antemortem and perimortal specimens of body fluids, vomitus, excreta, tissues, and paraphernalia; to understand and overcome difficulties associated with potentially evidentiary specimen collection; and, to understand the necessary scope of procedures and records, including the analytical method validation requirements, needed for meeting the *Frye* or *Daubert* admissibility hearing challenges used in judicial proceedings.

This workshop is designed to alert and enable forensic scientists, as well as health institutional personnel, law enforcement personnel, and health services oversight personnel to better detect and handle cases in which physicians or other patient healthcare providers commit poison murders using drugs which are unusual in other than hospital settings.

Actual cases and case clusters will be utilized for raising alertness to and recognition of salient facts and circumstances surrounding such deaths. Understanding the facts and circumstances may help to put the case into a "suspicion of poisoning" category.

The workshop will include the approach for selecting appropriate specimens at autopsy, bioanalytical methods, and the provenance of appropriate result interpretations.

Emphasis will be placed on proper specimen collection with chain of custody, specimen integrity, and specific specimen types to be submitted for forensic analysis. A discussion of the difficulties associated with developing and validating analytical methods that will stand up to "junk science" court challenges will be presented, as well as the use of forensic toxicological evidence in the prosecution of suspected homicidal healthcare providers who kill patients by poisoning.

Muscle Paralyzing Drugs, Succinylcholine, Hospital Homicidal Poisoning

W8 All in the Family: Interpersonal Violence in the Home

Eileen M. Allen, RN, BSN, Monmouth County, SANE Program, Monmouth County Prosecutor's Office, 132 Jerseyville Avenue, Freehold, NJ; Patricia M. Speck, APRN, BC*, Memphis Sexual Assault Resource Center, 2675 Union Avenue, Ext., Memphis, TN; Diana Faugno, RN, BSN*, Palomar Medical Center, 555 East Valley Parkway, Escondido, CA; Edmond "Ned" Tamburini, MSFS, U.S. Army Criminal Investigation Command, Ft. Gillem, Forest Park, GA; and Melinda J. Waddell, RN, MN*, 8111 East Wardlow Road, Suite 11, Long Beach, CA*

Upon completion of this workshop the participant will be able to discuss the concept of a coordinated multidisciplinary team approach to improve services provided to victims of interpersonal violence, to list the various members of response teams, to describe their roles and responsibilities, and to recognize potential barriers to victim disclosure.

This workshop will explore the multifaceted issue of interpersonal violence in the home by using a series of vignettes depicting a "typical" family in crisis. The panel of speakers will use these vignettes to illustrate various outcomes of the family members' contacts with the health care, social services, and law enforcement systems. Special attention will be given to the barriers faced by victims of violent crime.

Child Abuse, Domestic Violence, Interpersonal Violence

W9 Forensic Analysis of Trauma Due to Motor Vehivle Collisions

Michael J. Shkrum, MD, Department of Pathology, London Health Sciences Centre, University Campus, 339 Windermere Road, London, Ontario, Canada; Robert N. Green, MD*, University of Western Ontario Multidisciplinary Accident Research Team, P.O. Box 28089, London, Ontario, Canada; and Kevin J. McClafferty, BESc*, University of Western Ontario Multidisciplinary Accident Research Team, Room 2162, Elborn College, London, Ontario, Canada*

Upon completion of this workshop, participants will understand the necessity of a multidisciplinary approach when addressing issues related to motor vehicle impacts including the assessment of the significance of an injury and appreciate the mechanisms of certain common injuries arising from a motor vehicle collision.

This workshop will discuss engineering principles as applied to crash reconstruction and assessment of vehicle damage to determine crash forces and roadside and roadway safety implications along with various restraint systems. Also covered will be the biomechanics of human tissue injury from predicted kinematics and contact points occurring during various types of impacts including motor vehicle-pedestrian collisions and the role of restraint systems in injury prevention and causation.

Biomechanics of Motor Vehicle Trauma, Collision Reconstruction, Vehicle Dynamics and Kinematics

W10 International Forensic Automotive Paint Data Query (PDQ)

Denis Laflèche, Royal Canadian Mounted Police, 1200 Vanier Parkway, Ottawa, Ontario, Canada; and David B. Flohr, MSFS*, Trace Evidence Division, USACIL, 4553 North 2nd, Forest Park, GA*

Upon completion of this workshop, the participant should be able to effectively utilize the Paint Data Query (PDQ) program for three distinctly different purposes: generating potential manufacturer, make, model, assembly plant, and year information for questioned paints recovered from items collected from hit and run incidents; conducting a significance assessment for paints from K/Q comparisons that may then be used to lend weight to that evidence in court; and, maintaining and enhancing professional expertise and understanding of automotive paint systems as a result of having a searchable data base that supports more than 12,000 paint systems and contains pigment/binder information and infrared spectra for over 43,000 individual paint layers.

This workshop is designed to be a hands-on training session in which the attendees will receive instruction in the history and organization of the database, practice classifying paint systems for entry into PDQ, and gain the basic interpretive skills necessary for interpreting the results of a

search. Prior training and practical experience in paint analysis and FTIR paint examinations and classifications are required. Attendees wishing to keep PDQ must be from a recognized police agency, sign a non-disclosure confidentiality agreement upon registration, and agree to annually contribute 60 original full layer automotive paint samples to the PDQ maintenance team for analysis and inclusion into the database.

Each attendee should bring a laptop computer with the following minimum requirements: Pentium with WIN 95, CD-ROM, 16 MB RAM, 50 MB free HD space. Finally, full utilization of PDQ requires the utilization of Sadtler Searchmaster or Galactic Spectral ID software and the glossy and matte Munsell Color books. These items are not provided with the workshop.

Hit-and-Run Vehicle Identifications, Paint Data Query (PDQ), Automotive Paint Database

W11 So You're Going to Be an Expert Witness

Haskell Pitluck, JD, 573 Lake Avenue, Crystal Lake, IL; Christopher J. Plourd, JD*, Law Office of Christopher J. Plourd, 1168 Union Street, Suite 303, San Diego, CA; Joel S. Harris, BSc*, Royal Canadian Mounted Police, FL-O Document Section, 1200 Vanier Parkway, P.O. Box 8885, Ottawa, Ontario, Canada; Linda B. Kenney, JD*, Law Office of Linda B. Kenney, 2 Bridge Avenue, The Galleria, Atrium, Building 5, Red Bank, NJ; and Andre Moenssens, JD, LLM*, P.O. Box 193, Fairmount, IN; Cyril H. Wecht, MD, JD*, 14 Wood Street, Pittsburgh, PA*

Upon completion of the workshop, the participant should be able to prepare and testify as an expert witness.

Testifying as an expert witness is the opportunity for a forensic scientist to present and explain evidence to the trier of fact, be it judge or jury. You may be the greatest forensic scientist, with the best findings in the world, but if you cannot explain them to the trier of fact, your work will be in vain. This workshop will assist the forensic scientist to become not only a more competent examiner of evidence, but also a better testifying witness. The morning portion of the workshop will start from the beginning with hints to preparing your CV, submission and examination of evidence, report writing, preparing for testifying at depositions, motions and trials, pitfalls to avoid, dos and don'ts and in-betweens, ethical considerations, and payment for your services.

The afternoon session will include demonstration of direct and cross-examination. Attendees are encouraged to submit material for use in their practice examinations. What better way to learn now to testify than in a non-threatening learning situation in a realistic setting? The session will conclude with a round table discussion to discuss the covered material.

Expert Testimony, Trial Preparation, Expert Witness

W12 Clinical Chemistry and Forensic Toxicology—A Symbolic Relationship in Death Investigation

Jeri D. Ropero-Miller, PhD, North Carolina Office of the Chief Medical Examiner, 1001 Brinkhous Bullitt Building CB# 7580, Chapel Hill, NC; Amanda J. Jenkins, PhD*, Office of the Cuyahoga County Coroner, 11001 Cedar Road, Cleveland, OH; Larry A. Broussard, PhD*, Louisiana State University Health Science Center, 1900 Gravier, 10th Floor, New Orleans, LA; Michael J. Caplan, MD*, State of Delaware Office of the Chief Medical Examiner, 200 South Adams Street, Wilmington, DE; and Catherine A. Hammett-Staber, PhD*, McLendon Laboratories, University of North Carolina School of Medicine, Clinical Chemistry Laboratory, Room 100, 7 East Wing CB # 7525, University of North Carolina Hospitals, Chapel Hills, NC*

Upon completion of this workshop, participants should be able to understand circumstances in which results obtained in a clinical environment may be interpreted by forensic toxicologists and/or pathologists; to describe the correlation between the application of clinical chemistry and forensic toxicology in death investigations; and to improve their knowledge base for interpreting clinical and toxicological data in light of historical information by using illustrative case studies that demonstrate the symbiotic relationship between these two laboratory sciences.

This workshop will focus on clinical chemistry and its alliance with forensic toxicology during death investigation. While they are separate scientific fields, both clinical chemistry and forensic toxicology lend themselves to a forensic pathologist investigating a death. It is aimed primarily at toxicologists, but contains material relevant to General Sciences and Pathology/Biology audiences. Topics of this workshop will include an introduction to clinical chemistry: a general description on how it differs from forensic toxicology in mission and from a laboratory perspective; an explanation of how a forensic pathologist can utilize information from clinical chemistry and forensic toxicology to make a pathological diagnosis and assign a cause of death; and, an exploration of the relationship between clinical chemistry and forensic toxicology through discussion of actual laboratory examples, case reports, and professional experiences of the panel of speakers.

This workshop will offer a series of brief presentations on an overview of clinical chemistry, the evaluation of clinical and toxicological data by forensic pathologists, and understanding what the fields of clinical chemistry and forensic toxicology have to offer through practical demonstrations. The speakers will revisit old issues as well as address new concerns regarding the differences in laboratory practices, results, and overlap of these specialties.

The workshop will begin with a general description of clinical chemistry. The speaker will highlight the differences between clinical chemistry and forensic toxicology including considerations of laboratory missions, laboratory testing and methodology, specimen suitability and handling, and analytical considerations. Once the differences are established, the audience will be ready to learn how these two fields of toxicology can overlap and offer complimentary information to a forensic pathologist.

Next, a forensic pathologist will explain how clinical chemistry and forensic toxicology can simultaneously offer medical history that may assist in the determination of cause and manner of death. The pathologist will demonstrate the thought process that must be taken when ordering clinical chemistry and toxicological tests for a death investigation. In addition, case reports illustrating the utility of both fields of toxicology to the pathologist will further demonstrate to the audience the importance of including both antemortem and postmortem laboratory results of a patient in the pathological evaluation and assignment of cause of death.

Since toxicology is an applied science, a fitting conclusion of this workshop will be the presentation of authentic laboratory examples, case reports, and professional experiences to define the relationship of clinical chemistry and forensic toxicology. Examples that illustrate toxicological issues include problems a clinical laboratory may encounter when analyzing postmortem specimens, interpreting clinical results of a postmortem specimen, and evaluating antemortem results towards establishing a case timeline. Finally, the panel of speakers will reconvene to address questions and further discuss topics of interest to the audience. At the conclusion of this workshop, the attendee will have a better understanding of how clinical and forensic toxicology laboratories contribute essential information to a comprehensive forensic death investigation.

Forensic Toxicology, Clinical Chemistry, Death Investigation

W13 Managing Mass Fatality Incidents — Lessons Learned From Pervious Incidents

Robert A. Jensen, BS, Kenyon International Emergency Services, Inc., 15180 Grand Point Drive, Houston, TX; and Robert C Shaler, PhD* and Amy Zelson Mundorff, MA*, Office of the Chief Medical Examiner, 520 First Avenue, New York, NY*

The goal of this workshop is to provide the participant with an overview of recent incidents, to provide information on implementing successful management strategies, to and discuss valuable lessons learned. Each attendee should leave with a general outline of how to structure a mass fatality morgue and a checklist of coordinating tasks.

This workshop will describe what to expect when responding to a mass fatality incident; how to set up and manage a mass fatality morgue (beginning with receiving human remains and personal effects, progressing through morgue processing stations, and ending with final disposition of personal effects, identified, unidentified, and unclaimed human remains); family assistance activities (including the collection of familial and direct DNA samples, gathering of antemortem records, applying for court ordered death certificates and legally mandated family assistance briefings); and, morgue data and records management.

Workshop presentation is based on real world international experience from a variety of mass fatality incidents. Included are lessons learned from incidents involving terrorist acts, transportation accidents, and natural disasters.

Mass Fatality, Recovery Operations, Morgue Operations

W14 The Ethical Scientist: A Scientific and Legal Perspective

Max M. Houck, MA, Forensic Science Initiative, West Virginia University, 886 Chestnut Ridge Road, P.O. Box 6216, Morgantown, WV; and Sheri H. Mecklenburg, JD* and Michael P. Monahan, JD, City of Chicago, 30 North LaSalle Street, Suite 1400, Chicago, IL*

Upon completion of this workshop, the participant will be familiar with the philosophical and legal definitions of science, the legal obligations of the forensic scientist who is subject to a discover order, how the Brady decision affects forensic scientists, issues regarding bias, fraud, and historical re-investigations, and what information should be contained in notes, work product, and reports.

"The Ethical Scientist" is a presentation with discussion concerning the philosophical and legal definitions of science and how they factor into the legal arenas of discovery, Brady issues, bias, and fraud. What is a forensic scientist personally liable for in a dispute over the science he or she performed? What are the obligations of that scientist's laboratory? What should the scientist provide faced with a discovery order? What constitutes 'work product'? These issues are especially important given the increasing frequency of re-examined cases in light of new technologies (e.g., serology vs. DNA). "The Ethical Scientist" will help prepare forensic scientists to defend their discipline, their science, and their work in a legal setting.

Science, Bias, Fraud

W15 Professional Standards of Competence in Forensic Science

Keith Hadley, MSc, 16 Causey Farm Road, Hayley Green, Halesowen, West Midlands, United Kingdom; and Michael J. Fereday, BSc*, Forensic Science Service, Suite C, London Vale House, Hurricane Way, Woodley, Berkshire, United Kingdom*

Upon completion of this workshop, participants should be able to describe the true meaning of Professional Standards of Competence and how they differ from other 'standards;' describe how Professional Standards of Competence are developed; describe the principles of a flexible yet rigorous assessment strategy based on Professional Standards of Competence for ensuring the ongoing workplace competence of forensic scientists; and, describe how the Standards may be used as a focus for the development of training and education programs in forensic science.

Professional Standards of Competence have been developed for the assessment of ongoing workplace competence of forensic scientists.

The workshop will describe a procedure that has been developed to assess the ongoing workplace competence of forensic scientists, which is based on generic Professional Standards of Competence. The development of the standards will be described, as will the efforts made to gain national approval and agreement to them. The true nature of the generic standards will be described. The standards will not dictate how tasks must be carried ou, but it will show that the procedure is rigorous enough to detect, and reject, the use of unacceptable practices in forensic science.

Workshop participants will be taken through a suggested way of using the standards for the assessment of ongoing workplace competence.

Competence, Standards, Assessment

W16 Antipsychotics - Medicines for the Minds

Jeri D. Ropero-Miller, PhD, and Ruth E. Winecker, PhD*, North Carolina Office of the Chief Medical Examiner, 1001 Brinkhous Bullitt Building, CB# 7580, Chapel Hill, NC; William H. Reid, MD, MPH*, UTHSC, P.O. Box 4015, Horseshoe Bay, TX; Daniel T. Anderson, MFS*, Los Angeles County Department of Coroner, 1104 North Mission Road, Los Angeles, CA; and H. Chip Walls, BS*, Forensic Toxicology Laboratory, University of Miami, Department of Pathology, 12500 SW 152nd Street, Building B, Miami, FL*

Upon completion of this workshop, participants should be able to understand the different types of Psychosis and how they are medically treated; describe the differences between conventional and atypical antipsychotics including pharmacokinetics, side effects, associated syndromes, laboratory analysis, and toxicity; and, improve their knowledge base for interpreting data from actual cases studies presented to illustrate the salient issues involved in antipsychotic deaths.

This workshop offers a series of brief presentations on psychotic disorders, antipsychotic agents and their pharmacology, clinical effects, toxicological analysis, and lethal intoxication. It will include speakers practicing in the fields of psychiatry and behavioral sciences and forensic toxicology. The speakers will revisit old issues as well as address new issues concerning the analysis of antipsychotics and forensic cases.

Psychosis collectively refers to disturbances of perception and thought processes. The incidence of psychotic disorders is becoming more prominent in the United States and internationally. Greater than 1.1 percent of the American adult population are annually diagnosed with schizophrenia, a more prominent psychotic disorder. While there is no cure for schizophrenia, it is a highly treatable disorder. The 2000 National Ambulatory Medical Care Survey of the Centers for Disease Control and Prevention reported that the number of psychoactive drug mentions in office practice was more than 100 million. Given these statistics, it is easy to see why knowledge of antipsychotics and their toxicity is essential to a forensic scientist.

To begin, the workshop will include a general introduction to the different types and classifications of psychotic disorders. A description of the symptomology of each psychotic disorder will be presented. An explanation of the diagnosis and treatment of psychotic disorders will be discussed, touching on non-medicinal treatment, but focusing on pharmacotherapy. Clinical presentation of patients taking psychoactive drugs in compliant and non-compliant manners will also be presented.

Next, antipsychotic agents, categorized as either conventional or atypical agents, will be further discussed. Details of the pharmacology, toxicity, laboratory analysis, and postmortem tissue distribution will be covered. In addition, special attention will be given to drug syndromes and sudden death associated with the different categories of antipsychotics. All of these topics will highlight the findings from a review of the latest literature. Finally, issues that laboratories face when asked to analyze for the presence of antipsychotic drugs and interpret results will be introduced and interactively discussed.

To put much of this information about antipsychotics into perspective, a myriad of case studies will be included to represent the expansive presentation of antipsychotic overdoses. Inclusion of both typical and unusual presentations, and analytical data will demonstrate to the audience what a forensic scientist should consider when investigating their own cases.

Finally, the panel of speakers will reconvene to address questions and further discuss topics of interest to the audience. Attendees will be better equipped to investigate, analyze, and interpret toxicological issues associated with antipsychotics upon completion of this workshop.

Forensic Toxicology, Antipsychotic Drugs, Drug Toxicity

W17 Low Copy Number DNA Analysis: A Community Forum

William J. Watson, BS, MS, Orchid Cellmark Nashville, 1400 Donelson Pike, Suite A-15, Nashville, TN; Ray Wickenheiser, BSc*, Acadiana Criminalistics Laboratory, 5004 West Admiral Doyle Drive, New Iberia, LA; Patrick W. Wojtkiewicz, PhD*, North Louisiana Criminalistics Laboratory, 1115 Brooks Street, Shreveport, LA; Roland Van Oorschot, PhD*, Victoria Police, State Forensic Science Laboratory, Forensic Drive, McLeod, Victoria, Australia; Alexandra L. Lowe, MSc*, Forensic Science Services, 4th Floor, Priory House, Gooch Street North, Brimingham, United Kingdom; Deborah L. Hobson, BS, MPH*, FBI Unit I, FBI Laboratory, 935 Pennsylvania, NW, Washington, DC; and Matthew Greenhalgh, BSc*, Orchid Biosciense Europe, 22 Blacklands Way, Abingdon, Oxon, United Kingdom*

This workshop will benefit individuals who are currently performing casework DNA analysis and who wish to expand the potential application of that technology to a wider range of specimens. Upon completion of this workshop, the participant will gain a basic understanding Low Copy Number (LCN) DNA analysis; the theory, application, and limitations associated with current approaches; the experiences of forensic laboratories using these approaches on casework specimens; and, current research in platform and method development.

This workshop will provide a general overview of DNA analysis of biological specimens containing quantities of DNA below those currently considered amenable to, or acceptable for, PCR-based DNA analysis. The first session will focus on issues related to analyzing trace or LCN DNA specimens. These issues include defining what type of specimens would fall into the trace or LCN DNA category; the methods currently being used to analyze these specimens; the underlying theories behind the methods and interpretational peculiarities associated with data generated using these methods; and finally, the overall reliability of current methods. Casework examples will be discussed. The second session will feature the LCN DNA casework experiences of private and public sector laboratories from this country and abroad. These presentations will include both specific casework examples as well as general discussions about unusual and unlikely types of samples. The final session will present current research in platform and application development, as well as new methods of data analysis/interpretation being applied to LCN DNA analysis. All sessions will be followed by a brief panel discussion.

This workshop is designed to provide the participants with a well rounded introduction to the underlying theory and application of Low Copy Number (LCN) DNA analysis, the current techniques used by different laboratories to test and interpret these samples, a variety of casework experience with trace DNA samples, and the future developments and considerations of Low Level DNA Analysis.

Drug Analysis, Low Copy Number DNA Analysis, Trace DNA Analysis

W18 Quality Issues in the Analysis of Fire Debris and the Classification of Ignitable Liquids

Julia Ann Dolan, MS, Bureau of Alcohol, Tobacco and Firearms, Forensic Science Laboratory - Washington, 1401 Research Boulevard, Rockville, MD; and Reta Newman, BS, MA*, Pinellas County Forensic Laboratory, 10850 Ulmerton Road, Largo, FL*

Following this workshop, the attendee will be familiar with criteria for processing and classifying ignitable liquids and their residues, and will be aware of the options for insuring quality in this discipline.

This workshop will discuss the various quality assurance and quality control issues specifically relevant to the forensic discipline of fire debris analysis. Options for incorporating appropriate quality assurance methods into laboratory protocols will be discussed. It is designed to address quality assurance and technical analytical issues particular to the analysis of fire debris, including the contents of the newly revised ASTM methods. Through lectures, group discussions, and practical exercises, this workshop will address classification issues, potential effects of sample preparation methods, the use of reference collections, and appropriate quality control and quality assurance protocols.

Quality Assurance, Fire Debris Analysis, Ignitable Liquids

W19 Understanding of Patterns and Motives of Violent Sexual Offenders

Robert K. Ressler, MS, Forensic Behavioral Services International, P.O. Box 187, Spotsylvania, VA; Michael Osterheider, MD*, Westphalia Center for Forensic Psychiatry, Eichelbornstrasse 21, Lippstadt, Germany; and Thomas P. Muller, PhD*, Chief, Criminal Psychology Service, Federal Ministry of Interior, Republic of Austria & Assoc. FBSI, P.O. Box 100, Vienna,Austria*

Upon completion of this workshop, the participants should be able to understand the rationale for more in-depth research of violent sexual offenders; to understand and identify the difference between organized and disorganized sexual offenders; to recognize and identify the importance of violent sexual fantasies which develop in sexual offenders before, during, and after adolescence, that lead to future violent sexual crimes; to be able to use the information gained to better classify and evaluate sexual offenders in a law enforcement, mental health or penal setting to better recommend retention or release; and, to conduct improved interviews of violent sexual offenders which get at their true motivation as compared to traditional self report methods.

This workshop will focus on the early efforts of the FBI, under the direction of Robert K. Ressler, to research and study the patterns and motives of violent and repetitive serial and sexual offenders. The research was initiated by the FBI's Behavioral Science Unit. The workshop program will primarily focus on the deviant sexual fantasy development of violent sexual offenders, many of whom commit serial crimes. The notion of fantasy as a motivator will be illuminated through in-depth

examination of pertinent case examples which vividly demonstrate that early deviant fantasy becomes the eventual road map to future violent and repetitive sex crimes. The concept of organized and disorganized criminal behavior will be explored and demonstrated by viewing actual crime scenes and viewing video interviews with those who committed such crimes. Further, the workshop participants will demonstrate interview techniques in an on-stage role playing scenario designed to demonstrate how to draw important and necessary information from inmates in a law interview situation or in a prison setting in order to better serve the needs of mental health professionals working in a penitentiary.

Workshop attendees will be oriented to a pilot study conducted by the workshop presenters in 2001 at the Westphalia Center for Forensic Psychiatry, located in Lippsatdt, Germany. The study in Lippstadt focused on the difference between traditional interview method of self-report as opposed to a new approach utilizing law enforcement investigative reports and actual crime scene photographs as a basis for interview. During the study, the workshop presenters interviewed violent sexual offenders by the traditional method of self reporting and contrasted this method with an alternative style of first reviewing actual law enforcement investigative reports and vivid crime scene photographs which gave the interviewers additional insights into the criminal motivation and ultimately produced dramatic results in the second interview. This new method may produce a more accurate and valuable insight into the fantasy structure of a violent sexual offender. The goal of this new method is to provide the mental health professional with a better insight into the inmate for better evaluation, classification, and finally, to better recommend retention or release of the offender for parole hearings. The workshop participants will recommend new techniques and better training for prison mental health professionals with a goal of better evaluation, classification, and improved parole recommendations for the protection of society at large.

This workshop is intended to be both an interactive academic exploration of violent serial and sexual crimes, and will provide an opportunity for the attendees to analyze actual cases by video and slide presentation. Further, attendees will be encouraged to utilize the information gained through their own practical experience along with the newly gained knowledge obtained through active participation in this workshop.

Serial Sexual Offenders, Violent Sexual Fantasy, Violent Sexual Offenses

W20 Cyber Terrorism: Threat Assessment, Evidence Preservation, and Prosecution

Carl N. Edwards, JD, PhD, Four Oaks Institute, Two Spring Lane, P.O. Box 1776, Dover, MA; John P.L. Woodward, BS, MS*, Space, Intelligence & Information Operations, The MITRE Corporation, M/S K215, 202 Burlington Road, Bedford, MA; TC Lipe*, 140 Lakeview Drive, #2B, Clute, TX; Thomas C. Ervin, BS, MS, The MITRE Corporation, 2807 Wakefield Drive, Clarksville, TN; David W. Baker, MFS*, The MITRE Corporation, G023 - Secure Information Technology, Mail Stop W435, 7515 Colshire Drive, McLean, VA; William J. Cook, JD*, Freeborn & Peters, 311 South Wacker Drive, Chicago, IL; and Kelly Brennan, BS*, Federal Bureau of Investigation, 219 South Dearborn, Chicago, IL*

Upon completion of this workshop, participants should be able to describe the technologies used in the operation and control of the nation's critical infrastructures, and be able to assess their potential vulnerabilities and options to ameliorate potential abuse; understand the unique legal and operational challenges intrinsic to cyber terrorism, the range of stakeholders and specialists needed to address the problem, and the importance of creating and mainlining ongoing working relationships between all relevant parties; and apply a basic working knowledge of relevant skills in computer forensics, threat assessment, and evidence preservation.

The misuse of computers and network access to manipulate America's critical infrastructures has become a means by which utilities, communications, and financial services may be compromised or misdirected, inflicting sabotage, creating floods, crippling financial services, and disabling emergency services. While there is a history of documented cyber sabotage attacks, recent intelligence confirms that terrorists are also actively planning cyber terrorist attacks either by themselves or to leverage the impact of conventional acts of violence.

Containing and preventing cyber terrorism is a particularly challenging problem critical to national security. This has been complicated by technical and legal issues, and by the fact that much of the nation's critical infrastructure is maintained and operated by utilities and private corporations over which the government has had limited control.

This workshop will review the nature and elements of cyber terrorism. It will consider the psychological and operational profiles of terrorists and saboteurs as these relate to means, motives, and methods of operation. It will examine the technologies of infrastructure control and vulnerability. Case studies and demonstrations will be featured, drawing upon recently unclassified incidents of hacking and cyber warfare.

Building upon and extending the computer forensics concepts addressed at the 2001 Seattle Workshop (the co-chair of that Workshop, Howard Schmidt, is now chief computer expert at the White House's Critical Infrastructure Board), this workshop will examine procedures for criminal detection and evidence preservation both at the perpetrators' computer sites and at the impacted institutional sites.

The unique government/industry collaborations, such as InfraGuard, required to address cyber terrorism will be presented by experts with extensive experience in their creation and ongoing operation. Legal, investigative, and prosecutorial tools will be reviewed by prosecutors and law enforcement professionals. A National Research Council's Critical Infrastructure and the Law Committee faculty member will discuss the liability conclusions and recommendations contained in its forthcoming report.

Finally, through a full-faculty panel, the workshop will review and debate the current state of fast-changing and highly controversial existing and proposed legislation and regulations as well as the current move to combine the seven government agencies that now share responsibility for cyber security under a new undersecretary for information analysis and infrastructure protection within a Department of Homeland Security.

Terrorism, Technology, Computer Forensics

W21 Note Taking Considerations and Techniques for Document Examiners

Larry A. Olson, MFS, IRS National Forensic Laboratory, 29 North Wacker Drive, Chicago, IL; Thomas A. Nelson*, Michigan State Police (Retired), 638 North Edgar Road, Mason, MI; Frederick H. Panhorst, MSM*, U.S. Army Criminal Investigation Laboratory, 4553 North 2nd Street, Forest Park, GA; Margaret A. Nelson*, and Amy Ronayne-Krause*, Michigan Attorney General's Office, P.O. Box 30218, Lansing, MI; Mary K. Bacon, MS, Ferris State University, Physical Science Dept., 820 Campus Drive, ASC 3019, Big Rapids, MI; and Thomas P. Riley, BS*, Michigan State Police, 7320 North Canal Road, Lansing, MI*

Upon completion of this workshop, the participants will understand the philosophy, requirements, and basis of note taking, and will be provided with additional techniques of taking effective, efficient, and acceptable casework notes.

Most forensic document examiners never receive any formal - or even informal - instruction in taking casework notes. They tend to develop their own methods and techniques.

This workshop will address how current legislation, legal rulings, ASCLD/LAB accreditation requirements, and academic/scientific procedures may dictate how forensic document examination notes should be taken and stored. Legal aspects of taking, storing, and testifying from

notes will be discussed. Selected examiners will also share and discuss note taking techniques and formats for various types of examinations, e.g., handwriting, indentations, inks, alterations, typewriting, copiers, imaging processes, multi-faceted examinations, etc.

This workshop will give the practicing forensic document examiner a better understanding of the philosophy, requirements, and basis of taking effective, efficient and acceptable casework notes.

Notes, Document Casework Notes, Note Taking

W22 How to Setup a Digital Evidence Unit

Carrie Whitcomb, MSFS, National Center for Forensic Science, P.O. Box 162367, Orlando, FL; Mark Pollitt, MS*, Regional Computer Forensic Laboratory National Program Office, Federal Bureau of Investigation, 7142 Ambassador Road, Baltimore, MD; Robert P. Bianchi, BS, 5502 Chestermill Court, Fairfax, VA; Michael J. Phelan, BA, MA, Drug Enforcement Administration, 7704 Old Springhouse Road, McLean, VA; and George M. Sauers, Investigation and Operational Support Division, Pennsylvania State Police, 1800 Elmerton Avenue, Harrisburg, PA*

Upon completion of this workshop, participants will gain an appreciation for the requirements to develop and run a digital evidence unit. Additionally the participants will have a fundamental understanding of the costs and steps required to set up a unit within their agencies.

Computers, cellular phones, e-mail, and digital cameras have changed how people live and work. New technologies, which produce evidence stored and/or transmitted in digital form, are presenting investigators with new forensic needs. The fragile nature of digital evidence and the dynamic nature of the technology are creating new challenges for forensic laboratories. This workshop, which will be presented by the Scientific Working Group for Digital Evidence (SWGDE), will cover a wide range of topics in the continually growing field of digital evidence. The program will provide an overview of common problems (including costs), how things have changed in the past two years, and will provide a heavy focus on how digital evidence fits in with the laboratory accreditation process.

Digital Evidence, Cybercrime, Computer Forensics

W23 Non-Human DNA Typing: Methods and Casework Applications

Heather G. Miller Coyle, PhD, Connecticut State Forensic Science Laboratory, 278 Colony Street, Meriden, CT; Albert B. Harper, PhD, JD*, University of New Haven Institute of Forensic Science, 300 Orange Avenue, University of New Haven, West Haven, CT; Robert A. Bever, PhD, The BODE Technology Group, Inc., 7364 Steel Mill Drive, Springfield, VA; Margaret A. Sanger, PhD*, HIDTA Marijuana Signature Lab, 100 Sower Boulevard, Suite 10, Frankford, KY; Joselle Germano-Presby*, Connecticut State Forensic Science Laboratory, 278 Colony Street, Meriden, CT; Kristen N. Zinnamon, BS, Northern Arizona University, Department of Biological Sciences, P.O. Box 5640, Flagstaff, AZ; and Marilyn A. Menotti-Raymond* and Victor A. David, MS*, National Cancer Institute, National Institutes of Health, Building 560, Room 11-38, Fort Detrick, Frederick, MD*

This workshop is designed to introduce the audience to new ways to look at plant and animal evidence when limited human biological evidence is available, or for use in specialized casework or paternity applications; to inform the audience about DNA typing techniques that are in use or under development for both the identification of a species and the individualization of a sample; to inform the audience as to the best ways to collect the evidence, whom to contact for sample processing, what types of results to expect, the benefits and limitations of each procedure, and court acceptance of each technique; and, to illustrate the use of these techniques by discussing actual applications of these newer DNA typing technologies.

This workshop is designed to inform the attendees about basic DNA typing techniques that are currently available or under development for plant and animal evidence. These techniques address both the identification of a plant or animal species and methods to individualize a sample. The following topics will be discussed: analysis of trace plant evidence and how the information may be used to provide investigative leads, molecular methods to identify marijuana as a species (important for samples that have no detectable cannabinoids), the use of amplified fragment length polymorphism (AFLP) analysis to link clonal marijuana samples and cases, the construction of a nationwide marijuana AFLP database for comparative purposes, DNA analysis of wildlife species and casework, the development of an STR system for the individualization of cats and the use of DNA in a puma case where a jogger was killed. In addition, paternity testing on giant pandas bred in captivity will be described as a specialty application of DNA typing technology in animals.

Animal Identification, Plant DNA Typing, Non-Human DNA Evidence

W24 From Photoshop® to WinID — Mass Disasters and Radiographic Digitalization —What We Learned From the World Trade Center

Kenneth W. Aschheim, DDS, Mount Sinai Medical Center, 44 East 67th Street, New York, NY; and Jeffrey R. Burkes, DDS, Office of the Chief Medical Examiner, 875 Fifth Avenue, New York, NY*

The goal of this workshop is to train the forensic specialist to set up and run a Dental Radiographic Digitalization Team for the scanning of dental radiographs for use in WinID.

This hand-on workshop will be an in depth discussion of the digitalization (scanning) of radiographs and its application in dental forensics. It will begin with a basic background discussion of digital graphics, the terminology used, and the relevancy to forensic identification. The program will cover different graphic formats and the pros and cons of each type as they relate to WinID. Next there will be a discussion of computer basics with an emphasis on the minimum hardware and software requirements for forensic identification. The lecture will then focus on an actual step-by-step discussion of image correction, enhancement, and annotation. The final segment of the presentation will be a complete discussion on the requirements on how to set up a Dental Radiographic Digitalization Team for mass disaster.

WinID, Adobe Photoshop®, Radiographic Digitalization

W25 Asthma - Prevalence, Treatment, and Death Investigation

Amanda J. Jenkins, PhD, Cuyahoga County Coroner's Office, 11001 Cedar Avenue, Cleveland, OH; Rebecca A. Jufer, PhD*, State of Delaware, Office of the Chief Medical Examiner, 200 South Adams Street, Wilmington, DE; Kevin J. Kelly, MD*, Kameswari Konduri, MD* and Michael Zacharisen, MD*, Medical College of Wisconsin, Allergy and Immunology Clinic, Children's Hospital, 900 West Wisconsin Avenue, Milwaukee, WI; Jimmie L. Valentine, PhD*, University of Arkansas for Medical Sciences, 800 Marshall Street, Little Rock, AR; and Michael J. Caplan, MD*, State of Delaware, Office of the Chief Medical Examiner, 200 South Adams Street, Wilmington, DE*

Upon completion of this workshop, the participant should be able to understand basic asthma mechanisms and how asthma is diagnosed; to demonstrate a knowledge of the prevalence of asthma and asthma related deaths; to demonstrate a knowledge of various asthma treatment

strategies; to demonstrate an understanding of the toxicology and analysis of asthma pharmacotherapies; and, to understand the pathological and toxicological findings that may be present in the investigation of asthma related deaths.

The speakers in this workshop include clinicians involved in the treatment of asthma as well as a forensic toxicologist and a forensic pathologist involved in the investigation of asthma-related deaths. The program will discuss the biochemical and physiological basis of this disease; will describe the procedures used to diagnose asthma; and, will delineate treatment therapies including lifestyle changes, the pharmacologic basis of drug therapy, and the usefulness of therapeutic drug monitoring. The toxicology of asthma medications will be addressed, including interpretation of clinical and postmortem results. Lastly, the pathological aspect of the medicolegal investigation of possible asthma deaths will be presented with illustrative case examples.

Death Investigation, Analytical Toxicology, Asthma

WS1 Disputed Confessions: False, Forced, and Fine

Michael Welner, MD, The Forensic Panel, 224 West 30th Street, #806, New York, NY; Sheldon Greenberg, PhD*, Johns Hopkins University, 201 North Charles Street, Baltimore, MD; Gisli H. Gudjonsson, PhD*, Department of Psychology, De Crespigny Park, Denmark Hill, London, England, United Kingdom; and Welsh White, BA, LLB*, University of Pittsburgh, School of Law, 305 Law School Building, Pittsburgh, PA*

At the conclusion of this program, the participants will be familiar with research findings to date about those more likely to confess falsely, why they do so, confounding controversies, and how to assess this matter as a forensic examiner.

Confession evidence has undisputable power on jury decision-making in criminal cases. A number of reports from the literature in recent years have called attention to the potential for miscarriage of justice when confessions are forced, or false.

Research spawning from these reports has focused on those qualities that prompt individuals to confess to crimes they did not commit. From his earliest work with Icelandic offenders, Gisli H. Gudjonsson, PhD, a police officer-turned-psychologist identified suggestibility and compliance as important qualities that correlated with the likelihood of disputed confessions. Dr. Gudjonsson's work spurred reform in the British system in questioning of certain vulnerable populations, such as the mentally retarded.

Here in the U.S., disputes over confessions may be the pivotal battle of an otherwise ambiguous case. The controversy of disputed confessions has gained further attention from death row inmates whose sentences were overturned by contradictory evidence, but who had facilitated their convictions with confessions that later turned out to be coerced.

How prevalent is the phenomenon of false or forced confessions? The very question has spawned controversy, especially since articles in respected medical literature have been cited as the scientific underpinning of presentation of expert opinions before juries on the matter.

The panel includes the perspectives of important sides of this integral part of the justice system. Participants will learn of the research to date on why people confess, as well as those who later dispute their confessions. Dr. Gudjonsson's work, as well as that of others, will be presented for review.

From this review, populations at particular risk to false or forced confessions will be discussed with particular attention to what has and has not yet been established about risk factors. This is of particular importance given the ongoing controversy of the exact role that expert witnesses should be playing before juries who are pondering disputed confessions.

The controversy of prevalence is then presented, with a closer look at how cases represented as false or forced confessions may not be just that. In particular, one of the presenters will discuss his review of the widely cited case of *Leo and Ofshe* that loudly alerted courts to the potentials for miscarriage of false confessions.

Next, an expert in police science reviews how law enforcement interrogation procedures have evolved to minimize the risk for false confessions or those that lose evidentiary value.

Finally, a forensic psychiatrist presents guidelines for assessing disputed confession cases, from required evidence, to areas to probe, to the use of psychological testing.

Participants in law enforcement, legal professionals, and behavioral scientists will learn much of the background and state of the art of this compelling frontier of forensic science.

Forensic Psychiatry & Psychology, Confession Evidence, Jurisprudence

WS2 Forensics Takes to the War on Terror — *Flatlow vs. Iran*

Michael Welner, MD, The Forensic Panel, 224 West 30th Street, #806, New York, NY; Joseph Shelly*, 6301 Riverdale Avenue, New York, NY; and Meir Rogev, MD*, Zamenhof 11 Flat #1, Tel Aviv, Israel*

At the conclusion of this program, the participants will be familiar with legal remedies pursued by victims of terror, with the role of forensics in contributing to these cases, and with the constraints faced in pursuing such claims.

The recent decades have acquainted the world with air piracy, kidnappings, bombings, and random shootings. While local gangsters carry out many terror incidents, other acts prove to be sponsored by governments pursuing their own agenda through destructive means.

The September 11 hijackings awakened resolve and feelings of revenge in those affected and offended by the instrumentality of terror. All Americans have an appreciation for the tremendous losses of those killed, injured, orphaned, or displaced by the terror, and for now, shoulder the burden economically as well. Is there any recourse for Americans terrorized? The possibilities expanded with the success of *Flatow vs. Iran*.

1995, Alisa Flatow, a 21-year-old New Jersey native, was killed by a terrorist bomb that blew up a bus she was riding in the Gaza Strip, an area under Palestinian-Arab rule. Alisa's father Stephen pursued a legal remedy, and through attorney Thomas Fortune Fay, tracked the genesis of the terror attack to the government of Iran. Working within the parameters of the Anti-Terrorism and Effective Death Penalty Act, and the Foreign Sovereign Immunities Act, Fay sued Iran in U.S. federal court and won a judgment of 100 million dollars.

But that was just the beginning.

The period following has witnessed a fascinating sequence of events that chart the future of the war on terror. What damages can be claimed? What assets are recoverable? How are those assets to be found? The ongoing political maneuvering pits Congressional representatives drafting legislation to protect their constituents against not only foreign terror, but also the U.S. State Department and American big transnational interests.

Forensics has an important role to play in terrorism investigation in relation to event reconstruction, explosives expertise, pathology, assessment of the emotional injury of survivors, tracing the clandestine money trail, and identifying recoverable assets.

Attendees will learn of the background and constraints of fighting the war on terror in the courts. Limits of immunity, available targets, progression of legislation, and what participants can do to enlist will be discussed.

A veteran forensic pathologist with expertise in explosives and munitions will then present the science of reconstruction and how it relates to establishing links with state-sponsored terror.

Next, a forensic psychiatric review of the effects of terror on survivors, victims, and significant others, and how these events distinguish

themselves from other traumas. The effects of litigation on emotions and coping will also be presented.

The attorney at the heart of the *Flatow* case discusses the potentials and pitfalls to pursuing such cases. The forensic accounting of establishing responsibility is presented, along with the necessary steps to identifying recoverable assets. A look at how this is addressed in other countries follows.

Participants will gain an intimate understanding of legal approaches to the war on terror, and an appreciation for the role they can play as forensic scientists in consulting on cases that aim to pace the burden for remedy on the terror nations, rather than the people that terror targets.

Forensic Accounting, Forensic Psychiatry, Terrorism

WS3 Death in Beirut

Richard C. Froede, MD, 3930 North Placita de la Escarpa, Tucson, AZ; William C. Rodriguez III, PhD*, Office of the Armed Foreces Medical Examiner, 1413 Research Boulevard, Building 102, Rockville, MD; and John J. McDermott*, Hall, Estill, Hardwick, Gable, Golden & Nelson, Washington, DC*

Upon completion of this workshort, the participant will have an understanding of a historical kidnapping and forensic investigation and will gain an appreciation of the amount of time and effort in an investigation of terrorist activity.

The previously untold story of the kidnapping and subsequent deaths of two hostages, William R. Higgins, LTC, United States Marine Corps, and William F. Buckley, LTC, United States Army, in Beirut, Lebanon may now be told. The investigative findings in the deaths in 1985 and 1989 and the discovery as well as recovery of the bodies may be revealed. The subsequent identification of the bodies and the postmortem findings will be presented. Details of the "alleged hanging" of Col. Higgins in July 1989 will be discussed. Video presentations will be shown of the prepared statement by Col. Higgins, the digital identification by the Federal Bureau of Investigation, the evaluation of the "hanging," and of the story of Col. Buckley's activity in Lebanon. The plaintiff's attorney will present an analysis of the two trials in the U.S. District Court against the Islamic Republic of Iran, Ministry of Foreign Affairs.

Kidnapping, Identification, Recovery

B1 Alternative DNA Structures and Their Effect on Polymerase Activity in Polymerase Chain Reactions

Julie L. Langdon, MS, and Stephen A. Winkle, PhD, Florida International University, 8th Street, Miami, FL*

The goals of this presentation are to emphasize the importance of thoroughly researching the STR loci chosen for forensic DNA profiling.

This presentation will provide evidence that incorrect products can be obtained by Polymerase Chain Reaction when amplifying regions that have the potential of containing alternate DNA structures.

Polymerase Chain Reaction (PCR) is an enzymatic method currently used to amplify the Short Tandem Repeat (STR) loci used in forensics. Research has found that alternate DNA structures can modify polymerase activity. This is important for forensics because repeating DNA has been implicated in the formation of alternate DNA structures. To further investigate the effects of alternate DNA structure on polymerase activity, this study investigated the polymerase activity during PCR of a potential cruciform region and an alternate $(GC)_3$ region in the ϕX174 bacteriophage.

PCR products obtained by using various extension temperatures or magnesium concentrations were investigated using polyacrylimide gel electrophoresis, denaturing gel electrophoresis, and restriction enzyme digestion. Extension temperature and magnesium concentration was chosen to study because both factors can directly affect the polymerase activity during PCR. The results showed an increase in the amplification yield of the cruciform region when using a lower extension temperature (52ºC), while producing a very low amplification yield at the standard 72ºC extension temperature. The study also indicated the presence of stutter in the $(GC)_3$ region as the magnesium concentration increased. Prior to PCR, linearization of ϕX174 was completed to alleviate negative supercoiling, which is necessary for extrusion of the alternate DNA structures. The amplification of the cruciform region improved suggesting the presence of an alternate DNA structure reduced amplification prior to linearization. *Hha*I digestion of the cruciform region PCR product was altered signifying that the local sequence induces a structural deviation even in the absence of negative supercoiling.

In conclusion, this study demonstrated that Polymerase Chain Reactions are influenced by the presence of alternate DNA structures in the template DNA. The study also suggested that the formation of alternate DNA structures is influenced by the local DNA sequence even in the absence of negative supercoiling, therefore suggesting that even after PCR alterations in the amplified product may exist. These results suggest that the fidelity of forensically relevant STR loci may be affected if the loci have the ability to contain alternate DNA structure. The presence of an alternate DNA structure in the loci may cause a variation in the polymerase activity during PCR and therefore may inadvertently cause incorrect DNA profiling. This suggests the need to study the loci presently used or any loci developed to eliminate the possibility that the loci may exist as alternate DNA structures.

PCR, Alternate DNA Structures, STRs

B2 Selective Separation of Sperm and Vaginal Epithelial Cells on Microfabricated Devices for Forensic Analysis

Katie M. Horsman, MS, Department of Chemistry, Jerome P. Ferrance, MSE, PhD, Department of Chemistry and Department of Pathology, and James P. Landers, BS, PhD, Department of Chemistry, The University of Virginia, McCormick Road, P.O. Box 400319, Charlottesville, VA*

The goal of this presentation is to demonstrate the potential of microchip technology for the separation of sperm and vaginal epithelial cells in rape kit analysis.

DNA analysis has proven to be a valuable technique used to identify the perpetrator of a crime. Such analyses have had the greatest impact on the investigation of crimes involving sexual abuse, specifically rape. Unfortunately, current methods for DNA analysis in crime labs require approximately two weeks to complete. These time-consuming methods, along with a lack of appropriate funding, have led to a major backlog of cases to be analyzed. Because of this backlog, it is not uncommon for the evidence to be stored for six to nine months before being analyzed, if ever.

The ultimate goal of the current research presented focuses on reducing this backlog of rape kits needing DNA analysis by exploiting bioanalytical microdevice fabrication techniques. The successful development of a microfabricated device that could expedite this particular analysis would significantly reduce the analysis time, potentially from several weeks to approximately twenty minutes. Ultimately, this microchip will be fully integrated, that is, it will incorporate all of the necessary processing steps for complete analysis, from sample preparation to forensic DNA evaluation. These steps include: removal of the cells from the vaginal swab, separation of the sperm and epithelial cells, extraction of DNA from both sperm and epithelial cells, PCR amplification of the DNA, separation and detection of the PCR products. Introduction of this microchip technology to the forensic community will revolutionize forensic DNA analysis.

Not withstanding the ultimate goal of a micro-total analysis system (□TAS), microchip methods for the cell separation step alone will be advantageous to the forensic community. The proposed microscale method is much faster than the current differential lysis method. The time-consuming and labor-intensive preparatory steps translate directly into cost-ineffectiveness. Sample handling is significantly reduced in the microchip cell separation as compared to the current macroscale method, resulting in decreased chance of contamination and fewer opportunities for loss of biological material.

Development of a microchip for the selective separation of the sperm and epithelial cells is the focus of the research presented in this poster. Because the macroscale method is not easily transferable to a microscale process, new methods for sorting the male and female fractions were explored. Physical properties of the cells, such as density, size, and shape, are exploited as methods of sorting, rather than reverting to the more-complicated magnetic bead and/or antibody-based approaches. Gravity, pressure-driven, and electric field-driven flow have been explored to determine the best method of cell separation in the microchannel. These flow mechanisms are used to achieve a slow, stable flow of ~1 nL/sec. The sperm cells are concentrated in a designated sperm cell chamber, and the epithelial cells are retained in the sample reservoir. These cells can be subsequently lysed for DNA analysis or the microchip used as the storage vessel for analysis at another time. Methods for detection of sperm cells recovered, including electrical impedance detection and photodiode array detection, were

investigated. By integrating a detection method into the cell separation microdevice, the purity and quantity of the sperm cell fraction can be assessed. Preliminary experiments used digital video microscopy to show the efficiency of separation. Optimum cell separation conditions have been determined and will be presented in this poster presentation.

Differential Extraction, Cell Separation, Microchip Technology

B3 Validation of the AmpF*I*STR Identifiler™, Profiler Plus™, and COfiler™ STR Kits on the 3100 Capillary Electrophoresis Detection Platform

Nicholas CS Yang, BS, MFS, Heather Miller Coyle, PhD, Jennifer L. Hintz, MS, Eric Carita, BS, Carll Ladd, PhD, Timothy M. Palmbach, MS, JD, and Henry C. Lee, PhD, Department of Public Safety, Division of Forensic Scientific Services, 278 Colony Street, Meriden, CT*

The goal of this presentation is to validate the Identifiler™, Profiler Plus ™, and COfiler™ STR kits on the Applied Biosystems/Hitachi 3100 Capillary Electrophoresis platform for use in typing of convicted offender blood samples for the Connecticut Sex Offender DNA Database.

The Identifiler™ STR kit amplifies 15 STR loci (the core CODIS 13 STRs + D2S1338 + D19S433) and Amelogenin in a single reaction. The primary benefit of a single amplification system is the increased throughput achieved for processing specimens such as convicted offender database samples. In addition, there is a reduction in paperwork and tube labeling which minimizes the opportunity to mislabel or switch a sample during the processing procedure. A double amplification system (Profiler Plus™ and COfiler™), while providing a sample check by having overlapping loci between the two systems, results in twice the amplification preparation and run time per sample when compared to the Identifiler™ kit. The greater throughput volume of the ABI 3100 instrument makes it an ideal detection platform for databasing. The Profiler Plus™ and COfiler™ systems were also validated on the ABI 3100 detection platform for known sample processing to introduce additional flexibility in the laboratory.

In assessing the Identifiler™ kit and comparing to Profiler Plus™ and COfiler™ results, 1 nanogram of input DNA was amplified in a 25 µl reaction volume. A final extension step of 90 minutes at 60°C was added to the thermal cycling parameters. Within each run, capillary-to-capillary precision for each of the locus in the Identifiler™ kit was in the standard deviation range of 0.02-0.10 nucleotides and the Profiler Plus™ and COfiler™ loci were comparable to the Identifiler™ kit. Capillary precision between runs was calculated for each locus and the values for the ABI 3100 instrument were well below the 0.15 nucleotide standard deviation specification set by Applied Biosystems, Inc.

However, on occasion, a standard deviation value of 0.19 nucleotide was observed for the FGA locus. To correct for this, it is important to follow ABI recommendations for injecting at least 1 ladder per run on the instrument. The average stutter values (Identifiler™) were calculated for each locus and were as follows: D8S1179 (6.3%), D21S11 (9.1%), D7S820 (5.4%), CSF1PO (6.3%), D3S1358 (6.3%), THO1 (3.2%), D13S317 (8.1%), D16S539 (7.2%), D2S1338 (10.0%), D19S433 (5.0%), vWA (7.2%), TPOX (6.3%), D18S51 (6.8%), D5S818 (7.2%), and FGA (5.4%). The stutter values from Profiler Plus™ and COfiler™ systems were comparable to the Identifiler™ on the ABI 3100 instrument. For all three amplification systems, full STR profiles were obtained from 1 nanogram of DNA template; however, the sensitivity of the ABI 3100 instrument allowed the obtaining of profiles from as low as 100 picograms of input DNA template. In addition, the Profiler Plus™ and COfiler™ profiles generated on an ABI 377 instrument were concordant with those profiles generated on the ABI 3100 CE instrument.

In summary, this validation study demonstrates that the results of the Profiler Plus™ and COfiler™ amplification kits are comparable on the ABI 3100 instrument to the ABI 377 instrument. Identifiler™, as a single megaplex amplification system in combination with the use of the ABI 3100 instrument, does improve the handling and abbreviates the preparation time resulting in increased throughput processing of convicted offender samples. Moreover, the profiles generated by the Profiler Plus™ and COfiler™ kits were in agreement with the profiles generated by the Identifiler™ kit.

Identifier, ABI 3100, Concordance

B4 Concordance Study of STR Results Using Multiple ABI PRISM® Genetic Analysis Instruments, AmpF*I*STR® Kits, and ABI PRISM® Analysis Software

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The goals of this presentation are to present a concordant study using multiple ABI PRISM® genetic analysis instruments, AmpFLSTR® kits, and ABI PRISM® analysis software to demonstrate that accurate STR profiles are obtained.

Significant advances in the combination of reagents, instruments, and software have increased throughput capabilities for the profiling of casework samples and database samples in the human forensic and parentage communities. Multiplex assays amplifying greater than ten (10) STR loci, combined with higher-throughput instrumentation and higher-performance software have been developed by Applied Biosystems (Foster City, CA, USA) that allow laboratories to better address the demands of casework and databasing needs. Concordance studies are important to perform when evaluating a new assay, instrument, or software package.

The authors have conducted a comprehensive concordance study of STR profiles generated with six (6) different AmpFLSTR® PCR Amplification kits, analyzed on three (3) ABI PRISM® genetic analysis instruments, and using various ABI PRISM® software packages for both data collection and data analysis. This study presents an evaluation of STR profiles generated with different combinations of kits, instruments, and software (described as "systems" in this abstract) and illustrates: (1) verification of software packages; (2) comparison of instrument platforms with identical PCR products; and, (3) concordance in genotyping.

Six AmpFLSTR® PCR Amplification kits (Identifiler®, Profiler Plus™ ID, Profiler Plus™, COfiler®, SGM Plus®, and SEfiler™ kits) were used in evaluating a panel of forensic-simulated samples (e.g., stains, mixtures, degraded DNA). The AmpFLSTR® kits combine STR loci that meet CODIS, ENFSI, GITAD, and GEDNAP standards. All kits are multiplex assays that co-amplify six (6) to fifteen (15) tetranucleotide repeat loci and the Amelogenin gender-determining marker. For example, the Identifiler® kit amplifies all 13 loci required for CODIS, and the loci D2S1338 and D19S433. The combination of these 15 loci meets the requirements of several worldwide database recommendations. Furthermore, the SGM Plus® kit co-amplifies ten (10) tetranucleotide loci consistent with the Identifiler® kit (D2S1338, D3S1358, D8S1179, D16S539, D18S51, D19S433, D21S11, FGA, TH01, and vWA). Concordant genotype results are achieved regardless of the system used by various counties, states, or countries. These concordant results can support the forensic investigation of blind hits across jurisdictional lines, even internationally. This study demonstrates that inter-jurisdiction and even international database matching is possible worldwide with different system configurations.

Selected samples were processed on the ABI PRISM® 310 Genetic Analyzer (for both Macintosh® and Windows NT® operating systems),

377 DNA Sequencer (for both Macintosh® and Windows NT® operating systems), and 3100 Genetic Analyzer. All samples were then analyzed using both GeneScan® software and Genotyper® software, or GeneMapper™ ID software. Data were analyzed with GeneScan® software version 3.7.1 and Genotyper® software version 3.7, for use with Windows NT® OS; GeneScan® software version 3.1.2 and Genotyper® software version 2.5.2, for use with Macintosh® OS; and GeneMapper™ ID software in the following modes: Basic, Classic, or Advanced.

The presentation will include a comparison of the profiles generated from these samples and kits on the different systems listed above. Enhanced features of each system will be presented to demonstrate ease-of-use and throughput capabilities. Generated electropherograms and genotype profiles will be presented. The data support that these systems, regardless of the instrument, kit, or software, will produce accurate genotype profiles for comparative analyses. These analyses can then be used by databasing laboratories, criminal casework laboratories, identification laboratories, and parentage laboratories to report accurate genotypes.

Concordance Study, AmpFLSTR® Kits, Genotype

B5 Sonication Removal of Cellular Material From Nail Clippings and DNA Typing of Separated Components

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The goals of this presentation are to present the forensic community with an efficient method for removal of foreign cellular material from fingernail clippings followed by a rapid method for washing the nail material, such that removed cellular material and the nail can be individually typed using PCR DNA technology.

This poster presentation will introduce a routine processing method for fingernail clippings submitted as evidence for DNA typing. This method allows for rapid and efficient separation of nail material from foreign cells adhering to the nail prior to DNA typing and results in little product loss from either component. This is useful for addressing a variety of forensic questions that may arise; typing of the material beneath a nail is important in cases where victims have struggled in defense, while typing of a fingernail fragment can be used to associate an individual with a crime scene.

The method described employs soaking and sonication to remove cellular components adhering to the nail. With the nail material suspended in a filter basket, cellular components removed from the nail were pelleted by centrifugation and the supernatent removed from the cell pellet. The pelleted fraction was then referred to as fraction A. Should dividing this fraction become necessary, the resulting pellet may be resuspended in a known quantity of buffer and divided into equal halves. The nail material itself is then subjected to a sonication wash, a vortex wash, and a shaking wash to remove any trace amounts of remaining foreign material that may adhere to the nail. The cleaned nail material is then referred to as fraction B. Pellets (fraction A) and nail material (fraction B) can then separately undergo DNA extraction and typing.

Fingernail clippings from individuals were collected and treated with blood or semen originating from sources other than the fingernail donor to simulate forensic casework situations. Nails were also collected following vigorous scratching of a second individual. These nails, as well as untreated nail material, underwent the standard protocol for processing fingernail fragments. Resulting fractions were separately extracted using an organic extraction methods by Microcon® (Millipore, Corp., Bedford, MA) concentration and purification of the DNA. For nails treated with seminal material, the resulting pellets underwent a differential extraction designed to first isolate that portion of the sample containing "non-sperm" cells (referred to as the F1 portion of fraction A) and secondly to isolate DNA from all remaining cells including the sperm cells (referred to as the F2 portion of fraction A). Extracted DNA from all samples was quantified using 1% agarose yield gel analysis in conjunction with the QuantiBlot® (Applied Biosystems, Foster City, CA) human DNA quantification kit. Samples were then amplified using the PowerPlex™1.1 and Amelogenin Sex Identification Systems (Promega Corp., Madison WI) and amplified products were detected by fluorescent imaging for genetic loci CSF1PO, TPOX, Amelogenin, TH01, vWA, D16S539, D7S820, D13S317, and D5S818 using the Hitachi FMBIO® II Fluorescent Imaging Device (MiraiBio Inc., Alameda, CA). Following initial protocol development and validation, the processing method was applied to a forensic case in which one fingernail of unknown origin and one fingernail of known origin were submitted for PCR DNA analysis.

The DNA profiles obtained from both fractions of the untreated nail were consistent with the profile of the nail donor. This indicates that the quantity of cellular material present beneath the nail is sufficient for DNA typing. However, studies have indicated that when nails are treated with body fluids foreign to the nail donor, cellular material suitable for DNA typing was efficiently removed from the nail such that the contributors of foreign cells and the donor of the nail were easily differentiated. In cases where carry-over between fractions occurred, identification of a major contributor was possible, therefore alleviating the need for interpreting complex mixtures. This was true of both the blood-treated nail and the semen-treated nail. Clear major contributors were apparent in the non-sperm fraction of the pellet (AF1), the sperm cell fraction of the pellet (AF2), and the nail fraction (B). Profiles obtained from fractions AF1 and B were consistent with the nail donor, while the profile obtained from fraction AF2 was consistent with the seminal donor. However, in scratching studies, profiles obtained from both fractions (A and B) of the extracted nails yielded profiles consistent with the nail donor only; these findings are consistent with those previously reported by Oz and Zamir[1]. This is likely due to the limited quantity of cellular material transferred to the nail during the scratching process relative to that already present beneath the nail from the donor. With respect to forensic casework applications, the pellet fraction (A) of the nail of known origin yielded a single-source profile consistent with that of the donor; the nail fraction (B) was not typed since the origin was known. However, a mixture of at least two individuals was obtained from the pellet fraction (A) of the nail of unknown origin, while the nail fraction (B) yielded a single source profile. The nail fraction (B) profile could not be excluded from the pellet mixture profile, allowing for interpretation of obligatory alleles from other possible contributors present within the pellet fraction (A) profile.

In conclusion, the method employed for separation of nail material from foreign components proved efficient for most samples where a sufficient quantity of cells from the foreign source were deposited on the nail. Because this method allows for the separate typing of nail and adhering cellular material, it can be applied in a standard manner regardless of the forensic question at hand.

[1]Oz, C, Zamir, A. An evaluation of the relevance of routine DNA typing of fingernail clippings for forensic casework. *J Forensic Sci* 2000;45(1):158-160.

Fingernail, PCR DNA Analysis, PowerPlex™ 1.1

B6 The Analysis of Ignitable Liquid Residues and Explosive Material Using SPME/ GC/MS/MS

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This presentation will describe a comprehensive approach to improve the operating procedures of GC/MS and GC/MS/MS for the analysis and identification of ignitable liquid residues and to determine the absolute detection limits for the widely used GC/MS method and a proposed GC/MS/MS method for the organic class of compounds in a standard accelerant mixture (SAM). The analysis of explosives material will also be evaluated using SPME/GC/MS and SPME/GC/MS/MS.

Fire debris evidence from suspected arson cases and post-blast debris evidence from suspected explosions can be significantly degraded or destroyed during the crime and the subsequent scene recovery effort in such a manner that it is sometimes difficult to identify the compounds of interest. All aspects of the analysis of both types of debris must be evaluated in order to create a method for extraction, separation, analysis, and interpretation that will produce the best information for the investigators and, eventually, the tiers of fact.

Solid phase micro-extraction (SPME) provides some improvements over the use of activated charcoal strips (ACS) in the analysis of fire debris and explosive evidence due to its selectivity, cost, ease of use, shorter extraction times, and solvent free extractions. This presentation will briefly describe a comprehensive approach to improve the operating procedures of GC/MS and GC/MS/MS for the analysis and identification of ignitable liquid residues (ILR) and explosives in addition to looking at the use of SPME as an extraction technique.

A Varian 3400 Gas Chromatography instrument is used for separation while a Varian Saturn 2000 Ion Trap Mass Spectrometer with MS^n capabilities is used as a detector. Solid phase micro-extraction sampling of residues from debris containing ignitable liquid residues and organic explosives was compared to the more traditional method of activated charcoal strips. Standards are used to determine the analytical detection limit for the MS and MS/MS method in the presence and absence of background matrix products. SPME is also evaluated against activated charcoal strips to determine the absolute detection limits of target analyte compounds in the typical debris sample. The SAM compounds were studied for the ILR and the following high explosives were also studied: nitrobenzene, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, nitrobenzene, 1,3-dinitrobenzene, 2,4-dinitrotoluene, 2,4,6- trinitrotoluene, 4-amino-2,6-dinitrotoluene, 2-amino-4,6-dinitrotolene, tetryl, RDX, HMX, EGDN, PETN and nitroglycerine.

SPME/GC/MS/MS is demonstrated to improve the selectivity and sensitivity for the analysis of ILR compounds in the presence of pyrolysis products. This simplified method also reduces the background material in the extraction of organic explosives from a complex matrix. SPME/GC/MS/MS shows a great potential for incorporation into the standard analysis protocols of both ILR and high explosives analysis.

Additional work will involve studying ion-molecule interactions within the ion trap detector in order to best identify and characterize those compounds that are characteristic of explosives, ignitable liquid residues, and of pyrolysis products found in scene debris and from other sources.

Fire Debris Analysis, SPME, Explosives Analysis

B7 A DNA Paternity Case Involving a Two-Week Old Fetus

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The goal of this presentation is to present the techniques utilized in the preservation, preparation, and DNA analysis of a two-week old aborted fetus.

A woman was raped on July 5, 2001, which resulted in pregnancy. The pregnancy was verified through an ultrasound, and was terminated via a vacuum dilatation and curettage (D&C) on August 1, 2001. The product of conception specimen was collected and shipped through overnight delivery on ice, along with whole blood specimens from the mother and alleged rape suspect. All samples arrived at the laboratory eight days after the D&C procedure was performed on the victim.

The product of conception sample consisted of several pieces of tissue surrounded by a piece of gauze placed in a specimen container. Upon arrival, the sample was immediately examined visually. Segments of tissue were placed into four paraffin block cassettes and immersed in formalin to initiate the tissue fixing process. The four tissue cassettes were soaked in formalin for eight days and then were embedded into four corresponding paraffin blocks. A slide corresponding to each paraffin block was cut and stained for microscopic examination. A specialist in the field of Prenatal, Perinatal and Placental Pathology with the Armed Forces Institute of Pathology examined each of the four slides for the presence of fetal and placental cells (chorionic villi), which contain the same genetic profile of the fetus. Areas consistent with fetal tissue and/or placental tissue were marked on each slide. The marked areas on the slides were associated to their corresponding paraffin blocks, and these areas were targeted for DNA extraction.

A chelex extraction was performed on one of the slides that microscopically demonstrated the presence of fetal cells. STR analysis using AB's Profiler Plus system was performed, and limited data containing a mixture of the mother and the fetus was obtained. An organic extraction of the tissue in the corresponding paraffin block was performed, and a full STR profile containing a mixture of the mother and the fetus was obtained. The mixture results obtained from the product of conception contained half allele share with the alleged suspect in all nine loci analyzed. The suspect could not be excluded as the father of the product of conception, with a probability of paternity of 99.99%.

The opinions and assertions expressed herein are solely those of the authors and are not to be construed as official or as the views of the U.S. Department of Defense or the U.S. States Department of the Army.

Paraffin Blocks, Product of Conception, Probability of Paternity

B8 Comparative Analysis of the DNA IQ™ and QIAamp DNA® Extraction Kits for the Processing of Forensic Evidentiary Samples

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Participants will be able to evaluate the differences in DNA yield and the subsequent ability to amplify the DNA that has been extracted using alternative isolation methods in conjunction with more traditional extraction methods. The nature of these differences, specifically between the DNA IQ, QIAamp, organic extraction protocols, will be discussed.

Experiments which compared the DNA IQ™ and QIAamp® extraction systems to the more traditional phenol/chloroform and Chelex® methods were performed. The DNA extraction kits chosen were based on DNA yield, ability of resulting DNA to amplify, ease of use, efficiency, and the potential for robotic automation. The data were compiled to evaluate total DNA yield, DNA concentration and amplification performance of the resulting extracts. Because the final volume may affect the amount of DNA needed for amplification, additional steps may be required which concentrate the DNA sample prior to amplification.

Data were collected to evaluate two main issues. The first issue is the difference in DNA yield obtained when different isolation procedures were used. The second addresses an evaluation of the ability of the DNA obtained from each of the extraction procedure to amplify. To evaluate DNA yield, cells from blood, semen and mixed stains were lysed (SDS/Proteinase K). The substrate was then removed and the resulting lysate was then serially diluted (1, 2, 4, 8, 16-fold dilutions) to evaluate DNA recovery, particularly when a minimal amount of DNA is available. Each sample in the series was then split into 5 separate sets: 1) QIAamp® extraction with a 25ul elution volume, 2) QIAamp® extraction with a 200ul elution volume, 3) DNA IQ™ extraction with a 25ul elution volume, 4) DNA IQ™ extraction with a 200ul elution volume, and 5) an organic extraction suspended in 25ul. DNA yield from each extraction method was determined using the QuantiBlot® Human DNA Quantitation kit (ABI) and the results were calculated using the BioImage. To evaluate amplification performance, each sample was diluted to a concentration of 0.75ng/10ul and was amplified using the AmpFlSTR Profiler Plus™ PCR Amplification kit. It was observed that the DNA concentration of some samples eluted in 200ul was too diluted to amplify the target DNA amount without further concentrating the samples.

Because sample recovery during concentration is a concern, experiments were performed that compared sample recovery during an alcohol precipitation versus the amount of sample recovered during a Microcon® filtration procedure. The samples that were eluted in 200ul of elution buffer were concentrated using both of these methods and subsequently quantified using the QuantiBlot® kit.

The results of these experiments show a relative difference in the ability of each system to capture/elute DNA, with the QIAamp® (200ul elution) resulting in the highest DNA yield for all samples in the dilution series. It was also observed that although the elution volume affected the QIAmp® yield, it did not affect the DNA IQ™ results. The DNA yield obtained after concentration indicated DNA recovery was slightly higher during the Microcon® than the alcohol precipitation. However, for all samples that contained less than 60ng of DNA, the total amount of DNA decreased after each concentration procedure and the percent of DNA recovered was directly proportional to the original concentration. As DNA concentration decreased, the percent of DNA recovered decreased. Does the 200ul QIAamp® elution accompanied by a Microcon® step result in a lower DNA yield than the currently used organic extraction method? Results showed that the Microcon® concentration in association with the QIAamp® 200ul elution extraction procedure, resulted in a higher concentration of DNA than the traditional phenol/chloroform procedure.

As an alternative to concentrating the samples, a 25ul elution volume was considered for the QIAamp® extraction kit. For all samples, more DNA was lost using a 25ul elution volume than was lost using a 200ul elution followed by concentration.

Although commercial DNA extraction kits offer improved efficiency and enable the rapid extraction of forensic evidentiary samples, attention must be given to DNA yield and amplification performance while maintaining the integrity of these samples in processing. This is of particular importance given that many forensic evidence samples contain very little or degraded DNA where retesting may not be possible. Therefore, a poor isolation procedure could lead to a potential loss of interpretable data. Other considerations include ease of use, elution volumes, final DNA concentration, efficiency and the potential for robotic processing.

QIAamp, DNA IQ™, DNA Extraction

B9 The Occurrence of Non-Human Products in PowerPlex® 16 Profiles in Human Bone and Tooth Samples 8-11 Years Old

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Attendees will be given an overview of the non-human product that is observed in some of the STR profiles from bone and tooth samples recovered during identification of missing persons in the former Yugoslavia.

In the region of the former Yugoslavia there are may be up to 40,000 persons still missing as a result of the armed conflicts in the 1990s with an estimated 30,000 located in Bosnia and Herzegovina. The remains of approximately 12,000 persons have been found in mass graves throughout Bosnia and Herzegovina. Due to the magnitude of the losses coupled with the condition of the mortal remains, the majority of cases currently being exhumed can not be accurately identified without DNA testing. Because of this tremendous need, the International Commission on Missing Persons (ICMP) developed a high throughput DNA testing capability that is presently testing around 1,000 bone samples per month.

The decomposition process is still on-going in many of the bodies that have been recovered resulting in a rich environment for bacterial growth and proliferation. During the analysis of bone profiles, it is observed that there are apparently non-human artifacts appearing in the range of the allelic ladder when using the Promega PowerPlex® 16 system. Some of these appear in known allelic positions and are assigned an allele number by the ABI Genotyper® software. In addition, these bacterial peaks may be of such great intensity that true human alleles are masked. These two consequences of co-amplification of bacterial and human DNA have the potential of leading to incorrect STR DNA profiling of the human DNA, thereby interfering with a successful identification process. In order to prevent false exclusions it is occasionally necessary to eliminate questionable STR alleles in the final reported STR profile even though some of these omitted peaks may be genuine.

For the purposes of this study, one-month's output of the ICMP's bone processing laboratory was scanned for the occurrence of non-human artifacts. It was observed that approximately 50% of the bone profiles have some detectable artifacts. The artifact peaks are most intense in the green dye (JOE), although, due to their intensity, it is not rare that some of them bleed through into other dyes. There is a wide diversity in the appearance of these artifact peaks and ranges from very intense, high RFU, broad peaks, to ones much like the expected peaks originating from human DNA. Their occurrence can influence analysis twofold: along with the already mentioned possibility of false profiles, their height can interfere with the successful label filtering. In the green color there are non-human peaks that interfere with the calling of alleles at: D5S818, D13S317, D16S539, CSF1PO, and Penta D. The only loci where no artifact peaks have been observed is D7S820.

Thirty-five samples that, in total, included all observed artifact peaks, were further tested to determine which primers trigger the amplification of a given product. Tests were conducted using PowerPlex 16 primer sets that had one green loci deleted. Once primer sets were identified that caused the amplification of these artifact peaks, duplex reactions were performed to further identify the primers involved in the amplification.

STR, DNA, ICMP

B10 Mitochondrial DNA Heteroplasmy Among Hairs in a Single Individual

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The goal of this presentation is to study how frequently a heteroplasmy or a mutated sequence of mitochondrial DNA (mtDNA) was observed among hairs in a single individual.

Mitochondrial DNA (mtDNA) analysis is a useful tool in forensic analysis. The advantages of using mtDNA for human identification are: (1) The many polymorphisms in the control (non-coding) region can be used to distinguish between non maternally-related individuals; (2) The mtDNA of maternally-related individuals can be used to verify the identifications; and (3) The large numbers of mitochondria per cell permit mtDNA extraction from minute or degraded samples when there is insufficient nuclear DNA. One disadvantage of using mtDNA for human identification purpose is the possibility that a heteroplasmy (different base pairs at the same mtDNA site) may exist. MtDNA analysis often applies hair samples in caseworks. The proportion of heteroplasmy varied among hairs if the person has obvious heteroplasmy in blood or saliva sample, which contains a large amount of mtDNA. Small proportion of heteroplasmy is thought to be contained in most persons, but it is not detected by normal sequencing techniques. At this time, there is no report about the frequency of hairs containing heteroplasmic or mutated sequences within a single individual by examining large number of hairs. In order to know whether heteroplasmic or mutated sequences are found in hairs in a single individual whose blood sample doesn't contain heteroplasmy by an ordinal sequencing method, DNA was extracted from many hairs of a single individual, then analyzed with DGGE method.

A total of 144 hair shafts were collected from 7 head regions (16 hairs each from the left / right frontal, temporal, and occipital regions; and 48 hairs in the parietal region of a male individual). Hair DNA was extracted by using QIAamp DNA mini kit (QIAGEN). For DGGE analysis 3 regions [HV1-B region (15998-16173: 176bp), HV1-C region (16209-16400: 192bp) and HV2-E (30-289: 260bp)] were amplified respectively with the primer attached with GC-clamp and the primer labeled with FAM. DGGE electrophoresis was performed with the DCode mutation detection system (Bio-Rad Laboratories). Then DNA were visualized with FluorImager595 (Amersham-Pharmacia). The base positions of heteroplasmies were determined by sequencing with the BigDye Terminator Sequencing kit (Applied Biosystems).

In this study, DNA from 144 hairs could be successfully amplified in all three regions, and 14 contained the heteroplasmies by DGGE analysis. Heteroplasmies were observed in all 3 regions. A hair in a right frontal region contained heteroplasmy in both the HV1-B and the HV1-C regions, and a hair in a parietal region also contained heteroplasmy in both the HV1-C and the HV2-E regions. A total of 9 hairs (4 hairs in right frontal, 1 in left temporal, 2 in right temporal, 1 in right occipital, and 1 in parietal) contained heteroplasmies only in the HV1-C region and the remaining 3 hairs (1 hair in left frontal, 1 in right occipital, and 1 in parietal) contained them only in the HV2-E region. The base position of heteroplasmy observed in thee HV1-C region were in the same area (16291) except 1 out of 11 hairs, but that in HV2-E region was different from each other. The proportions of heteroplasmy in the nucleotide position 16291 varied among hairs. Although the heteroplasmy was not observed in the blood and saliva samples of this person, his mother has the 16291 (C/T) heteroplasmy. Therefore, the heteroplasmy of this position might be derived from his mother. The origins of other heteroplasmies were unknown, but it was probably derived from the mutation during the development of hairs. These results indicate that heteroplasmies are not rare a phenomenon in hairs from a single individual. Therefore, it is sometimes difficult to decide the match of the mtDNA sequence between hairs. For the interpretation of mtDNA analysis of hairs, the existence of heteroplasmies and mutations should be taken into account and the criteria for inclusion and exclusion should be established in each laboratory.

mtDNA, Heteroplasmy, Hair DNA

B11 Improvment and Comparison of Sample Collecting Methods of SPME, Charcoal and Tenax TA Adsorption for Accelerants in Fire Debris

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This presentation will provide the attendee with improved collection techniques for accelerants with SPME, charcoal, and Tenax TA adsorption and teach proper sample selection and preparation methods depending on the types of samples.

Collection and detection of ignitable liquids from fire debris are important in determining the cause of a fire. Since 1960, various kinds of sample preparation methods, such as distillation, solvent extraction, static and dynamic headspace enrichment, solid phase micro extraction (SPME), charcoal, and Tenax TA adsorption have been introduced. Of the above pretreatment methods, SPME, charcoal, and Tenax TA adsorption procedures could be thought as convenient, sensitive, and time saving methods for collecting accelerants from fire samples. The authors studied these methods to improve the sensitivity and collection efficiency and achieve much higher decontaminate remnants from a collecting tool using a vacuum and polyethylene bag. By reducing pressure of the heated oven over pretreatment, the recovery efficiency by methods of SPME, charcoal and Tenax TA, increased and sample preparation time was shortened compared to that of static heated methods. Those methods were compared for detection limit, time savings, convenience for treating the samples to collect ignitable liquids, and so on. The detection limit of ngs for kerosene in all extraction methods was very good. The SPME method was especially convenient and sensitive but should be adsorbed every time to check extracted samples with GC or GC/MS. Extraction of accelerants by the charcoal adsorption method using polyethylene bags and heated vacuum with reduced pressure was sensitive and time saving when putting many bags in an oven at one time. Compared to the SPME technique, the extracted samples by charcoal method can be checked many times in one pretreatment. This method could be much more time saving than SPMEs. The collection of flammables by Tenax TA adsorbent was also a sensitive and convenient method and especially good for large samples. However, should too much accelerant be absorbed in the Tenax TA adsorbent, the overload for the analysis column may lead to bad separation of components. Before pretreatment with Tenax TA adsorbent, the headspace method should be carried out to check the amount of ignitable liquids contained in a sample. As mentioned above, there are merits and deficiencies in every pretreatment method, therefore, forensic chemists should select the proper method according to the types of samples. Generally, SPME, charcoal adsorption, and Tenax TA adsorption procedures showed excellent results to collect ignitable liquids from fire samples.

Collecting Ignitables, Accelerants, Fire Debris

B12 Identification of the Missing From Srebrenica

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This presentation will discuss the difficulty of identifying remains recovered from the Srebrenica area that led to the development of a large-scale DNA testing effort and the results of this effort.

During July of 1995, an estimated 7,500–10,000 people went missing in the Podrinje region of eastern Bosnia and Herzegovina. This marks the single greatest loss of life event to occur in Europe since the end of World War II and the name of the largest city in this region, Srebrenica, is now associated with the deaths of thousands of individuals. The recovery and identification of these mortal remains is complicated due to the sheer number of missing as well as the conditions of the remains. As the front lines shifted during the later months of the war, the majority of primary mass graves were disturbed and the remains they contained moved and buried in secondary or, occasionally, in tertiary mass graves. This has resulted in a severe commingling situation in which the majority of bodies has been disarticulated and are frequently scattered over a geographic region. In addition, a significant number of bodies were never buried and were left exposed on the surface.

To date, the exhumation process of the missing from the Podrinje region that began in late 1996 has resulted in approximately 6,500 body bags of human remains. Of these, roughly 1,800 contain whole, intact bodies; another 1,950 contain partial bodies of one individual, with the rest comprised of commingled remains. While difficult to precisely state the number of missing, it is estimated that approximately 4,500–5,500 individuals are represented among these 6,500 body bags.

From the years 1996–2000, a total of 73 individuals who went missing from the Podrinje region were identified. Of these, 40 were identified without DNA testing while the remaining 33 required DNA testing for confirmation. This was a painfully slow process for the families of the missing and did not give hope that the majority of the missing would be identified. It was because of this failure of other forensic identification techniques that the ICMP (International Commission of Missing Persons) developed a large-scale testing strategy that would transform the emphasis of the identification effort into a DNA led process.

Beginning in early 2000, five blood collection centers were established throughout Bosnia and Herzegovina. These centers work with local authorities and family organizations to collect blood samples from the families of the missing. The first blood samples were collected in July of 2000 and, to date, more than 30,000 blood samples have been collected from throughout the region by ICMP teams. In addition, three DNA laboratories have also been established in Bosnia and Herzegovina with the first Bosnia DNA laboratory becoming operational in May of 2001. All DNA profiles obtained by these DNA laboratories are entered into the central DNA computer housed in Tuzla where the DNA matching program is housed. The first in-country DNA match occurred on November 16, 2001 and was of a 15-year-old boy who disappeared from Srebrenica in July of 1995. By the summer of 2002, approximately 100–150 DNA assisted identifications of the missing from Srebrenica occur each month. The vast majority of these are 'blind' hits, those that had no presumptive leads. Another benefit of using DNA testing on a large-scale is the ability to reassociate remains. While the current technology is not sufficient to fully reassociate bodies that have been completely disarticulated and commingled, there are multiple cases in which the upper and lower halves of bodies have been able to be rejoined, based on DNA profiles.

As this DNA led identification process proceeds, it also serves as a gauge as to the accuracy of other techniques as they were employed for Srebrenica. For example, initial family recognition of photographs of clothing and personal effects found on the bodies of the missing from Srebrenica were found to be incorrect more than 77% of the time. Indeed, even finding personal identification cards in the pockets of recovered remains was shown not to be correctly associated with the missing person in multiple cases. Ante/post mortem comparisons on such a large number of missing produced very few leads, and even fewer closed cases. Instead, it has been the successful development and operation of a large-scale DNA testing program that has led to increasing numbers of identifications of the missing from Srebrenica.

Human Identification, Srebrenica, DNA

B13 Detection and Identification of Date Rape Drugs Gamma-Hydroxybutyrate (GHB), Flunitrazepam (Rohypnol), Lysergic Acid Diethylamide (LSD), Scopolamine, Diphenhydramine, and Ketamine by Refocused Solid Phase Microextraction High Performance Liquid Chromatography (SPME/HPLC), and Solid Phase Microextraction High Performance Liquid Chromatography Mass Spectrometry (SPME/HPLC/MS)

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The objective of this presentation is to determine if Solid Phase Microextraction (SPME) is an effective extraction technique for drugs used to commit sexual assault. SPME will be coupled to High Performance Liquid Chromatography (HPLC) with Ultraviolet detection. Confirmation of the drugs will be determined by HPLC/MS. Quantitation of the drugs will take place for direct SPME/HPLC/UV, Refocused SPME/HPLC/UV, and SPME/HPLC/MS techniques.

There is an ever-increasing need to provide a faster, cheaper, and safer means of identifying illicit drugs. Research in this area is constantly being devoted for improving detection limits and for the development of analytical devices that are portable and measure samples on-site. The wide acceptance of these faster methods could greatly reduce the drug backlog observed in many private, state, and federal crime labs. Drug detection methods incorporating Solid Phase Microextraction (SPME) offer a potential answer to this problem.

The aim for this project is to develop a rapid and sensitive method for the detection and identification of illicit, thermally labile drugs.

This research will be used to determine if Solid Phase Microextraction coupled with High Performance Liquid Chromatography (SPME/HPLC) by two six-port valves along with a unique refocusing unit is an efficient and effective method of detecting and quantifying thermally labile drugs.

The drugs to be analyzed are Gamma-Hydroxybutyrate (GHB), Flunitrazepam (Rohypnol), Lysergic Acid Diethylamide (LSD), Scopolamine, Diphenhydramine, and Ketamine.

Quantitation of these drugs will be performed by HPLC/UV, SPME/HPLC/UV, Refocused SPME/HPLC/UV, and HPLC/MS.

Drug Facilitated Sexual Assault (DFSA), SPME, HPLC

B14 The Analysis of Gamma-Hydroxybutyric Acid (GHB) and Gamma-Hydroxybutyrolactone (GBL) in Forensic Samples Using GC/MS and ^{1}H NMR

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This presentation will describe a fast, simple, and solvent free method for detection of Gamma-Hydroxybutyric acid (GHB) without conversion to its corresponding lactone, (GBL). Distribution constants for the conversion between GHB and GBL at different pHs over time will also be presented.

Gamma-Hydroxybutyric acid (GHB), a CNS depressant, has been used repeatedly over the past decade to commit drug-facilitated sexual assault. The growing use of GHB for the purpose of date rape calls for the development of a method to determine if GHB is present in a drink that is suspected of having been spiked or if GHB is present in a urine sample of a person who believes they may have been drugged and assaulted. This study proposes to develop a method for detection of GHB in such samples. Limits of detection and linear range for the method developed will be determined and compared to existing methods.

Method development is complicated by the equilibrium that exists between GHB and its corresponding lactone (GBL) in solution. This study proposes to determine the equilibrium reached between GHB and GBL at different pHs over time using ^{1}H NMR.

Solid phase microextraction (SPME) will be used for the extraction and pre-concentration of GHB. Solid phase microextraction is a simple, effective adsorption/desorption technique, which eliminates the need for solvents or complicated apparatus for concentrating compounds in liquid samples or headspace. Many methods of extraction currently being implemented for GHB analysis either intentionally or inadvertently convert GHB to GBL or vice-versa. The method proposed for extraction, SPME, does not cause conversion between GHB and GBL, which is important due to the legal distinction between the two compounds. GHB will then be derivatized on-fiber using BSTFA/TMCS (99:1) in order to impart thermal stability so that conversion from GHB to its lactone does not occur in the heated injection port of the gas chromatograph. The best fiber for extraction and desorption of GHB will be determined based on extraction efficiency, carryover percentage and background produced by the fiber. Derivatization of GHB will be optimized by varying the amount of derivatizing agent used and the time the fiber is placed in the headspace of the derivatizing agent. Gas Chromatography-Mass Spectrometry will then be used for the separation and detection of derivatized GHB. A Varian 3400 Gas Chromatography instrument is used for separation while a Varian Saturn 2000 Ion Trap Mass Spectrometer is used as a detector.

Distribution constants between GHB and its corresponding lactone will be determined at different pHs over time in order to understand the effect of the sample medium on GHB detection. For instance, GHB is often spiked into alcoholic beverages with low pHs. It is therefore important to know how pH will affect the ratio of GHB to GBL so proper interpretation of results can be made. To determine equilibrium constants at various pHs, samples of GHB will be dissolved in deuterated water and buffered at pHs ranging from 2 to 12. The samples will be analyzed at selected time intervals using a 400 MHz NMR in proton mode over a period of several months. These same procedures will be followed for samples of GBL. Once stable conditions are reached, equilibrium ratios will be determined based on integration of peaks known to come from either GHB or GBL exclusively.

Gamma-Hydroxybutyric Acid, Solid Phase Microextraction, Equilibrium Constant

B15 Illicit Methamphetamine Profiling

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The attendee will understand the complexity of clandestine laboratory phenomenon and will be able to interpret the byproducts associated with specific clandestine methamphetamine manufacturing process.

In clandestine methamphetamine laboratories the most frequently encountered synthetic method is reduction of ephedrine. Due to diastereomeric nature of the ephedrines the stereospecifity of the reduction is responsible for different possible mechanisms. Two major reduction methods will be taken under consideration, the HI/red P I method and lithium-liquid ammonia known as a Birch or "Nazi" method. Ephedrine reacts with HI to form iodomethamphetamine. This compound can cause a ring closure to form aziridines through internal substitution catalyzed by alkali or heat. The aziridines can undergo a ring opening caused by acidic hydrolysis to form phenyl-2-propanone, which subsequently dehydrates to form naphtalenes. Methamphetamine sample produced using the lithium-ammonia reduction method may contain derivative of propanamine as a byproduct. Spectral data via GC/MS spectrometry will be presented to aid in the analysis of precursors, intermediates, and rearrangements.

Ephedrine, Methamphetamine, Clandestine Laboratory

B16 GHB Free Acid: More on Issues of Interconversion With Isolation and Spectroscopic Characterization of Forensic Analysis

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The detection and spectroscopic characterization of GHB (gamma-hydroxybutyric acid) free acid are presented and discussed in relation to forensic analysis. After attending this presentation, the participant will be familiar with the occurrence of GHB free acid in forensic evidence, will understand the limitations of current analytical approaches with respect to detecting GHB free acid and discriminating between GHB free acid and its salts, will learn about a successful approach to the isolation and spectroscopic characterization (IR, ^{1}HNMR) of GHB free acid for forensic analysis, and will gain an understanding of the aqueous solution chemistries of GHB and GBL derived from a multitechnique-based (IR, ^{1}HNMR, HPLC-UV) study of the effects of solution pH.

Clandestine manufacture of GHB typically produces GHB salts. The most commonly encountered salt has been the sodium salt, although potassium salts and sodium/potassium salt mixtures have also been encountered. GHB salts may occur as relatively pure solids, wet pastes, or in solution. Although GHB has frequently been encountered as a salt, GHB free acid has been encountered in forensic evidence according to one of two general scenarios: (1) from the "spiking" or "lacing" of acidic aqueous beverages with GHB salts; (2) from the conversion of GBL (gamma-butyrolactone) to GHB in acidic aqueous-based GBL products or spiked beverages. GHB free acid has not been encountered in isolated or neat form.

Analytical methods that have been reported for the detection and identification of GHB in forensic analysis include GC-MS, LC-UV, LC-MS, and IR. However, there have been no reports of analytical methods or approaches to discriminate between GHB salts and the free acid. In GC-MS analysis, GHB is typically derivatized (BSTFA) for

detection; discrimination between the free acid and salts is lost with the addition of pyridine or other organic bases during the derivatization process. In LC-UV or LC-MS analysis, the ability to discriminate is lost due to the use of acidic buffers in the mobile phase, or to the facile conversion between GHB free acid and anionic forms during the mass spectral experiment.

Previous reports of GHB analysis using IR have involved one or more of GHB's salts. Although GHB free acid is known to occur in large proportions in acidic aqueous-based GBL products, its infrared spectrum is largely masked in measurements made on the neat products. This scenario may lead to apparent discrepancies in the detection of GHB free acid in forensic samples analyzed by IR vs. other analytical techniques. The discrimination between GHB salts and free acid is made more difficult because analytical standards or reference materials for GHB free acid are not commercially available. Although it is well known that GHB free acid will exist in aqueous acidic solutions in equilibrium mixtures with GBL, isolation of the free acid from the lactone has not been reported. Moreover, the literature describing the properties of GHB free acid in its pure state or neat form is extremely limited.

In this work, small amounts (ca. 1 mg quantities) of GHB free acid were prepared for use as a reference material. GHB free acid was produced instantaneously in solution by reacting the sodium salt with a stoichiometric amount of hydrochloric acid, and subsequently isolated in its neat form. It was necessary to tightly control the amount of acid added in order to avoid either formation of lactone (GBL) in the presence of excess acid, or incomplete conversion of the salt to the free acid under limited acid conditions. Both infrared (IR) and proton nuclear magnetic resonance (^{1}HNMR) spectroscopy were used to verify the identity of the reference material, to discriminate between GHB free acid and salt, and to check for formation of GBL. High performance liquid chromatography with ultraviolet detection (HPLC-UV) was used to determine the yields of free acid produced from the salt and to monitor for presence of the lactone.

As a further basis for the understanding of the occurrence of GHB free acid in forensic samples, the aqueous solution chemistries of GHB and GBL were studied as a function of solution pH. Simultaneous measurements were made on freshly prepared GHB or GBL solutions using IR, ^{1}HNMR, and HPLC-UV. These measurements enabled the determination of the exact chemical species (free acid, anion, lactone) present in solution as a function of pH. Both the IR and ^{1}HNMR spectra were shown to track the changing proportions of GHB free acid and anion, which occur as a function of pH, while also detecting the presence of lactone which rapidly forms in low pH GHB solutions. Using these approaches, the detection of the free acid in actual forensic samples is presented, and apparent discrepancies in the detection of GHB free acid may be avoided.

GHB Free Acid, Gamma-Hydroxybutyric Acid, Spectroscopic Analysis (FTIR, NMR)

B17 Infrared (IR) Spectroscopic Identification of GHB Free Acid, GHB Salts, and GBL

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The IR spectroscopic identification of GHB free acid, GHB salts and GBL will be discussed. After attending this presentation, the participant will have an understanding of the molecular structural changes that result in the infrared (IR) spectral differences between GHB free acid and its salts. The participant will also have an understanding of the changes observed in the IR spectra which can be used to identify GHB free acid in the presence of GBL in solutions following interconversion.

Infrared (IR) spectroscopy has been applied successfully to identifying GHB salts as well as GBL, both as neat materials and in a variety of forensic matrices. While other analytical techniques are capable of differentiating between GHB and GBL, IR has the advantage in that it can differentiate between GHB salts, GHB free acid, and GBL. In the case of GHB free acid, the molecular structure is partly composed of a protonated carboxylic acid functional group. Currently, no reference standard of GHB free acid is available. Based on its molecular structure, a predominate feature observed in the infrared spectrum of GHB free acid is a strong carbonyl absorbance band. The position of the carbonyl absorbance band of GHB free acid in the IR should be at approximately 1710 cm^{-1}. The molecular structure of a GHB salt exhibits a carboxylate functional group where the carbonyl functionality would normally be present in the molecular structure of the free acid. The IR spectrum of a GHB salt exhibits two absorbance bands at approximately 1556 cm^{-1} and 1409 cm^{-1} representing the O-C-O or "bond and a half" structure of a carboxylate functional group.

It has been previously shown that GBL will interconvert to GHB free acid in aqueous solutions over a period of time based in part on the pH of the solution. GBL solutions encountered in forensic casework have frequently been aqueous based. Determination of the presence of GHB free acid, as a result of interconversion, is made difficult in the IR due to the presence of an IR absorbance band associated with water (H_2O) at 1650 cm^{-1}. The presence of the H_2O band at 1650 cm^{-1} and the strong absorbance band associated with GBL at 1750 cm^{-1} result in overlapping bands. The carbonyl absorbance band associated with the GHB free acid is present underneath this set of overlapping bands.

The first series of experiments focused on determining which changes in the IR spectra could be used to make an in-situ identification of GHB free acid in the presence of GBL and water. Following this series of experiments, the focus shifted to the extraction and isolation of GHB free acid as a reference standard and to obtaining an IR spectrum of the GHB free acid.

The first experiments used a model system composed of different mixtures of GBL, water and a GHB free acid analog, beta-hydroxybutyric acid (BHB). BHB is readily available as a standard and exhibits a strong carbonyl absorbance band at approximately the same position in the IR as GHB free acid. A series of standard solutions of GBL and BHB were prepared within concentration ranges observed in forensic samples that contained both GBL and GHB free acid. These standard solutions were analyzed by LC-UV and IR spectroscopy. The IR profiles generated by these mixtures were then analyzed, and observed spectral differences were correlated with a change in concentration of GBL or BHB. The IR spectral changes observed in the model experiments with GBL and BHB were then used in the interpretation of IR spectra generated on real GBL forensic samples. The real samples analyzed were determined to contain both GBL and GHB free acid that was present as a result of interconversion. The IR identification results were compared to the LC-UV results generated for the same set of forensic samples.

Based on the knowledge gained in working with the model system of GBL and BHB, a series of interconversion experiments were conducted with GBL in D_2O instead of H_2O in order to more readily observe the carbonyl associated with GHB free acid. The OH bend normally observed in H_2O at 1650 cm^{-1} is shifted to lower wave numbers in D_2O. Removal of the interfering water band permitted the observation of the carbonyl associated with the GHB free acid. Attempts to isolate the GHB free acid from the interconversion samples were unsuccessful. An alternative approach to generate GHB free acid was developed by reacting GHB sodium salt with a stoichiometric amount of HCl. The GHB free acid was then extracted and an IR spectrum was obtained.

Structurally the GHB salts, GHB free acid, and GBL are different and as a result generate different IR spectra. IR spectroscopy can be used effectively to identify the presence of GHB free acid, GHB salt, and/or GBL in forensic evidence/samples.

GHB Free Acid, GBL, IR Spectroscopy

B18 A NMR Study of the Stability of Gamma-Butyrolactone (GBL) in Water

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The goals of this presentation are to present to the forensic community the results of a study concerning the rate of GBL hydrolysis to gamma-hydroxybutyric acid (GHB) over time and as a function of initial GBL concentration (5% to 90%). Attendees will gain an appreciation of the value of ^{1}HNMR for studying the conversion of GBL to GHB over time.

The increased use of GBL as an alternative to salts of the club drug gamma-hydroxybutyric acid (GHB) and the subsequent increase in sample submissions to forensic laboratories for analysis has required the forensic chemist to use a variety of analytical tools for proper identification. The most useful technique to identify these compounds and to observe their chemical interconversion, especially in liquid samples, appears to be ^{1}HNMR. Most importantly, ^{1}HNMR is minimally invasive with respect to the sample matrix which allows for direct observation of the chemistry without chemically altering the compounds or promoting interconversion.

The ^{1}HNMR analysis of a recent submission of the product "Verve 5.0" revealed that the GBL partially hydrolyzed into GHB (the free acid). Upon further investigation, this process of hydrolysis was confirmed when an authenticated pure standard sample of GBL (several months old) used for identification of GBL was also found to contain GHB free acid, the hydrolysis product of GBL. To better understand this instability of GBL in aqueous media, the hydrolysis of GBL to GHB in deuterium oxide was studied by ^{1}HNMR over a one year time period. During this same time, the pH of the GBL solutions was also measured and compared to the conversion data. The rate of hydrolysis was revealed to be a function of and inversely proportional to the initial GBL concentration. At lower GBL concentrations, measurable hydrolysis occurs within days. At higher GBL concentrations, measurable hydrolysis takes several months to occur. This hydrolysis is accompanied by a concomitant decrease in pH; however, there does appear to be an induction period during which the pH decreases without any measurable GHB formation. This induction period occurs from neutral to approximately pH 4-5. The pK_a of GHB stated in the literature is 4.71, which is within this pH induction range. The chemical shifts of GBL and GHB signals observed in the ^{1}HNMR spectra change as a function of initial GBL concentration, but not as a function of pH. At lower GBL concentrations, equilibrium is reached at a pH of 2-3 and approximately 25% hydrolysis. Quantitative data were calculated from integration of the NMR signals. High Performance Liquid Chromatography (HPLC) was used to confirm the presence of multiple chemical species. The conversion of GBL to GHB was measured by simple integration of the areas from the methylene triplets furthest downfield (directly bonded to oxygen). All signals appear at unique chemical shifts and all splitting follows simple first order principles. The rate of hydrolysis of GBL is a function of the initial GBL concentration and the extent of hydrolysis can be correlated with the concomitant decrease in pH. ^{1}HNMR has proven to be an ideal technique to observe this chemical process.

GBL, GHB Free Acid, NMR Spectrometry

B19 Development of a Nationwide AFLP DNA Database for Marijuana *(Cannabis Sativa)*

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The goal of this presentation is to identify DNA polymorphisms that will enable the individualization of marijuana samples and build a database of the DNA profiles.

The Connecticut State Forensic Science Laboratory is validating Amplified Fragment Length Polymorphism (AFLP) analysis as a means of DNA typing/individualizing marijuana (*Cannabis sativa*) samples. An important application of this research is to identify and link clonally propagated marijuana plants from different cases, suspects, locations or growing operations to one another. The authors have demonstrated that cloned plants generated by Dr. Gary Shutler (formerly of the Royal Canadian Mounted Police) exhibit identical AFLP profiles and that different marijuana "varieties" have dissimilar profiles. However, the estimation of a random match probability requires knowledge about the amount of genetic variation present among local and national marijuana "populations." Therefore, an AFLP database from statewide and nationwide marijuana samples is being generated. This database will enable the authors to survey genetic diversity present within and between grower-identified varieties of marijuana, as well as to look for differences between marijuana grown locally and marijuana that is smuggled into the U.S. from various countries. Furthermore, profiles will be made available to the forensic community for comparative purposes.

Thus far, 68 unique AFLP profiles have been obtained from samples seized in Canada, Connecticut, and Vermont, and many more samples from additional states nationwide are in the process of being acquired. Four selective primer pair combinations of the AFLP™ Plant Mapping Kit (Applied Biosystems Inc.) were chosen to generate the data for the database. These include EcoRI-ACT FAM/MseI-CAA, EcoRI-ACT FAM/MseI-CAT, EcoRI-AAG JOE/MseI-CAT, and EcoRI-AAG JOE/MseI-CTA. In order to facilitate data management, specific fluorescent peaks of each profile were selected to be automatically scored by Genotyper® software (ABI) and converted to binary code. Although all of the DNA fragments (~75-100) in an AFLP profile are informative and would be used to demonstrate a match in court, binary coding is a useful search tool for screening the database for candidate matches, and assessing the degree of similarity between particular profiles. For the four selective primer pairs, a total of 100 DNA fragment peaks were selected using more than 100 marijuana plant profiles, of which 60% were unique. Peaks were chosen based on their variability, peak height, interference from neighboring peaks, and amplification consistency. The average size of each selected peak, plus or minus 0.25-0.50 base pairs (to account for variation in size measurement precision), and a minimum peak height value (50 relative fluorescence units) were used to define bins or "categories." Several non-variable "control" peaks per primer pair profile were also selected to help the analyst gauge amplification yield/efficiency. Genotyper® scores for the presence or absence of peaks within the defined categories and converts the data into binary code. The authors plan to build a database of at least 500 unique AFLP profiles; therefore additional seizure samples are being sought. Since the use of the counting method (1/N where N equals the number of individuals within the database) to estimate the frequency of observed profiles, more unique profiles are identified and more value can be assigned to a match between two evidentiary marijuana samples.

Marijuana, DNA Database, AFLP

B20 Continuing Exploration of Cocaine Contamination of U.S. Currency

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The goals of this presentation are to develop an understanding of the contamination of currency by the illicit cocaine trafficking trade and to establish concentration ranges characterizing background vs. money laundering and/or trafficking levels of contamination.

This study had its beginnings in response to a 1994 decision by the 9th Circuit Court of Appeals in the case of U.S. v. U.S. Currency (Alexander), 39 F.3d 1039, in which the court(s) acknowledged the wide-spread contamination of the U.S. currency supply by the illicit cocaine importation trade. Cocaine importation has increased in recent years, according to the U.S. government, to a level estimated at 521 metric tons during 2001. These authors have put forth the argument, and successfully so during expert witness testimony in federal court on several occasions, that the absolute amount of the drug on currency, and not its mere presence, is probative.

The ink on U.S. currency never really dries. In effect, one can conceptualize currency as in a microscopic sense a "sticky" surface on to which, as it is circulated; various oils (e.g., human sebaceous) and miscellaneous environmental dirt and grime (including residue amounts of drugs of abuse) become attached. In the case of cocaine, the authors submit that a person who has handled the drug the then handles currency transfers residue in the low hundreds of nanograms range to the bill(s), and that this amount over the course of subsequent circulation and manipulation is reduced to a steady state "background" level.

The writers are engaged in an on-going study of the currency in general circulation in the U.S. and on a regular basis examine currency specimens from urban as well as rural financial institutions. Quantifiable levels of cocaine have been encountered on approximately 90% of the bills thus far examined. Because it is unlikely that members of the illicit drug trade have actually physically handled this volume of bills, the authors suggest that some other agent is responsible for the extent of the distribution of the drug on currency in general circulation. It is submitted that this agent is the mechanical currency counters that are universally employed in financial institutions which have a "homogenizing" effect on the currency supply.

Currency is sampled ten bills at a time. The initial screening is performed with a Barringer Instruments (Toronto, Canada) IONSCAN ion mobility spectrometer (IMS), an instrument with nanogram sensitivity for a number of the commonly encountered drugs of abuse, and cocaine in particular. Confirmation and quantitation is accomplished using liquid chromatography-mass spectrometry with electrospray ionization (LC/MS-ESI) on a Finnigan LCQ instrument. A deuterated internal standard is employed in the quantitation process.

In addition to the survey of currency in general circulation in the U.S. for residue amounts of cocaine, the authors have analyzed currency from in excess of fifty (50) criminal cases. The processing of such a large number of criminal cases has allowed for the establishment of concentration ranges differentiating background, money laundering, and actual drug trafficking levels of cocaine contamination.

Additional areas have been explored, to include relative contamination levels (1) across denominations of bills, (2) between so called "high crime rate" versus "low crime rate" areas of several metropolitan cities, as well as, (3) between urban versus rural areas. The mechanism of the suggested homogenizing effect of mechanical currency counters has also been explored.

Cocaine on Currency, Cocaine Residue Recovery/Quantitation, Cocaine: IMS Screening-LC/MS Confirmation

B21 Comparison of Extraction in a Drop and Solid Phase Microextraction

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Upon completion of this presentation, participants should have a better understanding of two newer extraction methods.

This research involves the comparison and evaluation of two analytical separation techniques, solid phase microextraction (SPME) and extraction in a drop (ED). These two techniques have been evaluated for the extraction of commonly encountered drug materials of forensic interest.

The solid phase microextraction technique was developed a number of years ago [1] and has begun to have significant applications in many fields[2] including some application to forensic science problems. The extraction in a drop technique first appeared in the literature more recently[3] and few forensic applications have been reported in the literature[4,5].

In the solid phase microextraction (SPME) technique the actual extractant is a thin film of a non-volatile liquid coated on silica fibers, similar to the interior of a capillary gas chromatographic column. A bundle of these fibers are dipped into an aqueous solution containing the target compounds, which then partition between the supported liquid phase and the aqueous phase. In the extraction in a drop (ED) the process is analogous to the classic liquid/liquid extraction. However, by using a single microliter size drop hanging on the end of a micro syringe submerged in the aqueous solution, the extraction in a drop technique miniaturizes liquid/liquid extraction by a factor of many thousands.

For both the ED and the SPME experiments five milliliters of the solution to be extracted was placed in a small conical vial. For the ED experiments a five-microliter syringe with a Chaney adapter was used to draw up one microliter of the extraction solution and then inserted into the solution so the tip was several millimeters below the surface of the liquid. The extraction solution was then gently expelled from the tip to form a hanging drop. For the SPME experiments the fiber holder was placed into the vial with the fiber withdrawn into the protective barrel. The fiber was then extended so that it was also several millimeters below the surface of the solution. In both cases the solution was stirred with a triangular Teflon coated stirrer bar designed to fit the conical bottom of the vial. The solution was stirred at a moderate rate, so as not to knock the hanging drop off the end of the syringe. In all the ED experiments pristane was used as internal standard in the extraction solvent. When the extraction period was over, the drop was drawn back into the syringe or SPME fiber into the protective holder and then withdrawn from the vial and immediately placed into the injector port of the GC/MS at 250ºC.

Initial experiments were done with cocaine hydrochloride solutions at fifty or one hundred micrograms per milliliter. The solutions were made in a pH 5.5 citrate buffer because some preliminary work indicated reproducibility problems in the absence of the buffer. It was found that that both ED and SPME extracted cocaine well from such solutions. It was found that at the above concentrations the SPME method required only one to two minutes to obtain strong signals in the GC/MS and with ED thirty seconds to a minute were adequate.

The methods were compared using a cough and cold Elixir containing phenyl propanolamine (12.5 mg/5ml), Brompheniramine maleate (2 mg/5ml) and Dextromethorphan (10 mg/5ml). It was diluted with an equal volume of buffer solution (Citrate 5.5) and then extracted as above. The ED extractions provided readily detectable peaks in ten seconds and sizable peaks for all three drug components in sixty seconds. In fact, the longer times were problematic because glycerol caused chromatographic problems that obscured the phenyl propanolamine peak. Again with SPME, identifiable peaks were seen after short extraction times and the peak sizes reach a maximum at a five to ten minute extraction time.

The effect of concentration on extraction efficiency also were studied with a four drug mixture made up in a pH 10 buffer solution. This drug mixture contained pseudoephedrine at 120mg/100ml, doxylamine at 25mg/100ml, dextromethorphan at 40mg/100ml and acetaminophen at 1000mg/100ml. The selection of the pH 10 buffer was dictated by the insolubility of the acetaminophen at lower pH values. Four additional serial dilutions were made producing five concentrations ranging from base to one-sixteenth of the base concentration. These were examined for extraction times from thirty seconds to two minutes. Although acetaminophen was the largest component, it extracted and chromatographed poorly. It was detectible in the majority of extractions, but gave a broad peak with poor reproducibility.

Using ED at the base concentration good-sized peaks were obtained even at short extraction times. At one to eight and one to sixteen dilutions the pseudoephedrine was not seen and extraction times of about a minute were required for good peaks from the doxylamine & dextromethorphan. Using the SPME, with the same solutions, it was found that pseudoephedrine did not extract. The other two components gave good results when extracted from the base solution and one to two dilution in thirty seconds and with the higher dilutions in a minute or less.

Conclusions:

- Both ED and SPME are very rapid and useful methods of performing microextractions of a variety of drug substances.
- ED does not require any equipment that is not immediately available in most crime laboratories. SPME does require purchase of a holder and some coated extraction fibers for an initial cost of several hundred dollars.
- At the concentration ranges of interest for street drug analysis, the extractions will usually require a minute or less for either technique.
- Using ED one can try a variety of different solvents very quickly to find the most suitable. SPME actually offers a wider range of extraction conditions since a number of different fibers are commercially available.
- Both techniques are better for qualitative analysis than quantitative analysis although with proper controls quantitative analysis can be performed. With ED the use of an internal standard in the extraction solvent simplifies quantitative analysis.
- SPME is the more mature technique with hundreds of paper having been published including some applications to forensic problems.
- ED is much newer and has been less researched, but appears to offer some real potential for a number of forensic applications.

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Sample Preparation, Drug Analysis, Extraction

B22 Digital Evidence and Laboratory Accreditation

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The goal of this presentation is to inform the forensic science community about current activities to have digital evidence become an accredited section in crime laboratories utilizing the ASCLD/LAB criteria.

The FBI, following the recommendation of the Federal Crime Laboratory Directors in Washington, DC, formed the Scientific Working Group Digital Evidence (SWGDE) in 1998. SWGDE and the National Center for Forensic Science (NCFS) have worked with the community to define terms, principles and best practices for digital evidence. SWGDE defined digital evidence as "any information of probative value that is either stored or transmitted in a binary form." The American Society of Crime Laboratory Directors/Laboratory Accreditation (ASCLD/LAB) has worked with SWGDE and NCFS to develop criteria for accrediting a digital evidence section. Approval by the ASCLD/LAB Delegate Assembly will lead to other activities, such as the development of proficiency tests, competency tests, training, examination protocols and laboratory evidence procedures related to digital evidence.

The presentation will describe the steps and time lines in accomplishing the first inspection of a digital evidence section for ASCLD/LAB Accreditation and some of the challenges encountered.

Digital Evidence, Accreditation, Scientific Working Group Digital Evidence (SWGDE)

B23 Seize All Find All: Crime Scene Recovery of Digital Evidence

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The goal of this presentation is to present to the forensic community several guidelines for proper crime scene recovery of digital evidence.

The burgeoning field of computer forensics is expanding into almost every traditional forensic situation. Whether at an on-site seizure, in the laboratory, or responding to an unknown crime scene, the traditional investigator or first responder must be aware of some special considerations that may prove crucial to their ensuing investigation. Digital evidence is present in almost every crime scene and permeates every type of crime. It is paramount for an investigator to be aware of the need to properly search for, handle, and process digital evidence. Digital evidence is regularly processed in such varied investigations as death, drug, fraud, counter-intelligence or counter-terrorism, child abuse or exploitation, and sexual assault cases.

In addition to home or business computers, digital evidence is present in almost every format; cell phones, pagers, Personal Digital Assistants (PDAs), internal phone systems, fax machines, mp3 players, videotapes, digital cameras, and audiotapes are just a few of the many types of digital evidence that may be encountered and merit consideration. Many of these types of digital evidence have special time constraints or processing requirements that are tantamount to evidence retrieval in the laboratory. Pagers, cell phones, laptops, and PDAs may be unable to be processed without properly charging or having power supplied during evidence collection or storage. PDAs in particular need a constant power source such as batteries or a charger in order to preserve data stored within its extremely volatile memory. Addresses, names, phone numbers, calendars, or other significant leads may be lost without proper evidence collection technique specific to these types of digital evidence.

Another area of consideration is the expanded role first responders must take when encountering a crime scene with digital evidence. In addition to their traditional roles of securing the crime scene, first responders must uncover and assess telephone or Internet connections and the possibilities of remote access. It is important to immediately seize control of all computer and communication systems and networks by disabling external connections and stopping any potentially destructive processes. Any actions taken by the first responder should be thoroughly documented with notes or photographs.

Investigators must also expand their documentation when encountering digital evidence in the field. Paper, software and notes found on or near digital media may provide user names, passwords, account information or other information useful to laboratory analysis. When

encountering a computer, investigators should carefully document any processes running including email applications, Internet access or open files. If possible, investigators should close all documents and running processes to perform a proper shutdown. If necessary, investigators may choose to simply power off or pull the power cord. It is important to note that investigators not do anything that could possibly alter digital media. Simply opening a file on a computer can unintentionally alter or destroy data. At the very least, date and time information may be lost that later proves to be relevant to the investigation; at worst, the investigator may start a destructive process unintentionally.

After initially stabilizing the digital crime scene, investigators need to assess any special constraints presented by digital evidence. Searches, seizures and analysis may be limited by time, equipment or legal restrictions. Investigators can triage digital media to determine what, if anything, can be processed on-site or if media should be seized and processed in the laboratory. Processing on-site may consist of creating an exact duplicate of the media or simply copying files depending on the needs of the crime scene. In the majority of cases, it is important to make a forensic copy of the original media.

If processing on-site is not possible and seizure is necessary, simple steps ensure proper packaging and handling of digital evidence. Most media found in the digital crime scene is magnetic and highly susceptible to electrostatic discharge. Anti-static bags and packaging materials mitigate loss or corruption of data during shipment. Traditional investigators, first responders and crime scene technicians need to be aware of some of the special considerations of digital evidence handling in the field to preserve data for later analysis.

Computer Forensics, Digital Evidence, Crime Scene Investigation

B24 Glitter: The Analysis and Significance of an Atypical Trace Evidence Examination

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The goals of this presentation are to present the analytical approach and assessment of the significance of an atypical type of trace evidence.

Locard's theory of exchange is demonstrated in this unusual case involving craft glitter. The analytical approach utilizing non-destructive techniques to examine and compare glitter recovered from a crime scene and the suspect's car will be discussed. Numerous commercially available glitter materials were also examined to determine the significance of an association between the case samples.

In the early 1990s, a young mother and her 5-year-old daughter were murdered in the bedroom of their home. Glitter, commonly used by children in arts and crafts projects, was scattered on the bed and carpeting where the victims were found. Vacuum sweepings, as well as other items from the crime scene, were submitted to the FBI Laboratory for trace evidence analysis. Items from the suspect, including carpets and floor mats from his car, were submitted for comparison.

A total of ten pieces of glitter of four different colors were recovered from the driver's side carpet of the suspect's car. Each piece of glitter was comparable in size, shape, and color to corresponding glitter from the crime scene. All were approximately $1mm^2$ with an aluminum substrate and each had a distinctive notch on one side. The coating on each piece of glitter was analyzed using Attenuated Total Reflectance (ATR) infrared spectroscopy and scanning electron microscopy with energy dispersive X-ray analysis (SEM/EDXA). These two techniques are non-destructive and required no sample preparation. Based on these analyses, each piece of glitter recovered from the suspect's car was consistent with respect to physical appearance and chemical composition of the substrate and colored coating with glitter found at the crime scene.

In order to evaluate the significance of these findings, eleven different commercially available glitter materials were examined. Through this study, it was determined that the most discriminating feature of this type of sample was the physical attributes. The reference glitter materials varied significantly in size, shape, and color. Further, it was found that a plastic (polyester or poly (vinyl chloride)) substrate was encountered more frequently than a metallic substrate. One reference glitter sample examined was consistent in color, substrate composition, size, and shape with the case samples, complete with the distinctive notch on one side. Instrumental analysis using ATR was not able to discriminate between the physically similar reference glitter and case glitter samples on any of the four colors examined. Utilizing SEM/EDXA however, it was determined that the elemental composition of the coatings on the physically similar reference glitter differed from the case samples in three of the four colors examined. Employing this analytical scheme on all of the glitter samples evaluated, all but one color from one reference sample could not be differentiated from the case samples.

Locard, Glitter, Atypical

B25 Extraction Methods of Capsaicin Encountered in Aerosol Defense Sprays: A Comparative Analysis

Oliver S. Spicer, Jr., and José R. Almirall, MS, PhD, Department of Chemistry, International Forensic Research Institute, Florida International University, Miami, FL*

The goals of this presentation are to present a comparative analysis of methods that may be used to extract and identify the compounds capsaicin and dihydrocapsaicin, which are the major components found in pepper spray products.

Instrumental analysis of capsaicin by Gas Chromatography Mass Spectrometry (GC/MS) has been shown to provide an excellent means for the identification of pepper spray residue after extraction from cloth samples. Solid Phase Microextraction (SPME) has been used to recover capsaicin and dihydrocapsaicin with limits of detection at 48 ng and 23 ng of material respectively.

The purpose of this presentation is to compare the extraction techniques used to recover capsaicin resulting from the use of defense sprays as weapons and present limits of detection by GC/MS for each extraction method. Additionally, persistence studies data and collection protocols detailing short-term and long-term recovery of residue is also presented. The interpretation of the results from this analysis leads to the conclusion that the residue from pepper sprays is more likely to be present as forensic evidence at crime scenes or civil disturbances.

Data from spiked cotton swabs extracted using the techniques solvent extraction, SPME, and solid phase extraction (SPE) is presented and summarized. Collection and packaging protocols of spiked samples are compared and summarized. Finally, data from the analysis of hand swabs collected after normal use of spray canisters collected over an eight-hour period will also be presented.

SPME, SPE, Pepper Spray

B26 Y-STR Diversity in Pakistani Populations and Their Phylogenetic Relationships

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Y chromosome specific STR database for the Pakistani population was required for forensic analyses. Such a database would also allow the study of the phylogenetic relationships of these highly endogamous and old ethnic groups. A male sample of 562 individuals from six ethnic groups was profiled for seven Y-STRS and genotyped using in-house allelic ladder. The haplotype analyses using various software revealed interesting patterns of diversity. The data was used to elicit the phylogenetic relationship between these ethnic groups.

In all human societies the majority of violent crimes are committed by the males, thus the characteristics that could identify and/or exclude a male have been of acute forensic interest. Most of the Y chromosome does not undergo recombination during meiosis thus the paternally inherited chromosome bears the genetic prints along the whole paternal lineage. Y specific short tandem repeats are now popular forensic markers that can be used as an adjunct to other markers and have also proved to be a useful forensic tool on their own. Various STRs have been described and many of these markers have been applied for building up population databases across the world in order to apply them to forensic casework. Due to the mode of inheritance, Y chromosome markers have also been utilized as a tool for studying phylogenetic relationships. The population of Pakistan is peculiar in that it is comprised of distinct groups, which are largely endogamous due to cultural and linguistic differences. These populations inhabit the area of one of the world's most ancient civilizations, i.e., the Indus Valley, thus it would be of interest to compare them with one another, and populations of other regions.

In this study 562 males belonging to six Pakistani populations, Punjabi, Sindhi, Pustoon, Baluchi, Makrani, Brosho, and Kalash were profiled for seven Y specific STR markers (DYS 391, 392, 393, 19, 389I, 389II amd 390) to generate a haplotype (Yh1) in order to assess the forensic utility of this new tool. These STR markers were amplified in two multiplex reactions and an in-house allelic ladder was developed to genotype the amplified products. Genotyping was performed on ABI 310 DNA sequencer.

The haplotype diversity for the Pakistani population was found to be higher as compared to other populations, thus Yh1 would perform better in Pakistani than the European Caucasian population. For the individual populations the frequency of most common haplotype (MCH) in this database was not more than 6% in the mainland populations while it was only 3% in Sindhi and Punjabis which are the two major populations. The Y STR analysis revealed higher Yh1 haplotype diversity for Pakistani population in comparison to Caucasian populations. The discrimination capacity of this haplotype was only slightly lower than that of the extended haplotype which includes two more loci DYS385 and YCAII to the seven locus Yh1, in European populations. The Y STR analysis in Pakistani populations would be thus very valuable even when the Yh1 is used for forensic casework.

The AMOVA analyses of the haplotype data performed using Arlequin software. AMOVA showed that the variation between the individuals of populations was much greater than that between the populations or to the arbitrary groups formed for the analysis. The variation between the major Pakistani ethnic groups was very low when the northern and southern ethnic groups were compared. Locus by locus AMOVA was also performed which showed that for all the groups major contribution of diversity was by the locus DYS393. The significant finding of pair-wise Fst showed that for the paternal lineages Punjabis were more closely related to Sindhis (as were Baluchis to Makranis) than to any other population. Mean pair-wise differences were calculated for all population pairs, highest values were obtained for the Baluchi population, while the lowest were for the Kalash. Molecular relationships of the component ethnic groups were studied using phylogenetic techniques. Distance matrices were used for generating phylogenetic trees. 'UPGMA' and 'Neighbourhood Joining' trees generated by PHYLIP were viewed with TREEVIEW program. Data from African populations was used to root the trees. The basic structure of the trees was similar. The Punjabi and Sindhi population cluster together showing common origin of the Y chromosome of these two populations; a similar cluster was seen for the Baluchi and Makrani.

In conclusion the analyses have revealed that a high degree of substructure exists in the Pakistani populations for Y STRs and the work has generated a large database of Y STRs for component ethnic groups of the Pakistani population. The AMOVA and the phylogenetic analyses have shown closer genetic relationship of Punjabi/Sindhi and Baluchi/Makrani populations which is consistent with the recent history of these populations.

Pakistani, Forensic, Y-STR

B27 SEM-EDS Analysis and Discrimination of Forensic Soil

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This presentation will demonstrate how to analyze and discriminate forensic soil by using microscopic techniques.

Soils vary among different areas and have distinct characteristics due to natural effects and residues left by living beings over time. Because of the complex form and variations in compositions of soil between areas, several examination techniques and instruments for forensic soil analysis must be used. In examining soil evidences, building materials such as plaster, brick, etc., and dust must be considered in addition to ground soil.

In this study to discriminate the soil evidences, 108 soil samples were collected from 30 different locations in Istanbul and were analyzed by using stereo microscope and scanning electron microscope equipped with an energy dispersive X-ray spectrometer (SEM-EDS). All soil samples were prepared by using 0,5 mm sieve and then the samples were fixed to an adhesive tape placed on a stub (a sample holder of SEM). After the analysis with SEM/EDS, compositions of each sample were determined. The samples from the top of the sieves were examined with a stereomicroscope and natural and artificial materials with characteristic features were identified. Moreover, all soil samples were dried at 120°C and over 780°C. Their colors were compared.

The results of the analyses were appraised by using SPSS statistic program, and it was observed that these results can be used for forensic soil examinations. It has been determined that the examinations provided useful information for discrimination of soil evidences and supported the other analyses data.

Applications were also performed on evidence from crime scenes from Istanbul. In addition to routine analysis, the particles containing high atomic number elements were identified in the back scattered electron image of a scanning electron microscope and analyzed with an energy dispersive X-ray spectrometer. It was determined that this procedure could provide useful information to discriminate the soil evidence and determine whether they fit or not.

It was concluded that soil evidence can be used in forensic investigations and SEM-EDS is fast, reliable, and more accurate in even very small amounts of samples.

SEM-EDS, Forensic Soil, Stereomicroscope

B28 Identification of Active Odor Signature Chemical in Methamphetamine and 3,4-Methylenedioxy-N-Methylamphetamine (Ecstasy) Using *Canis Familiaris* as Biological Detectors

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The goals of this presentation are to determine the active signature odor that canines are alerting to when trained on MDMA and to establish whether this chemical is exclusive to MDMA or present in other commonly encountered non-illicit tablets.

It was found that canines alert to 10-100 mg of piperonal (a starting material in the synthesis of MDMA) and that compounds found in the headspace of tested over the counter tablets (OTCs) did not share common chemicals with MDMA.

The use of the illicit designer drug 3,4-Methylenedioxy-N-Methylamphetamine (Ecstasy or MDMA) has risen in recent years. MDMA is now the fifth most identified controlled substance in crime labs and the newest controlled substance law enforcement detector dogs are being trained to alert to.

Many seizures of illicit drugs such as marijuana, cocaine, and heroin have been made possible by the assistance of detector dogs. The aim of this project was to identify the signature odors in MDMA street samples that detector dogs are alerting to and also to determine if those signature odors are exclusive to MDMA or also found in other commonly encountered non-illicit tablets.

The volatile chemicals that comprise the odor of the illicit drug 3,4-methylenedioxy-N-methylamphetamine (MDMA) were analyzed by Solid-Phase Microextraction (SPME) and identified with the use of GC/MS. Open system SPME studies revealed that the odor composition within the headspace of the sample does not change with respect to where the fiber is placed or the opening size of the system during the extraction period. These studies also indicate that as sample size increases the dominant headspace chemical becomes piperonal. A series of field studies with the assistance of certified narcotics detector dogs were conducted in order to determine the dominant odor compound to which dogs alert. Data suggests that the dominant active odor signature chemical emanating from MDMA tablets is piperonal rather than the parent drug itself. It was found that canines alert to 10-100 mg of piperonal. Studies dealing with the analyses of the headspace composition of different over the counter drugs (OTC) suggest that there is no common headspace compounds found in OTCs that could potentially lead to false positive alerts from the canines in association with these commonly encountered tablets.

MDMA, Detector Dogs, SPME

B29 Performance Comparison of the Penta D and Penta E Loci With the D2S1338 and D19S433 Loci in the Massive DNA Identification Effort in Former Yugoslavia

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The decisions involved in the selection of materials needed for the operation of a large-scale DNA testing effort involving skeletal remains and the results of those studies will be discussed.

The primary mission of the International Commission on Missing Persons (ICMP) is to help resolve the fate to the tens of thousands who are still missing in the former Yugoslavia from the conflicts in the 1990s. Paramount to the realization of success in this mission has been the development of a state-of-the-art DNA testing system which posses a capacity of processing up to ten thousand skeletal cases per year. In order to implement such a DNA testing system, the selection of appropriate equipment, methodologies and systems is critical. One of these critical components is the choice of an appropriate STR multiplexing. This is especially true today since faced with numerous STR multiplex kits from various providers, in addition to cost, also differ in the loci included in the analysis.

One of the first experiences in the ICMP's DNA department was that certain STR loci in closed enclaves such as Srebrenica offer relatively low levels of diversity inside the associated reference population. In the case of Srebrenica, where the number of missing are in thousands, and number of family reference blood samples are in tens of thousands, half-band sharing between the DNA profiles of bone samples and an unrelated family reference sample is a frequency occurrence, even when 15 loci have been successfully profiled. Because of this, either multiple family members must be profiled for each missing person or extended DNA testing involving additional STR loci, mtDNA or Y-chromosome testing must be performed on both the bone sample in question and the corresponding blood family references. Still, for a large-scale DNA identification effort such as this one, it is important that bulk processing, and therefore the bulk of identifications, is performed as often as possible by a single multiplex reaction, or in other words, one kit. This approach saves two very important elements for operation of this scale: time and money.

Among the kits that have been validated for ICMP casework are two 16 multiplexing kits, Promega's PowerPlex® 16 system and ABI's AmpFLSTR® Identifiler™ system. With the exception of Penta D, Penta E, D2S1338, and D19S433, these two kits amplify the same loci, including all of the CODIS 13 loci. The former two are incorporated in the PowerPlex 16 system, while the latter two are incorporated inside ABI's Identifiler™ five-dye kit.

The Pentas are 5-base repeats, ranging from in size 375bp to 471bp (for Penta E), and from 368 bp to 438 bp (for Penta D). In the PowerPlex 16 kit they are labeled with blue (Fluorescein) and green (JOE) dyes, respectively. Naturally, due to their size, the Pentas are on the far right of the allelic ladder, appearing as the fifth loci in blue, or sixth loci in green.

D19S433 and D2S1338 loci are four-base repeats. D19S433 is significantly shorter than both Pentas with a size range of 106 bp to 144 bp and appears as the first loci in yellow of the Identifiler's allelic ladder. D2S1338 ranges from 300 bp to 365 bp and, due to its greater size, is the last loci to appear in green.

The statistical significance of these four loci have been investigated within the appropriate reference population of the families of the missing, as well as the results obtained from both blood and bone samples. In addition, the amplification response to the reduced DNA quantities as recovered from skeletal remains, as well as the appearance of artifact peaks from bacteria, can represent a problem in allele calling. For these purposes, 500 blood and 50 bone samples were analyzed using both kits. Statistical analysis indicates that Penta E and Penta D have the higher power of discrimination and heterozygosity percentage. Paternity statistics favor the Pentas, especially Penta E, which scored highest Typical Paternity Index, and also had the highest observed power of exclusion among these four loci. Differences in the sensitivity and bacterial peak emergence were observed as well.

STR, DNA, ICMP

B30 A Comparison of Varying Body Storage Conditions on DNA Typing Results

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Participants will be given an overview of the relative difficulties in producing STR profiles from human bones that were stored for 7–11 years in a variety of environmental conditions.

The International Commission on Missing Persons (ICMP) has been charged with the task of identifying mortal remains from the armed conflicts in the former Yugoslavia that occurred in the 1990s. This process is complicated due to several factors: at least seven years have passed since the conflicts ended; there are up to 30,000 missing persons in graves scattered throughout the former Yugoslavia; the conditions of the mortal remains being recovered; and, because DNA testing has become the only reliable means of identification in the majority of these cases.

The missing of tens of thousands of people cannot be observed as an isolated incident, but rather as a series of incidents in which different numbers of people went missing under different circumstances. The nature of the incidents ranges from individual graves to hundreds within one grave, with Srebrenica being the most infamous of the latter. In the ICMP's identification efforts, bodies have been found in rivers, buried in mass graves in direct contact with soil and other bodies, placed into body bags, recovered on the surface, placed into caves, and many diverse areas and terrains that have dramatically different soil conditions. Numerous deviations were observed in the type of burial, with early war victims often placed in body bags, which rarely occurred in later years. Lastly, as the front lines changed, many bodies were relocated, so some remains were subject to several different environmental conditions.

DNA testing of skeletal remains is a rather challenging task because the DNA in such bone samples is generally highly degraded. In addition, it is normal that a substantial microbial population infests the bone samples. The process is further complicated because of the diverse storage conditions in which bodies were placed at time of death. The recovery of the bodies started before the establishment of the ICMP, while the hostilities were ongoing, and several years before the DNA program was in place. As a result, not only have the locations of bodies differed, but also the post exhumation storage has been variable. Nonetheless, the ICMP has developed an extraction procedure that is successful in obtaining STR profiles in over 90% of the skeletal cases from the former Yugoslavia.

The effects of diverse storage conditions of mortal remains have been investigated and significant differences observed in the quality of the resulting STR profiles. It has also been observed that superior STR profiles were obtained from buried bodies compared to unburied surface remains. Preliminary results indicate that samples taken from bodies buried in body bags pose increased challenges. The data presented will reflect the quality of the STR profiles obtained from samples taken from mortal remains exposed to various environmental influences as well as the observed differences among them.

DNA, STR, ICMP

B31 Rapid Identification of Accelerants in Arson Analysis Using GC/ToF-MS and Automated Chromatogram Matching

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This presentation will discuss how the application GC/ToF-MS using fast GC techniques can greatly reduce the data acquisition period and, when coupled with an automated processing method, ultimately reduces the total analysis time.

The investigation of suspected arson cases is both a time and _labor-intensive operation; not only is the work highly repetitive in nature, but very large volumes of data are generated which need to be reviewed. A skilled fire debris investigator can often identify an accelerant hidden in complex chromatographic data by recognizing patterns formed by the relative abundance of key compounds. The specialized skills of an experienced analyst can be significantly augmented by the use of a sophisticated data collection and analysis system, relieving many of the more tedious aspects of the work and delivering a rapid identification. Historically, fire debris analysis has consisted of long GC/MS run times, followed by review of the mass chromatographic data. The data discussed here describes the rapid analysis of arson samples using GC/ToF-MS and automated chromatogram matching.

Fire debris samples were analyzed as follows. Fire debris is incubated in a steel can containing a carbon strip suspended from the lid. The strip is then placed in a vial and carbon disulfide is added to desorb the entrained material. Samples were analyzed by GC/ToF-MS. Data was automatically processed and results generated using Xaminer software. The chromatograms acquired during the analysis of fire debris cases can be complex and typically require lengthy oven programs to sufficiently resolve components to allow for accurate identification of the accelerant in question. When fire debris samples are analyzed with a high speed time of flight (ToF) instrument, run times were drastically reduced while retaining resolution, sensitivity that approaches that of selected ion monitoring data, and full screen spectra. Due to higher data acquisition rate of the ToF, use of fast GC techniques were employed, reducing the run time to approximately one quarter of the time required for the conventional quadrupole run. In addition to reduction of run time, the chromatographic resolution of the ToF data is maintained due to high data acquisition rates.

The ability to acquire data rapidly still leaves the analyst with the perhaps more daunting task of analyzing data, therefore, the use of an automated data processing program would be beneficial to the analyst. If an automated approach to data processing is undertaken, it is important that the system be validated by use of simple examples. An accelerant containing methyl esters of dicarboxylic acids was analyzed; the resulting trace contained four peaks also found in the authentic standard, and the relative amounts of the corresponding peaks in the fire debris sample are consistent with the standard. Thus, it was shown that a simple mixture could be analyzed and processed, but most fire debris samples are of a more complex nature. A more complex arson sample was analyzed and matched with the 25% Weathered Gasoline authentic standard.

In addition to rapid analysis, the ToF is extremely sensitive, thus enabling identification of fire debris samples with minute amounts of residual accelerant. The analysis of a fire debris sample that contained extremely low levels of accelerant was performed. The automated matching program identified the sample as 75% Weathered Gasoline in the absence of any detectable peaks on the TIC. The basis for identification of this sample as gasoline is only obvious when the summed ion chromatograms and individual extracted ion chromatograms are reviewed showing a high correlation with the naphthalene profile of the standard.

Currently, the analysis of fire debris samples is laborious and time consuming. This fact is due to both the actual data acquisition and the subsequent manual data analysis. It was shown that through the use of GC/ToF-MS analysis and automated pattern matching software (Xaminer), that fire debris cases can be rapidly and accurately analyzed. Actual data acquisition time is reduced by the fact that the high-speed acquisition rate of the ToF enables the use of fast GC techniques without loss of resolution or sensitivity. The application of automated chromatogram pattern matching software resulted in accurate and rapid identification of actual fire debris samples. The reduction of both run time and analysis time increases sample throughput and productivity. Finally, a repetitive and arduous task is removed from the analyst while the analyst's confidence is increased in the ultimate identification of the accelerant.

Fire Debris Analysis, GC/ToF-MS, Automated Chromatogram Matching

B32 Developing New Forensic Science Programs to Meet Current and Future Challenges: The Pace University and Cedar Crest College Perspectives

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This presentation will introduce two new collegiate programs in forensic science and their rationale for curriculum development.

New academic programs in forensic science have recently been introduced at Cedar Crest College in Allentown, PA, and Pace University in New York, NY. Pace University began offering a BS and MS in forensic science in the Fall 2002 and Cedar Crest College currently offers a BS in Chemistry with a concentration in forensic science.

Cedar Crest College is an undergraduate, liberal arts college for women. The liberal arts portion of the curriculum offers the opportunity to develop skills in public speaking and technical writing that can greatly benefit the forensic student. In addition, the liberal arts curriculum is aptly suited for the development of critical thinking skills that are necessary when approaching forensic problems.

Pace is a large urban and suburban university with campuses in New York City, and in White Plains and Pleasantville, NY. Pace is a liberal arts university featuring undergraduate and graduate degrees through the Dyson College of Arts and Sciences, the Lubin School of Business, the School of Education, the Lienhard School of Nursing, the School of Computer Science and Information Systems and its School of Law. The Forensic Science program will be offered through the Dyson College of Arts and Sciences with classes given primarily at the New York City campus.

Both Pace University and Cedar Crest College have designed their curriculums based on the premise that students in Forensic Science need a strong science foundation. The first two years of undergraduate study are essentially the same as those of a Biology or Chemistry majors. Students will then begin learning basic concepts in forensic science using a crime scene focus. The guiding belief in both programs is that more mistakes are made in the recognition and collection of significant evidence at the crime scene than in the laboratory's subsequent analysis, a view held strongly by Paul Kirk years ago. Students will be taught how to use the scientific method to formulate meaningful hypotheses to evaluate physical evidence at crime scenes and how best to prove or disprove them. Specialty areas will not be taught in a vacuum but always with a particular criminal investigation in mind.

In an era when forensic science programs are becoming more specialized, Cedar Crest and Pace are taking a more traditional approach. Both curriculums will attempt to educate the student from a generalist perspective. In most jurisdictions, forensic questions are posed by non-scientists (i.e., prosecuting attorneys, case detectives). Cedar Crest and Pace hope to change this trend by teaching students to formulate their own questions based on their knowing the strengths and limitations of a broad range of analytical techniques.

Given the probable expansion of many forensic laboratory systems, the curriculums were devised so students will be able to meet educational hiring guidelines for most entry-level positions in forensic laboratories regardless of specialty. Graduates of these programs will be able to meet typical civil service requirements for employment as well as educational requirements mandated by such groups as the DNA Advisory Board. Core coursework areas in trace evidence, microscopy, forensic biology, crime scene reconstruction and pattern analysis, chemical and instrumental methods of analysis, and law and ethics are offered in both programs. Students will also be introduced to forensic science literature.

Integrating other applicable college courses not traditionally found in forensic science programs will be offered in both curriculums to meet current and future needs. For instance, given the role that computer interface technology plays in forensic laboratories and the prominent role that computers play in such areas as DNA matching and crime scene documentation and reconstruction, the Cedar Crest curriculum plans to include courses in structured programming and computer-aided design. Furthermore, specialty courses in digital photography, PCR, and DNA sequencing will be offered as electives.

Other non-traditional class formats such as one week intensive courses or 1 credit mini courses are being explored by both programs as a method of increasing student exposure to the field of forensic science.

In response to heightened awareness toward the field of forensic science, Pace will also offer an accelerated five year Masters Degree. This program was designed for students to enter the program directly from high school. The design of the program will be discussed in detail.

Research leading to the development of new laboratory techniques and method validation work is often part of the duties of laboratory scientists. In order to prepare students for these possible assignments in the workplace, both programs offer a research component. Pace University has a masters thesis requirement based on laboratory research and Cedar Crest College offers the opportunity for students to perform forensic research in their junior and senior years cumulating in a manuscript and an oral defense of the research. Both programs hope to offer research opportunities for students both on-campus and off-campus. A network of forensic laboratories with research opportunities for students will be solicited.

Education, Forensic Science, Academics

B33 The Abu Dhabi Population Database for 16 STR Loci

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The goals of this presentation are to establish a basic database in regards the 16 STR loci for native population and other population groups living in Abu Dhabi and to determine the best probability of discrimination between individuals using the 16 loci fluorescent STR multiplex system for the examined population groups.

This population study was conducted on blood samples that were collected from unrelated healthy adults living in Abu Dhabi, United Arab

Emirates (U.A.E.) including the native population in Abu Dhabi and other population groups commonly encountered in U.A.E. DNA was extracted by both the organic phenol-chloroform, and FTA™ paper extraction protocols, after quantitation of the extracted DNA (organic extraction only) amplification was carried out for 16 loci (15 + amelogenin). The amplified product was tested with the ABI 310 genetic analyzer and the obtained profiles were interpreted and analyzed. Allele frequencies were calculated for each STR locus for the population groups. The number of heterozygotes, both observed and expected, was determined. The Hardy Weinberg Equilibrium was verified using the Chi-square goodness of fit test and the exact test (P). Power of discrimination (PD) and mean paternity exclusion probability (MEP) were calculated for each locus and for the combined 16 loci. The obtained results were compared with relevant Arab and other ethnic groups databases.

Abu Dhabi, STR, Database

B34 Population Data on 9 DNA Loci in Qatari

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The objective of this presentation is to provide results and statistical parameter of forensic interest (H, PD, PE, PIC) of the Qatari population for 9 DNA loci with evaluation of the forensic, anthropological/genetic applications in the studied population.

The analyzed DNA loci: HLADQα, D1S80, VWA, F13A01, F13B, CSF1PO, TPOX, TH01, and FES/FBS using polymerase chain reaction (PCR) with several different analytical and detection methods

This study presents data on genotypes distribution, alleles frequencies, allelic diversity (H), power of discrimination (PD), chance of paternity exclusion (PE), and polymorphism information content (PIC). Blood samples of 200 healthy unrelated Qatari were collected, and DNA was extracted using phenol-chloroform extraction procedure. HLADQ? locus was analyzed using hybridization to allele specific oligonucleoid probes in a reverse dot blot format, VNTR (D1S80) locus and STRs (VWA, F13A01, F13B, CSF1PO, TPOX, TH01, and FES/FBS) loci were analyzed using polyacrylamide gel electrophoresis. Denaturing gels were used for the STRs. All the 9 loci showed no deviation from Hardy-Weinberg equilibrium (HWE).

Locus	PD	PE	PIC
HLADQα	0.9321	0.6090	0.7735
D1S80	0.9137	0.5901	0.8863
VWA	0.9290	0.6010	0.7657
F13A01	0.9066	0.5480	0.7315
F13B	0.7761	0.5060	0.6985
CSF1PO	0.8855	0.4990	0.6917
TPOX	0.8450	0.4290	0.6219
TH01	0.9170	0.5670	0.7454
FES/FBS	0.8736	0.4750	0.6698
Total	< 0.9999999	< 0.9999999	< 0.9999999

In conclusion, the studied DNA loci found to be very highly polymorphic valuable markers for forensic identity, paternity, and anthropological/genetic applications.

DNA, Qatari, Population Genetics

B35 Population Data of Ecuador for Fifteen STR Loci (Powerplex™ 16)

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The goals of this presentation are to present the results and parameters of forensic interest (HWE, PD, PE) of the Ecuadorian population for the 15 STR loci included in the Powerplex™ 16 (Promega Corporation, Madison, WI, USA).

The typing of STR loci is facilitated by the ability to amplify several loci simultaneously in a multiplex polymerase chain reaction (PCR). The 16 STR loci D3S1358, TH011, D21S11, D18S51, PentaE, D5S818, 13S317, D7S820, D16S539, CSF1PO, PentaD, vWA, D8S1179, TPOX, FGA, and the locus amelogenin can be amplified simultaneously using the Powerplex™ 16 kit.

This paper presents allele distribution data in the general population of Ecuador. Blood samples were spotted and preserved on FTA paper (Whatman Bioscience, Newton, MS). Extracted DNA samples (n=150) were amplified at the 16 loci using the Powerplex™ 16 kit. Samples were analyzed using the ABI Prism™ 310 Genetic Analyzer (PE Biosystems, Foster City, CA) according to the manufacturer's recommended protocol.

All 15 loci are highly polymorphic in the Ecuadorian sample population with the locus TPOX having the lowest observed heterozygosity, and the locus PentaE displaying the highest heterozygosity. The most discriminating loci were PentaE (PD=0.982) and FGA (PD=0.964). The combined probability of exclusion for the 15 STR loci is 0.99999937. There was no evidence for departures from Hardy-Weinberg expectations (HWE) in this sample population. An inter-class correlation test analysis was performed to detect any correlations between alleles at any of the pair-wise comparisons of the 15 loci. A résumé of the PD and PE are shown in this table:

Locus	PD(Obs)	PD (Exp)	PE
1 D3S1358	0.88053333	0.87806905	0.48881837
2 vWA	0.87048889	0.88978649	0.51403170
3 FGA	0.96382222	0.96962447	0.73911909
4 D8S1179	0.93226667	0.93287722	0.61280461
5 D21S11	0.95600000	0.96066452	0.70285973
6 D18S51	0.96311111	0.96512124	0.71989860
7 D5S818	0.88800000	0.88500218	0.50397428
8 D13S317	0.94382222	0.95140078	0.66869408
9 D7S820	0.90204444	0.90069071	0.53330873
10 THO1	0.87813333	0.88681666	0.50250889
11 PentaE	0.98204444	0.98667742	0.82867494
12 D16S539	0.91893333	0.92314258	0.58330714
13 CSF1PO	0.84835556	0.86821432	0.46531012
14 PentaD	0.93937778	0.94479720	0.64719527
15 TPOX	0.82284444	0.83083170	0.41087974
Total	>0.9999999	>0.9999999	0.99999937

In conclusion, an Ecuador database has been established for the 15 Powerplex loci. The allelic frequencies of these PCR-based loci can be used to estimate the frequency of a multiple locus DNA profile in the Ecuadorian population.

STR, Powerplex™ 16, Ecuador

B36 Paraguayan Population Data on the Fifteen STR Loci Included in the Powerplex 16™ Kit

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The goal of this presentation is to present the results and parameters of forensic interest (HWE, PD, PE) of the Paraguayan population for the 15 STR loci included in the Powerplex™ 16 (Promega Corporation, Madison, WI).

The typing of STR loci is facilitated by the ability to amplify several loci simultaneously in a multiplex polymerase chain reaction (PCR).

The 16 STR loci D3S1358, TH011, D21S11, D18S51, PentaE, D5S818, 13S317, D7S820, D16S539, CSF1PO, PentaD, vWA, D8S1179, TPOX, FGA, and the locus amelogenin can be amplified simultaneously using the the Powerplex™ 16 kit.

This paper presents allele distribution data in the general population of Paraguay. Blood samples were spotted and preserved on FTA paper (Whatman Bioscience, Newton, MS). Extracted DNA samples (n=168) were amplified at the 16 loci using the Powerplex™ 16 kit. Samples were analyzed using the ABI Prism™ 310 Genetic Analyzer (PE Biosystems, Foster City, CA) according to the manufacturer's recommended protocol.

All 15 loci are highly polymorphic in the Paraguayan sample population with the locus TPOX having the lowest observed heterozygosity, and the locus PentaE displaying the highest heterozygosity. The most discriminating loci were PentaE (PD=0.979) and FGA (PD=0.966). The combined probability of exclusion for the 15 STR loci is 0.99999944. There was no evidence for departures from Hardy-Weinberg expectations (HWE) in this sample population. An inter-class correlation test analysis was performed to detect any correlations between alleles at any of the pair-wise comparisons of the 15 loci. A résumé of the PD and PE are shown in this table:

Locus	PD(Obs)	PD(Exp)	PE
1D3S1358	0.89151077	0.89271689	0.51483624
2vWA	0.91546202	0.91200720	0.55883360
3FGA	0.96598639	0.97001290	0.74098142
4D8S1179	0.92368197	0.92780471	0.59971637
5D21S11	0.95351474	0.95583990	0.68506984
6D18S51	0.95897109	0.96280685	0.71032591
7D5S818	0.86323696	0.86249670	0.46343428
8D13S317	0.93594104	0.94339041	0.64294426
9D7S820	0.92906746	0.93591004	0.62024462
10THO1	0.89817177	0.90678134	0.54415416
11PentaE	0.97966270	0.98337683	0.80853391
12D16S539	0.92410714	0.92410099	0.58835125
13CSF1PO	0.87337018	0.86933277	0.46963725
14PentaD	0.94720805	0.94939159	0.66195898
15TPOX	0.82667234	0.82783182	0.40801803
Total	>0.99999999	>0.99999999	0.99999944

In conclusion, a Paraguay database has been established for the 15 Powerplex loci. The allelic frequencies of these PCR-based loci can be used to estimate the frequency of a multiple locus DNA profile in the Paraguayan population.

STR, Powerplex™ 16, Paraguay

B37 Detection of Sequence Variation in the HVI and HVII Regions of the Human Mitochondrial Genome in 889 Individuals and Casework Samples Using Immobilized Sequence-Specific Oligonucleotide Linear Array Assay

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The attendee will gain knowledge of the frequencies of distinct SSO mitotypes and the level of discrimination of the current HVI/HVII SSO linear array as well as gain appreciation of the usefulness of this technology as a screening tool for casework samples.

The immobilized SSO probe linear array technology has proven to be a rapid, sensitive method for detecting sequence polymorphism within the mtDNA genome and is a useful screening tool for various biological samples submitted as evidence material. Detection of sequence variation in the HVII region of the human mitochondrial genome in 689 individuals from four population groups using a panel of 17 sequence-specific oligonucleotide probes immobilized on a nylon membrane has been previously reported by Reynolds et al. (2000) in the *J Forensic Science*. Since that report, the linear array assay has been expanded to include additional probes in 4 regions of the HVI region and for positions 16093 and 189. Also, several probes from the original HVII assay have been redesigned and the HVII E region ("C-stretch") probe has been removed. Currently, both the HVI and HVII regions are co-amplified simultaneously rather than separately. In order to evaluate the performance of the new array and to obtain population frequencies for a database, 689 unrelated individuals were typed (200 U.S. Caucasians, 200 African Americans, 200 U.S. Hispanics, and 89 Japanese) with the current panel of 31 SSO probes spanning the HVI and HVII regions. As with the HVII linear array, one of four categories of probe signal within each probe binding region was observed for the HVI/HVII linear array: (1) a single probe is positive, (2) a single probe signal is visible but its intensity is weaker than a positive signal in other regions, (3) no probe signals are visible, or (4) two probe signals are visible. To characterize these categories, DNA sequence analysis was performed when blanks or "0" signals and weak signals were observed. In addition, samples in which mixtures of two sequences were observed by SSO typing were sequenced and the second sequence was either attributed to heteroplasmy or contamination. Also, the genetic diversity value for each population was calculated from the frequency data and the frequencies of distinct mitotypes in each group were determined and compared to the published values and frequencies obtained with the original HVII linear array.

The current HVI/HVII linear array was also used to generate a regional database for Georgia at the Georgia Bureau of Investigation (GBI). For this database, blood samples randomly collected from 100 Caucasians and 100 African Americans from individuals who resided in Georgia, previously used to generate their regional STR and AmpliType PM databases, were typed with the SSO linear array. The HVI and HVII regions of each of the 200 samples were sequenced as well. The genetic diversity values for each population was calculated from the frequency data for both typing methods and are compared to each other as well as to the general U.S. population database. Also estimated was the frequency of heteroplasmy detected by both typing methods. In addition to the samples from the Georgia population database, samples from multiple cases submitted to the GBI also were typed using the SSO linear array and sequence analysis. Cases in which the suspect had been

excluded by STR typing were chosen for this study to assess the value of the linear array assay as a screening tool for the exclusion of individuals. In all but one case, linear array typing was sufficient to exclude the suspects who had been excluded by STR analysis. In this particular case, the suspect excluded by STR analysis had the same SSO mitotype as well as the same HVI and HVII sequence as the donor of the semen stain. Prior to mtDNA typing, it was thought that the suspect was a brother of the donor of the semen stain based on STR analysis. The mtDNA analysis was consistent with this conclusion. Several additional cases will be summarized, along with the mitotype frequencies of the individuals in these cases obtained from the Georgia database and the U.S. database.

Since the current method for reporting mtDNA frequencies is the counting method, a large database is necessary to increase discrimination. Therefore, with this study as well as through collaborations with several crime laboratories, a substantial increase to the SSO population database is hoped. It is concluded that, based on the population data collected from these 889 unrelated individuals and the casework samples, the HVI/HVII immobilized SSO probe linear array typing system provides valuable, discriminating information and is an effective screening method prior to sequencing.

mtDNA, Population Database, Linear Arrays

B38 Presumptive Casework and the Usefulness of a Prior Knowledge From Antemortem Data

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Participants will be given an overview of the use of ante mortem and post mortem data in the identification of mortal remains recovered from the former Yugoslavia. The use of DNA data will also be compared and contrasted and a discussion of causes of discrepancies between the two types of data will be conducted.

The mortal remains recovered from within the former Yugoslavia as a result of conflicts in the 1990s can be categorized as presumptive or non-presumptive cases. Presumptive remains are those in which circumstantial evidence or a priori knowledge of the conditions associated with the loss develops into a presumption of the identity of the individual. A lack or relative paucity of such information defines non-presumptive cases.

Presumptive cases primarily occur in two instances. The first is when documents or other personal possessions are discovered on recovered remains and can be used to make a preliminary identification. Related to this is visual recognition from family members of clothing, jewelry or other personal items. For these cases a bone sample is taken and DNA testing performed to ensure that the presumptive identification is correct. The second instance of presumptive identification occurs when local governmental authorities exhume an individual who had been buried by a relative, or in which there is eyewitness testimony as to the identity of the missing individual.

DNA testing has become increasingly common in aiding in the identification of recovered remains. The use of DNA testing in the identification process is expected to increase as the successes obtained by the International Commission on Missing Persons (ICMP) are reported throughout the region. The expectation is that a majority of recovered remains will be non-presumptive and therefore DNA testing will play a key role in many of these cases. In previous mass disasters such as plane and train crashes, ante mortem data has proven useful in the identification of victims. However, the situation in the former Yugoslavia is compounded due to the magnitude of the incidents, the nature of the losses, and the time since the incidents occurred. However, the use of ante mortem/post mortem data comparisons as the primary basis for identification has been disappointing so say the least.

The ICMP performed DNA testing on several hundred cases in which a presumption of identity was established using the above-mentioned criteria. The results of this DNA testing indicated that the presumption of identity was correct in approximately 55% of the cases, while incorrect in approximately 45% of the cases. These rather startling results warranted a review of the methods that led to the presumption of identity as well as an increased reliance on DNA testing. Since the ICMP had already developed a large-scale DNA capacity within the former Yugoslavia designed to test thousands of cases per year, the addition of such presumptive cases into the system does not place excessive strain on the DNA testing system, nor does it result in a significant delay in obtaining results. However, it does offer compelling proof or refutation of the identity of the individual. Nevertheless the a priori knowledge of ante and post mortem data from presumptive cases did often provide a strong lead in the identification process. For this reason, ante and post mortem data should not be dismissed as assuming key roles in any identification system, but the context and conditions in which they are used will directly influence their accuracy and reliability.

DNA, Antemortem – Postmortem, Identification

B39 Development of a Method for Electrophoretic Separation of DNA for Forensic Analysis Using a UV-Transparent Microchip and a Photopolymerizable Polyacrylamide Gel Matrix

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The goal of this presentation is to demonstrate the use of photopolymerizable gel as a sieving matrix in tandem with microchips as a viable method for forensic analysis of DNA.

A method for high-resolution, CE-based separation of DNA for forensic analysis, translatable to the microchip platform, using a photopolymerizable gel in a UV-transparent capillary and microchip is described. Achieving the high-resolution DNA separations necessary for forensic analysis in a cross-linked, non-replaceable, gel-filled capillary or microchip system has previously presented a number of problems, including filling difficulties, gel placement issues, and gel degradation problems. However, photopolymerizable polyacrylamide gel differs from classic polyacrylamide gel by the presence of a UV-active initiator. The polymerization reaction will, therefore, only take place when and where the acrylamide monomer solution is exposed to UV light. The solution can, thus, be injected into the capillary or microchip as a liquid, with no polymerization taking place. This eliminates the filling difficulties previously encountered with conventional polyacrylamide gel and, in addition, simply covering regions of the capillary or microchip where gel is not desired before exposure can control gel placement. In this way, exact placement of the gel in the microchip channel or capillary is ensured, eliminating yet another obstacle encountered with conventional chemically initiated polyacrylamide. Also, the extent of polymerization and, thus, gel pore size, can be controlled by length of exposure to light. Altering the exposure (polymerization time) will change pore sizes and, by this control, resolution can be affected and the system tailored to the length of fragment being considered. Fragment mixtures of short fragment lengths can, therefore, be run through a gel

with smaller pores, while longer fragments can be run through a gel with larger pores. This can also affect the length of time needed for separation, with a more tailored system allowing for higher throughput of samples. Also described is a method for the creation of a gel gradient utilizing this property by variation of the length of exposure time across a channel or capillary for high-resolution separations. In addition, the effects of other parameters (voltage, temperature, ionic strength of buffer, etc.) on separation and resolution are described. Increasing voltage can lead to better resolution, but there also exists a threshold for the gel beyond which a breakdown of the gel matrix occurs. This impacts the duration of time during which the gel is viable and effective. Gel lifetime testing is also discussed, including how the gel performs under varying conditions, how long separations can be attempted before degradation occurs, and the feasibility of this method for implementation in a crime laboratory situation. Removal and replacement of the gel in the channel and capillary is also discussed. In addition to the advantages of the photopolymerizable gel, the advantages of the microchip system are also highlighted. These advantages include smaller injection/sample volume, faster analysis time, and multi-channel, multi-sample analysis on a single chip. The microchip system is conducive to the small sample volumes often present in forensic casework and the speed with which separations can be obtained, along with the ability to analyze more than one sample at a time are of great time and cost saving benefit. This poster presents data from preliminary studies aimed at evaluating the effects of various parameters on the polymerization of the gel and the subsequent effect on DNA fragment separation and conditions on the resolution of DNA fragments in CE and microchips. Conditions necessary for attaining the high resolution separations needed for microchip analysis to be pertinent to forensic DNA analysis will be described.

DNA, Capillary Electrophoresis, Microchip

B40 A Comprehensive Study of the Scientific Foundation of Explosive Detector Dog Performance

Ross J. Harper, MSci, José R. Almirall, MS, PhD, and Kenneth G. Furton, PhD, Department of Chemistry, Florida International University, University Park, Miami, FL*

This presentation will outline the research approach presently being performed for the scientific validation of detector dog performance for the detection of explosives. Research currently focuses upon the vapor headspace analysis of a variety of explosives by SPME-GC/MS to facilitate dog trials of individual headspace components. A closer look has also been taken at the analysis of explosives and blast debris by SPME-GC/MS/MS.

Analysis and identification of the headspace 'fingerprint' of a variety of explosives, followed by double-blind dog trials of the individual components have been performed in an attempt to isolate and understand the target compounds to which the dog is sensitive. Studies to compare commonly used training aids with the actual target explosive have also been undertaken to determine suitability and effectiveness.

The vapor headspace of a range of explosives have been analyzed using non-equilibrium rapid Solid Phase Micro Extraction GC/MS. Samples of a variety of explosives have been obtained from local law enforcement agencies for odor signature determination. The odor signature have been tested at time intervals to observe sample degradation under different conditions to study any effect that this may have on the dogs' detection performance.

Studies have also been performed using HPLC/MS to observe the non-volatiles within the samples. Diffusion studies are executed to observe the production and maintenance of an active odor headspace above the explosive media.

Following successful characterization of the odor signatures of the explosives, attention is then turned to the canine detection through a combination of double-blind trials of individual components from the odor signature. This work will facilitate a better understanding of the active odor compounds and how they may be exploited to advance the field of explosive detection.

Statistical analysis includes Method Detection Limit calculations, Vapor Pressures and Diffusion Constant studies of selected explosives related to canine sensitivity.

SPME has been demonstrated to have a unique capability for the extraction of volatiles from the headspace of ignitable liquids and explosives. Furthermore it has been shown to reduce the sampling of background matter from multifarious debris sample matrices. Results to date have shown comparable differences between readily available training aids and the actual explosive matrices that they seek to replicate.

SPME-GC/MS shows great potential to aid in the investigation and understanding of the complicated process of canine odor detection.

SPME-GCMS, Explosives, Canine Detection

B41 Formation of a Glutathione Adduct With a Cocaine Pyrolyis Product - Anhydroecgonine Methyl Ester

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The goal of this presentation is to develop an in vitro model for the formation of adducts of a pyrolysis product of cocaine with cellular nucleophiles, such as glutathione.

The smoking of crack cocaine is a major drug abuse concern. Anhydroecgonine methyl ester (AEME) is a known pyrolysis product of cocaine derived from heating crack cocaine. AEME contains an alpha-beta unsaturated carbonyl functional group that can undergo a Michael addition reaction with nucleophiles. Glutathione is a tripeptide found in most mammalian tissues. The nucleophilic thiol group within the cysteine residue of glutathione functions biologically as a free radical scavenger. The formation of glutathione adducts with xenobiotics, such as AEME, may serve as markers of toxicity for new or established compounds. Glutathione conjugation products are further metabolized via enzyme mediated pathways to mercapturic acid derivatives that are commonly excreted in mammalian urine. The glutathione and mercapturate adducts of AEME may provide markers that could facilitate forensic identification of crack cocaine smokers and serve as a basis for a better understanding of the toxicology of smoked cocaine.

AEME (1 mg/mL in acetonitrile, Cerilliant, Austin, TX) was combined with reduced glutathione (10 mg/mL in water, Sigma, St. Louis, MO) and was stirred in a sealed tube under a nitrogen atmosphere. Aliquots (50 µL) were taken at 0, 30, and 60 min, diluted with HPLC-grade methanol, and analyzed by direct infusion into the electrospray ionization source of a ThermoQuest Model LCQ/DECA 1000 ion trap mass spectrometer.

Glutathione-AEME adduct (*m/z* 489), and reactants, AEME (*m/z* 182) and glutathione (*m/z* 308), were detected within 5 min following mixing. Further mass spectral analysis of the parent adduct ion (*m/z* 489) by MS^2 showed daughter ions consistent with the masses of AEME and glutathione. Further fragmentation (MS^3) of the daughter ion at *m/z* 182 provided the same spectrum as that produced by the MS^2 fragmentation of authentic AEME. In addition, fragmentation (MS^3) of the daughter ion at *m/z* 308 yielded the same spectrum as that produced by the MS^2 fragmentation of authentic glutathione.

An adduct between AEME and glutathione was detected and its structure elucidated by mass spectrometry. Identification of this adduct suggests that AEME can covalently link with cellular constituents which may explain in part toxic responses to smoked cocaine. Further studies on the stability of the adduct will be conducted to establish the applicability of AEME-glutathione adduct as a standard material for forensic analysis.

AEME, Glutathione, Adduct

B42 Dr. Walter C. McCrone's Contributions to Microscopy, Microchemistry, and Crystallography

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The name of Dr. Walter Cox McCrone stands preeminent as the leader and most outspoken champion of analytical chemical microscopy in the Twentieth Century. He was born on June 9, 1916, and received his PhD in chemistry from Cornell in 1942. During his university studies he came under the influence of Professor Emile Chamot, then the most influential chemical microscopist in the U.S. As a result of this association, Dr. McCrone began his lifelong love affair with chemical microscopy. His influence extended over the fields of industrial, pharmaceutical, and forensic microscopy as well as conversation science in the areas of art and archaeology.

This presentation will focus on *some* of Dr. McCrone's original contributions to chemical microscopy that have a wide range of applications not only in forensic science but in other areas of applied science as well. These include the approach and technique for the manipulation and identification of small particles culminating in the publication of *The Particle Atlas,* dispersion staining, fusion methods, the petrographic characterization and identification of high explosives, and the ultramicrominiaturization of microchemical tests.

Microscopy, McCrone, Microchemistry

B43 Remembering Walter C. McCrone - Scientist, Educator, Microscopist

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Walter C. McCrone, scientist, mentor, leader, and friend - a very special person. On first meeting Dr. McCrone in June of 1958, he greeted this author saying, "You're the one who signed up for all three courses this summer; I really wanted to meet you." The spark in his eye, the smile on his face, and the tone of his voice conveyed his honesty and sincerity. Imagine this young man's feelings – Dr. McCrone wanted to meet him. In the forty-four years since, Dr. McCrone has inspired thousands of students with the same sincere interest in their learning microscopy combined with his special talent to teach.

Dr. McCrone was blessed with qualities that set him apart. If Walter were an entertainer, then he would be called a superstar. He was elevated because he had a special way of connecting with people. Walter's feelings for all people were broadcast by his words, his actions, and his strength. His special insights were scientific, artistic, and humanistic. His loyalty to Cornell University is legendary. He was a disciple of Professor Emile Chamot and an evangelist for chemical microscopy. Walter inspired many young people to excel by revealing talents concealed by their youth and suppressed by feelings of inadequacy. His praise and counsel were valued by all. He will always be a superstar.

Dr. McCrone was a scientist who championed light microscopy. He strongly believed that observation is the primary tenant of the scientific method and the light microscope was the fundamental tool of science. Many read into his writings a reluctance to accept advances in instrumental analysis; this is erroneous. Dr. McCrone's unique approach to the integration of light microscopy with other analytical instrumental methods has special importance to the forensic scientist. His message was always to begin a scientific investigation with observation and use microscopy as the initial step. Often, his simple observations and disciplined thinking led to solving major problems. Ranking the microscope as the first tool of scientific investigation does not diminish contributions by other technologies. Conversely, new technologies neither eliminate microscopy nor displace its primary position.

Dr. McCrone was dedicated to scientific principles, was driven by his convictions, and was a tireless worker. Now the baton has passed; it must be grasped and the race continued. Dr. McCrone's challenge is to keep the fundamentals of microscopy ranked number one.

Society was truly blessed by his life.

Walter McCrone, Tribute, Microscopy

B44 Dr. McCrone's Participation in LEAA Activities, Including Proficiency Testing, Certification, and Forensic Microscopy Workshops

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Twenty-five years ago, crime laboratories were in a very different condition than they are today. The Law Enforcement Assistance Administration (LEAA) had released the initial wave of proficiency testing results and the reliability of examinations was being questioned. Crime laboratories were still undergoing expansion, and certification, accreditation, and *Daubert* were still far in the future. LEAA and NILECJ (National Institute of Law Enforcement and Criminal Justice) provided some budgetary support to the forensic community but it was on a very limited basis. The proficiency testing studies had underscored the difficulties laboratories were experiencing in applying microscopical techniques to various forms of physical evidence. Training opportunities were severely lacking. One of the bright beacons in the field, though, was the course work offered by Dr. Walter McCrone in his facility in Chicago. The Forensic Sciences Foundation, Inc., secured a grant from LEAA, Dr. McCrone generously offered his services, and Walter and the McCrone Research Institute (MRI) went on the road all over the U.S. to offer training to state and local laboratory personnel. Nothing had been done like this before and has not been done (of this scope) since. With an advisory committee made up by the likes of Peter R. De Forest, John I. Thornton, and Barton P. Epstein, a curriculum was offered that reached more than 350 forensic scientists. This is but one example of the many contributions that Dr. McCrone made to the forensic science field.

Dr. McCrone, Microscopy, Tribute

B45 Dr. McCrone's Teaching Methods in Forensic Microscopy, Their Nature, History, and Durability

Gary L. Laughlin, PhD, McCrone Research Institute, 28205 Michigan Avenue, Chicago, IL*

The microscopy teaching activities of Walter C. McCrone started long before the McCrone Research Institute (McRI) was incorporated as a not-for-profit research institute in Chicago. McCrone obtained his first

microscopy training at Cornell University, with Emile Monnin Chamot, and was shortly thereafter appointed a full instructor in chemical microscopy before obtaining his PhD in 1941. After leaving Cornell, he had classes at the Armour Research Foundation (now Illinois Institute of Technology Research Institute - IITRI) from 1942-1956 and founded McRI in 1960.

The course and student totals from Dr. McCrone's educational activities are impressive. As of January 1, 2002, the cumulative for McRI (1942-2002) is 2,130 courses for 22,557 students. There has been an average of 600 students in an average of 60 classes for the last several years. Nearly all of the courses contain one week of intensive hands-on microscopy training with usually only one instructor for the entire duration of the class, making it a unique teaching experience for both student and instructor.

Thousands of students have successfully completed at least one of Dr. McCrone's specialized forensic microscopy (trace evidence) courses and the number will steadily increase as a result of McRI's continued efforts to interest forensic investigators in microscopy.

Dr. McCrone, Microscopy, Teaching

B46 Dr. Walter C. McCrone's Contributions to the Characterization and Identification of Explosives

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Dr. McCrone was an amazing individual, possessing many talents and having many interests. He especially loved applying polarized light microscopy (PLM) to answering the question-at-hand and solving problems. He applied PLM to many different fields including the identification of air pollution particles, asbestos identification, art conservation, pharmaceuticals, industry problems, and forensic sciences. A field that this author believes he enjoyed the most was the characterization and identification of explosives. A trip to Cornell University with Dr. McCrone in the mid-eighties, where a PLM course was to be taught, is remembered. After setting-up for the course, 'Doc' escorted the author on a tour around Cornell showing the sites, including some of his old swimming holes, and where Professor Chamot lived. He also told a story, when he was a graduate student, about a young lady who was showing an unwelcome amount of attention. Doc said he whipped up a batch of ammonium tri-iodide crystals and placed the crystals along the hall where he lived at that time. A few hours later he heard the door open and as the footsteps came down the hallway the ammonium tri-iodide crystals "popped." Doc was surprised they did not impede what he thought was the young lady and got up to answer the knock on the door. To his surprise, it was Professor Chamot who said, "What are you up to McCrone?" One would have only needed to see the smile on the Doc's face to wonder if the story was true.

What is true is the "bible" on the characterization and identification of explosives that Doc developed for the military while he was at Cornell. The dissolved gases that appear as TNT re-crystallizes from a melt caused numerous problems would be a puzzle until Doc looked through a microscope and explained it. He encouraged two young forensic scientists in the early eighties with the Alabama Department of Forensic Science to publish a couple of articles on the characterization and identification of inorganic explosives. Throughout his life he continued work on and published articles on explosives. No one could take one of his courses without melting some TNT and watching with amazement as the crystals develop. The author hopes to show a brief glimpse into the world of explosives as Doc saw it through the PLM.

Dr. McCrone, Microscopy, Explosives

B47 Dr. McCrone's Impact on Forensic Asbestos and Environmental Microscopy

Thomas A. Kubic, MS, JD, John Jay College of Criminal Justice, 445 West 59th Street, New York, NY*

This presentation will briefly highlight Dr. McCrone's contributions to the recently emerging field of forensic environmental microscopy.

Few, if any, criminalists are not familiar with Dr. Walter C. McCrone's voluminous contributions to the field of forensic microscopy and the analyses of micro and ultra micro transfer (trace) evidence. Dr. McCrone was renowned for his life long efforts in promoting the application of the Polarized Light Microscope (PLM) to problem solving. His countless publications and presentations in diverse forums dealing with the detection, analysis, and characterization of small particles combined with his intuitive interpretation of the data, have made an unequaled contribution to the field of quantitative light microscopy.

It is therefore not surprising that Dr. McCrone would also apply his analytical and deductive skills employing the PLM to problems in environmental analysis. He is well known for his many publications dealing with the analysis of asbestos and asbestos like materials by PLM. His greatest impact in this field resulted from his tireless research and efforts in developing, refining and promulgating the focal plane staining method (better known to us as dispersion staining or DS) as a rapid, accurate method for the analysis of insulation samples for asbestos. Through McCrone Research Institute, Dr. McCrone can be said to have been responsible for the training of a large majority of microscopists who literally analyzed tens of millions of samples. These analyses were performed utilizing methodologies developed predominately by him and adopted by regulatory agencies in the United States and abroad. The methods he fostered are a major part of the arsenal of microscopical techniques employed by forensic environmental microscopists in their efforts to identify a manufacturer of an insulation product for the purpose of litigation. Less well known are the applications of the PLM to investigations involving civil and criminal violations of laws regulating the dumping of polluting materials.

Dr. McCrone was not adverse to adopting additional microscopical methods when sample condition or particulate size prevented the PLM providing a conclusive answer. He adopted, when necessary, phase contrast and analytical transmission electron microscopies along with morphological analysis for airborne asbestos and mold spore identification and quantification. His philosophy of presenting intense professional training courses stressing the practical applications of the PLM carried over to a series of courses offered to students requiring education in other areas of microscopical analysis.

Dr. McCrone, Microscopy, Asbestos

B48 Dr. McCrone's Life of Science - Its Significance and Impact in Criminalistics From an Academic Perspective

Peter R. De Forest, DCrim, John Jay College of Criminal Justice, 445 West 59th Street, New York, NY*

There is no question that Dr. Walter C. McCrone had a very significant and profoundly positive impact on training, scientist certification, and education in forensic science. The awards bestowed on him by an impressive array of scientific societies attest to this. But this is only part of the story. The contributions of his students and others he influenced are another. He was a multifaceted man with many talents. Among others he was a dedicated scientist, a gifted teacher, and a very suc-

cessful entrepreneur. He was active on many fronts. Information and insights on these activities can be presented far better by other contributors to this session. On the subject of Dr. McCrone's successful entrepreneurship, it should be noted that the bulk of the proceeds from these endeavors was used to support worthy causes, including the vigorous promotion of microscopical teaching and research. In addition, although tuition was charged for his courses, he freely awarded "tuition free scholarships" to many students.

The author first learned of the work of Dr. McCrone 40 years ago as a forensic science student at the University of California at Berkeley. Dr. Paul L. Kirk introduced students to Dr. McCrone's contributions of particular relevance to forensic science. Dr. Kirk recounted and reviewed many of these for his students. It was at this time that the author first learned of electron beam microanalysis from Dr. Kirk's descriptions of Dr. McCrone's work with an early electron microprobe. There were many other examples including fusion microscopy. All stimulated the imagination of a young student of criminalistics.

Dr. McCrone was deeply concerned about the decline of and lack of appreciation for chemical microscopy. In the years following World War II, even more sophisticated chemical instrumentation was introduced into analytical laboratories at an increasing pace. Gradually chemical microscopy, once very widely employed, began to be abandoned for many applications in science and industry. Advocates of chemical microscopy, including Dr. McCrone, recognized that the newer techniques were more efficient for routine and repetitive high volume analyses, but that chemical microscopy was unsurpassed for complex non-routine problems such as those occurring regularly in criminalistics casework. Unfortunately, there were few such advocates. One illustration of the decline in the use of chemical microscopy, and of Dr. McCrone's efforts to counter this decline, can be seen in the publication history of a classic two-volume reference in this field. This reference was first published in 1930 by two of Dr. McCrone's mentors at Cornell University, Drs. Émile Monnin Chamot and Clyde Walter Mason. Volume I of the *Handbook of Chemical Microscopy* by Chamot and Mason went through three editions, the last of which was published in 1958. The first volume of the series had a broader appeal. It contained information applicable to a range of microscopical problems beyond chemical microscopy. Volume II, an unrivaled reference for microchemical crystal tests directed to the detection of inorganic ions, never made it past its second edition of 1940, although it did go through additional printings for about another 20 years. When copies of Volume II became scarce after John Wiley and Sons ceased publication, Dr. McCrone arranged to reissue it and distributed it at very low cost to students under his McCrone Research Institute (MRI) imprimatur. He also made other publications available to students at affordable prices. It is a pleasure knowing that Volume II of "Chamot and Mason" continues to be available to students. There is no substitute.

Dr. McCrone was far and away the most effective advocate of the virtues of chemical microscopy and the microscopical approach to problem solving. He decried the fact that this analytical approach had nearly vanished from university curricula and worked tirelessly to make students and forensic scientists aware of the exceptional power of the microscopical approach to problem solving. Although the centerpiece of the approach was the polarized light microscope (PLM), it assumed the intelligent incorporation of other analytical instrumentation. He saw that this approach was particularly well suited to problems in criminalistics.

The battle is not yet won. Dr. McCrone's mission does not end with his death and his work must be continued. In some ways the situation has worsened. Certainly on a percentage basis there has been a decline in the numbers of scientists who could be described as forensic microscopists. In large measure this is due to the rapid and sustained influx of personnel into forensic science laboratories to meet the demands for DNA typing. Trace evidence and the problem solving approach that Dr. McCrone espoused, as persuasive as his exhortations were, has been neglected. Even simple admonitions about "looking at the sample with the microscope before dissolving it or mindlessly stuffing it into and instrument" bear repetition. That this was difficult to appreciate suggests that more sophisticated concepts need to be explained. Dr. McCrone's torch must be picked up and carried it into the 21st Century where the next generation can carry it farther.

Dr. McCrone, Forensic Science, Tribute

B49 A Selection of Some of Dr. McCrone's High and Low Profile Cases in Forensic Analysis of Art

David A. Stoney, PhD, McCrone Research Institute, 28205 Michigan Avenue, Chicago, IL*

Dr. McCrone performed considerable casework focused on the materials analysis of works of art. This includes his very high profile work on the Shroud of Turin and the Vinland Map, but includes a variety of other casework that is less well known or known principally among art conservators, rather than forensic scientists.

A selection of these cases will be reviewed, which incorporate a basic forensic science approach and, of course, microscopy.

Dr. McCrone's analysis of tape lifts from the Shroud of Turin established the presence painted linen fibers that corresponded to the image areas of the Shroud. The paint was made of a collagen tempera medium and two pigments: red ochre and vermilion. Red ochre (a form of hydrated iron oxide) has been available throughout recorded history, but the form of vermilion used was one commonly available only in the Middle Ages.

Dr. McCrone's analysis of the Vinland Map established the presence of a fabricated yellowing of the parchment associated with the map's ink lines. The yellowing incorporated the synthetic pigment form of titanium dioxide as anatase. Anatase in this pigment form was not available until the early 20th century.

In other work, Dr. McCrone has uncovered many similar forgeries based on the detection of materials that are inconsistent with the alleged date of origin and the detection of methods used for the fabrication of the appearance of age. Much more rarely he was able to demonstrate that a questioned piece of art was entirely consistent with its alleged date of origin, or was very likely to be from a specific artist by comparison of the materials used in contemporaneously produced, unquestioned works of art.

Dr. McCrone, Forensic Science, Tribute

B50 Implementation of CODIS^{mt}: The National Mitochondrial DNA Database

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The goal of this presentation is to introduce CODIS^{mt}, the first national mitochondrial DNA database, to the forensic DNA community

Databanks that contain DNA profiles of convicted felons, missing persons, and/or profiles from evidence from cases are useful for providing investigative leads for resolving certain crimes. Use of the COmbined DNA Index System (CODIS) can assist in resolving crimes, particularly violent crimes, and prevent further crimes by quickly identifying the perpetrator. CODIS^{mt} enables federal, state, and local crime laboratories to exchange and compare DNA profiles electronically, thereby linking crimes to each other and to convicted offenders.

The use of CODIS^{mt} was expanded to include mitochondrial DNA (mtDNA) profile searching software, a missing persons index, and a relatives of missing persons index once authorized by federal missing

persons legislation. The new software, known as CODIS^{mt}, facilitates the searching of mtDNA nucleotide sequences developed from evidentiary samples against one or more sequence database(s) and provides a population database index for statistical applications.

In order to ensure an effective system, all profile identification numbers and the designation of genetic variants have been standardized across participating laboratories in order to facilitate profile searching at the national level. In addition, minimum requirements for the processing of controls, reporting of polymorphisms, and submitting of sequence data have been established.

Laboratories participating in the National DNA Index System (NDIS) must establish evaluation criteria for the use of controls in their analyses, including but not limited to a positive control, a negative control, and a reagent blank control. These control samples must be processed through nucleotide sequencing as is done with corresponding questioned or known samples. DNA purified from the HL60 cell line is the NDIS-accepted positive control. If the reagent blank and/or the negative control of a particular amplification yield a sequence that is the same as that of the sample, or if contamination is present above the threshold set by laboratory, then the data will not be acceptable at NDIS.

CODIS^{mt} archives profiles as differences from the revised Cambridge Reference Sequence (rCRS) according to the nucleotide position and the DNA base difference from the reference (e.g., 16089 C). There are no minimum length requirements for nucleotide sequence data obtained from questioned (Q) samples, but nucleotide sequence from known (K) samples should include both hypervariable region 1 (HV1; nucleotide positions 16024-16365) and hypervariable region 2 (HV2; nucleotide positions 73-340) whenever possible. Nucleotide sequence obtained from population database samples must include a minimum of HV1 and HV2, and must not contain over 1% ambiguity over the length of the sequence. Both strands of the amplified product must be sequenced for one to reduce ambiguities in a sequence region.

Laboratories must develop guidelines for evaluation of cases and for the presence of heteroplasmy. At NDIS, mtDNA profiles are considered candidate matches if there are two or fewer differences between the profiles in question. Differences between sequences caused by length heteroplasmy are not considered when determining a candidate match. The mtDNA committee of the Scientific Working Group on DNA Analysis Methods (SWGDAM) has proposed the following interpretation guidelines that can be used in most cases:

Exclusion: If there are two or more nucleotide differences between the questioned and known samples, the samples can be excluded as originating from the same person or maternal lineage.

Inconclusive: If there is one nucleotide difference between the questioned and known samples, and no additional data are available (i.e., no other samples have been typed), the result will be inconclusive.

Cannot Exclude: If the sequences from questioned and known samples under comparison have a common base at each position or a common length variant in the HV2 C-stretch, the samples cannot be excluded as originating from the same person or maternal lineage.

Mitochondrial DNA, CODIS, Database

B51 The Design and Compilation of a National Y-STR Haplotype Reference Database

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The goal of this presentation is to inform the forensic community on the design, establishment and statistical analysis of a comprehensive on-line Y-STR database, the aim of which is to type all potentially useful Y-STR markers in a variety of geographically and ethnically diverse populations.

The establishment of a U.S. National Y-STR reference database is essential to facilitate the generation of reliable estimates of Y-STR haplotype frequencies. Such haplotype frequencies are required to provide a statistical estimate of the significance of a match. A U.S. Y-STR Haplotype Reference Database has been created by the International Forensic Y-User Group and is maintained by the Max Plank Institute for Evolutionary Anthropology, Leipzig, Germany. However, this database is limited to a set of 9 core Y-STRs which limits its operational usefulness, particularly in light of the development of Y-STR multiplexes consisting of over 40 different loci. Y-STR loci, unlike traditional STR markers, are not independent of one another and are co-inherited as extended haplotypes of linked markers. The estimation of the frequency of occurrence of a particular haplotype therefore necessitates the use of a counting method which is entirely dependent upon the size of the database.

The database records initially comprise data generated in the laboratory based upon a 19 Y-STR locus extended haplotype. The loci tested include DYS19, DYS385 (a) and (b), DYS388, DYS389I, DYS389II, DYS390, DYS391, DYS392, DYS393, DYS425, DYS434, DYS437, DYS438, DYS439, Y-GATA-C4, Y-GATA-A7.1, Y-GATA-A7.2, and Y-GATA-H4. Data was compiled from various Caucasian, African American, and Hispanic populations. Although some (unpublished) data exists for some of these loci in U.S. populations, it is not readily accessible to the crime laboratory community and usually does not contain 'extended' haplotype data due to the technological restraints of the systems employed by the investigators. A key component of the strategy is to allow for the continuous updating of haplotype data using the same samples. This ensures that as new markers are developed, the same samples would be re-typed, and a new extended haplotype developed. Thus, any laboratory needing haplotype data for any combination of Y-STR markers would be served. The aid of geographically diverse crime laboratories was enlisted to obtain the necessary samples. In exchange for the samples, the crime laboratories benefit by obtaining a custom built no-cost local Y-STR database.

The database is in the process of being extended to include 42 loci, and the results of that effort will be described.

Y-STR Database, Halotype Reference Database, Statistical Analysis

B52 Application of the CFS-HumRT Quantitive PCR Assay With Non-Probative Forensic Casework Sample

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The goal of this presentation is to demonstrate an efficient method of quantifying amplifiable human DNA for use in forensic science.

The Centre of Forensic Sciences' (CFS) laboratory is in the process of completing developmental validation of a rapid and automated Real-Time Quantitative PCR assay for detection of human DNA utilizing the ABD 7900HT SDS platform. This assay utilizes CFS-HumRT, a TaqMan®-MGB sequence specific probe developed at the CFS. The probe has a fluorescent reporter dye (VIC) attached at the 5' end and a quencher dye attached to the 3' end. When the probe is intact, the reporter dye emission is quenched. During PCR, the probe anneals specifically between the forward and reverse primers. When the probe is cleaved by the 5' nuclease activity of the DNA polymerase, the reporter dye is separated from the quencher and a sequence-specific signal is generated. With each additional PCR cycle more reporter molecules are cleaved and thus more fluorescence is generated. At some point during the PCR, sufficient target has been amplified and a significant change in fluorescence is detected. This point is referred to as the threshold cycle (CT) and at any given cycle during the geometric

phase of the PCR, is proportional to the log of the starting amount of nucleic acid.

Developmental validation of the CFS-HumRT has followed TWGDAM guidelines and has demonstrated the following: a) analysis of over 550 human DNA samples, including 100 samples from each of our Caucasian, Black, South Asian, and South East Asian databases indicates the assay performs similarly for all racial classifications tested, b) analysis of numerous non-human samples indicates the probe to be highly specific, only cross reacting with some primate species, c) the assay yields accurate results for human/non-human mixtures even when the latter is in excess by 1000-fold, d) repeated analysis of DNA standards have shown the assay to be highly sensitive capable of detecting as little as 6pg of template DNA and reliably quantifying from 25ng down to 25pg of DNA, e) replicate amplifications of known samples have shown the technique yields consistent results with standard deviations of less than ±0.15, f) the assay can identify human DNA extracted from a variety of body fluids/tissues including blood, saliva, vaginal epithelial, seminal fluid, and hair, and g) when operating within the dynamic range of the system and using known high quality DNA samples, the technique yields comparable quantification results to the current QuantiBlot™ assay with the added benefit of automation.

During this presentation the utilization of the CFS-HumRT assay with non-probative forensic casework samples will be highlighted. Specific issues that will be addressed are as follows:

- The effects of sample quality and purity on PCR efficiency;
- The interpretation of assay results;
- The impact of DNA quantification using the CFS-HumRT assay on subsequent STR typing using ABI AMPFlSTR Profiler Plus™ amplification kits; and
- The development of laboratory specific protocols for the deployment of a fully automated Real-Time Quantitative PCR assay for detection of human DNA.

DNA Quantitation, Real-Time PCR, CFS-HumRT

B53 Automating the DNA Preparation and Analysis of Casework Samples

Paraj Mandrekar, MS, Laura Flanagan, BS, Robert McLaren, PhD, and Allan Tereba, PhD, Promega Corporation, 2800 Woods Hollow Road, Madison, WI*

After attending this presentation, the participant will understand how the various steps in DNA analysis are being automated and integrated to increase throughput and generate more reproducible results.

DNA analysis in the forensic setting frequently consists of cell separation (differential extraction), and/or sample extraction, DNA purification, human-specific quantitation, PCR amplification, DNA fragment separation, and data analysis. Automating these steps to increase throughput and control expenses will become a necessity as the demand for DNA testing increases due to new legislation, advances in trace evidence techniques, and a need to analyze backlogged non-suspect samples. The current techniques to automate sample extraction, DNA purification, human-specific quantitation and PCR setup on a Beckman Biomek® 2000 robotic platform will be described.

Casework samples are quite varied and initial sample extractions are a significant bottleneck. While heated enzymatic digestions and centrifugation steps to increase yields are frequently necessary but are not amenable to automation, many of these processes can be performed in a 96-well format to increase efficiency and prepare the samples for robotic manipulation. The authors will demonstrate the efficient preparation of many common casework sample types using inexpensive equipment and will show how this step fits seamlessly into automated DNA purification.

The robotic purification of DNA is based on the binding of DNA to a proprietary paramagnetic particle in the presence of a strong protein denaturing solution that is effective at removing most PCR amplification inhibitors. The use of paramagnetic particles renders the DNA IQ™ System suitable for a variety of robotic platforms such as the Beckman Biomek® 2000 robotic system. A completely walk-away format has been developed, requiring about 2 hours for 88 samples. The automated system can handle different sample volumes from a variety of extracted materials, elutes DNA in a volume of 25ul to 100ul in individual tubes or 96 well plates, and makes judicious use of filtered disposable tips that are assigned to each sample well.

Following DNA purification, the robotic system can be quickly set up to perform human-specific quantitation using a unique technique based on the polymerase-catalyzed depolymerization of a probe hybridized to repeated human DNA sequences. Liberated dNTPs generated during depolymerization are used to generate ATP, which is a substrate for Luciferase, generating a light signal that is proportionate to the amount of human DNA present in the solution. Large excesses of non-human DNA do not interfere with the quantitation. The process requires 2 hours to process 80 samples including a one-hour incubation. The values generated from the AluQuant™ Human DNA Quantitation System, using an injecting luminometer capable of reading 96 well plates, are converted to DNA concentrations. These values can then be used to set up PCR reactions using the Biomek® 2000 robotic platform and a normalization wizard. The PCR setup is designed for accuracy and conservation of expensive reagents and provides a plate that can be placed in a thermalcycler for STR amplification. The reliability of this system will be demonstrated.

Automation, DNA Purification, Quantitation

B54 Customizing Genotyper® Macros to Individual Laboratory Specifications

Brendan F. Shea, MS, Deborah L. Hobson, MPH, Jill B. Smerick, MS, F. Paul Keller, MS, and Richard A. Guerrieri, MS, Federal Bureau of Investigation DNA Analysis Unit I, Washington, DC*

The goal of this presentation is to present the audience with sufficient background knowledge and information so that the individuals would be capable of returning to their own laboratory and making modifications to their macros to better suite their analytical needs.

When analyzing short tandem repeats (STRs) utilizing the ABI Prism 310 Genetic Analyzer, Genotyper® software is commonly used to assist in allele calls following an electrophoretic run. The macros that are provided along with the software, normally Kazam and Kazam 20%, can aid in this process. During this presentation, some of the basics of the macros supplied with Genotyper® will be explained for fundamental understanding, then the presenter will delve into the details of making alterations to the default macros in order to better serve the user based on the stutter and -A values of each individual laboratory.

Three different types of macro modifications will be discussed. The first will be a simple modification to change the value of a global filter (e.g., changing the Kazam 20% to a 4% filter level). The second modification to be discussed will "Focus" the basic Kazam macro so that only targeted areas (where stutter and -A would be present) will be filtered. This allows for specific peak height or peak area values to be used in filtering the stutter and -A without fear of filtering true off-ladder alleles. The final modification will combine both a low level global filter to aid in the removal of baseline noise, and will make use of the "Focus" principals to target the areas being filtered based on stutter and -A values.

DNA Analysis, STRs, Genotyper

B55 Illinois State Police DNA Outsourcing Project: On the Hit Parade!

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Participants will learn about the successes and lessons learned from a DNA outsourcing contract between a state forensic laboratory system and a private DNA testing laboratory that began in November of 2000. Discussion of the nature of cases sent, types of samples sent, management and organization of the contract, interpretation methodology, and hit rates will be presented. The implications of batched contract work on court and discovery requests will also be presented. Both authors will jointly make this presentation.

This presentation will review some of the experiences and data arising from a DNA outsourcing project undertaken by the Illinois State Police (ISP), under contract with Orchid Cellmark Germantown, formerly Cellmark Diagnostics, to perform DNA testing on forensic casework. The ultimate goal of this ongoing outsourcing project is to reduce the backlog of cases at ISP while enabling the rapid upload of high-quality profiles into the national, state and local CODIS^{mt} databases. This project is currently entering its third year of operation and to date has yielded over 180 CODIS hits.

In its first year alone, this outsourcing project involved the testing of approximately 2,000 pieces of evidence and corresponding victim standards from forensic no-suspect cases. One third of the samples came to Cellmark as previously extracted DNA samples. An additional ~700 suspect standards (unrelated to the above cases) were also tested in the course of this first year. The second year involved the testing of approximately 1,700 forensic cases, including over 1,570 semen and 570 non-semen stains. Over 150 of these cases had suspects and, if a match were observed, required the inclusion of a statistical analysis in the written report. It is anticipated that similar numbers and distributions of cases will be tested in the next two years of this outsourcing contract.

Many different kinds of samples have been tested including semen stains, vaginal and rectal swabs, items of clothing, swabs taken from burglaries, and hair samples. The decision-making process, management, organization, and prioritization of how to outsource these various types of samples and cases will be discussed. Information on the amount of work needed to prepare the samples for outsourcing (i.e., presumptive screening requirements, packaging and shipping), as well as complications of evidence-return will be presented. From the contract laboratory perspective, details on processing modes for larger-scale forensic work will be described including a discussion on some methods of batching, use of a laboratory tracking system (LIMS), and interpretation and reporting methodologies.

Both suspect and no-suspect cases have been tested in the course of this contract. Appropriate profiles are marked for possible CODIS^{mt}-upload by the contract laboratory and sent via diskette to ISP. As a measure of the success of this program, the percentage of samples marked for CODIS^{mt}-upload out of the total of those sent will be presented. For no-suspect cases involving a sexual assault sample, a "deduced" profile must often be determined from a mixture of sperm donor and victim. Two types of deduced profiles are possible: 1) those that correspond to a clean single-source male profile, and 2) those in which the victim alleles cannot be entirely removed from the profile, thus yielding a degenerate profile. Data will be provided on the percentage of samples yielding each of these two types of deduced profiles. Likewise, information will be provided on the number of hits obtained for the contract in total, per each type of deduced profile and per category of case-to-case hits vs. case-to-offender hits. Where possible, inter- and intra-state hits will be distinguished, as well as multiple vs. single case hits. The process used by ISP to review and upload the CODIS^{mt} ready data from this outsourcing project will also be outlined.

As this and other outsourcing projects grow over time, requests for discovery and court testimony will become increasingly more common. In fact, this trend has already been noted at Cellmark for discovery requests. Although there have been few court requests to date, these are anticipated to increase within the next year or so. As larger-scale processing procedures typically involve sample batching and a team approach to testing, the implications of court and discovery on both the state and contract laboratory will be briefly discussed in this presentation.

Undoubtedly, the value of producing high-quality casework CODIS data in a rapid and efficient manner is enormous. Diligent teamwork and open communication between administrators, contract managers, analysts, and technicians from all relevant parties are required to ensure the successful execution of a forensic DNA outsourcing project. It is hoped that the lessons learned by the parties involved in this particular project and described in this presentation may be a useful source of information for other such joint endeavors.

DNA Outsourcing, No-Suspect and Suspect Casework, CODIS^{mt}

B56 Decision Branches for Testing of No Suspect Casework

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The attendee will gain an understanding of the many decisions that are involved in processing samples in no-suspect cases, some of which will also apply to routine casework. This information should assist crime laboratories in addressing the alternative options available and the decision processes involved in testing no-suspect cases in house or in planning for outsourcing of testing as funding becomes available.

In the past few years, there has been increased emphasis in the U.S. on testing samples from unsolved, "cold" or "no-suspect" cases. Funding has recently become available from the federal, state, and local governments to support the testing in these cases. Once funding is available, laboratories have many decisions to make regarding which cases to test and how to prioritize the testing, how the samples from the cases will be selected, screened, and processed, and how the data will be reviewed and entered into databases at the local, state and/or federal level (e.g., CODIS^{mt}, NDIS).

At each step in the testing process, there are decisions that must be made which affect the next step of the testing for that case, as well as the overall goals and successful outcome of the entire project. Over the years, Orchid Cellmark has been contracted to provide testing services in suspect and no-suspect casework for many jurisdictions. Because of these many relationships with varied testing strategies and requirements, Orchid Cellmark has gained extensive experience in different strategies used in organizing and performing the testing processes. As a result, Orchid's laboratory is familiar with the various decision branches that arise prior to, during, and after testing of casework samples. This presentation will focus on many of these decision branches a laboratory may want to consider. The merits of various testing strategies and alternative solutions will be presented. These decisions are applicable to crime laboratories which plan to do all testing in house as well as crime laboratories planning to contract out all or portions of their casework.

Some of the areas that will be discussed are: goals of no-suspect casework testing and the resulting selection of cases and samples for testing; screening for stains and presumptive testing in house vs. outsourcing; number of samples per case to test; strategies when samples need to be consumed; strategies when little or no DNA is recovered from a sample; what information could be returned at the end of testing, including reports and report wording, profile printouts and/or electronic files on compact diskettes, tables of results with or without deduced profiles for CODIS^{mt} and/or complete case files.

DNA Testing, No-Suspect Casework, CODIS^{mt}

B57 A DNA-Led Identification Program for the Former Yugoslavia

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The development, implementation, and results of a high throughput DNA testing system designed to aid in the identification of thousands of skeletal remains and the understanding that has been gained by the operation of such a system will be detailed.

The International Commission on Missing Persons (ICMP) was created at the G-7 conference in Lyon, France, in 1996 with the mission of aiding in the identification of the missing from the former Yugoslavia. During the conflicts in the former Yugoslavia from 1991–1999, several hundreds of thousands of people were killed, and it is estimated that up to 40,000 individuals remain unaccounted for from these conflicts. The exhumation of bodies from the region continues and results in several thousand bodies being recovered annually. Due to the number of losses and the conditions of the recovered mortal remains, the use of 'classic' forensic identification techniques, i.e., those not utilizing DNA testing, frequently fail to establish the identity of mortal remains. By the end of spring of 2002, it was estimated that over 7,000 sets of human remains had been recovered but could not be identified without DNA testing. Further complicating the identification efforts are numerous secondary graves sites that contain severely commingled remains. As battle lines shifted during the conflicts, primary mass graves were often exhumed and the human remains transported farther behind the front lines. This exhumation process frequently resulted in bodies becoming fragmented and subsequent reburials often mixed bodies from various individuals together. Furthermore, multiple primary mass graves were often combined into one secondary mass grave. In the Podrinje region, which contains Srebrenica, many of the dead were never buried and were left exposed on the surface, resulting in many cases of scattered surface remains.

In order to help address the identification process of these most challenging of cases, the ICMP has developed a state-of-art DNA testing system within the former Yugoslavia. This system consists of four DNA laboratories located in Sarajevo, Tuzla, Banja Luka, and Belgrade with each having its own unique function as follows:

1. Sarajevo – Processes 45 bone samples a day, in duplicate, and has between a 90% - 95% success rate in obtaining STR profiles from bone samples.
2. Tuzla – Obtains STR profiles from an average of 352 blood samples per day.
3. Banja Luka – Responsible for the testing of presumptive cases as well as challenging cases, i.e., those that have been exposed to fire or other extreme assault. In addition, Banja Luka is ICMP's primary DNA research facility focused in improving DNA identification techniques.
4. Belgrade – Primarily focused on Y-chromosome and mitochondrial testing.

These four DNA laboratories must work together as a system in order to bring answers to the families of the missing. All data obtained from these four DNA laboratories is submitted to the central computer system in Tuzla, Bosnia, and Herzegovina. In addition, the ICMP has great support and cooperation from the DNA laboratories located in Croatia.

There are eight blood collection centers and a comprehensive, centralized computer system in which all data relating to the missing is stored. All blood and bone samples collected in Bosnia and Herzegovina as well as the Federal Republic of Yugoslavia, including Kosovo, are submitted to ICMP's central Identification Coordination Center (ICC) located in Tuzla. All samples are bar coded at the ICC and then distributed throughout the ICMP DNA laboratory system according to the type of DNA testing required. All DNA data obtained at any of these DNA laboratories is submitted to the ICC, where it is entered into the central DNA matching program. Once a DNA report has been generated, it is given to the pathologist in charge of the case, who is usually the person who submitted the bone sample. It is the legal responsibility of this pathologist to contact the family and officially close the case.

By the end of spring 2002, this system was generating between 200–300 DNA matching reports per month. Once a DNA match report has been returned to the pathologist, he/she will review antemortem records, articles of clothing and personal effects, and the body to ensure consistency between these 'classic' forms of evidence and the alleged identity of the individual as developed by DNA testing. The magnitude and success of this DNA testing system has altered the role of DNA testing in the former Yugoslavia where DNA testing is now frequently used to produce the initial lead with other identification methods assuming the confirmation role. As a result, names are being returned to thousands of missing.

Human Identification, ICMP, DNA

B58 Verification of GeneMapper™ *ID* Software for STR Analysis

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The goals of this research project are to present an integrated fragment analysis software application for STR analysis and to describe the verification performed and results obtained.

ABI PRISM® GeneMapper™ *ID* software (Applied Biosystems, Foster City, CA) provides automated genotyping for linkage analysis, SNP validation, population genetics and other DNA fragment analysis applications. GeneMapper™ *ID* software was specifically designed to be a complete solution for forensic laboratories performing STR analysis using ABI PRISM® genetic analysis instruments and AmpF*ℓ*STR® PCR Amplification kits. Currently, many forensic laboratories are using GeneScan® and Genotyper® software to perform analysis and genotyping of STR profiles. GeneScan® software analyzes the raw data collected from the ABI PRISM® instrument platforms and automatically identifies peaks, quantitates signal intensity, and sizes each DNA fragment. After the data analysis step with GeneScan® software, sample files are imported into Genotyper® software. Genotyper® software is then used for the automated genotyping of alleles when used with specific Genotyper® software template files designed for use with the AmpF*ℓ*STR® kits. GeneMapper™ *ID* software integrates the major functions of GeneScan® and Genotyper® software within one application and provides additional capabilities to aid the user.

GeneMapper™ *ID* software provides a graphical user interface which combines a sizing view with a genotyping view to allow for analysis and editing of alleles within the same window. The user interface also provides for the ability to observe samples on a per marker basis or on a whole sample basis. All views pertinent to forensic analysis are supported with GeneMapper™ *ID* software, including the ability to view raw data and analyzed data with colors displayed independently or overlapped. High throughput analysis is addressed with the incorporation of process component-based quality values (PQV), which monitor major components of the size- and allele-calling process. The quality values are reported by GeneMapper™ *ID* software as an aid to flag criteria related to sample preparation, PCR, separation, detection and analysis on a per marker basis. These quality values are represented as symbols to reflect "pass," "check," or "low quality" and are weighted by the user.

The PQV criteria related to genotypes are Boolean in that the sample either passes or fails a specific criterion. These criteria include: allele number error for markers containing more alleles than specified in the analysis method; out of bin alleles; peak height ratios, low peak height, and spectral pull-up levels below that specified by the user; broad peaks when the width of the called alleles' peak is wider than a specified value; offscale; control concordance when the designated control sample's genotype does not exactly match the definition; and, overlap for peaks positioned within the overlapping size range of two markers.

GeneMapper™ *ID* software includes three peak detector algorithms allowing different levels of user control over data analysis. This includes the "classic" mode which generates the same results as those generated from GeneScan® software version 3.1.2 designed for the Macintosh® operating system. This algorithm aids in the adoption of GeneMapper™ *ID* software for laboratories currently using GeneScan® software developed for use with the Macintosh® OS wishing to maintain current interpretation guidelines while upgrading to an improved software application. The "advanced" mode provides the user with the same analysis parameters available in GeneScan® software version 3.7.1 designed for use with the Windows NT® operating system including several improvements made to the algorithm. An additional "basic" mode allows for analysis using limited parameters consisting of a user defined minimum peak height threshold. Additional features new to the software include CODIS export functionality, automated sample concordance checking and search capability within the GeneMapper™ *ID* software database.

An extensive study to verify genotype concordance and the overall robustness of the features within GeneMapper™ *ID* software was performed. Here, six (6) AmpFℓSTR® PCR Amplification kits including Profiler Plus™, Profiler Plus™ *ID*, COfiler®, SGM Plus®, Identifile®, and SEfiler™ kits were used to amplify a set of forensic type samples. The samples were then run on four instrument platforms including the ABI PRISM® 377 DNA Sequencer (for use with both Macintosh® OS and Windows NT® OS), 310 Genetic Analyzer (for use with both Macintosh® OS and Windows NT® OS), and 3100 Genetic Analyzer. This paper will present the results of this study as well as illustrate the features present in GeneMapper™ *ID* software.

GeneMapper™ *ID* Software, Automated Genotyping, AmpFℓSTR® PCR Amplification Kits

B59 Forensic STR Analysis of Bone Samples: Improvements in Extraction and Amplification With a Focus on High Throughput

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Attendees will be given an overview of the setup and optimization of the International Commission on Missing Persons' (ICMP) high throughput bone typing lab including development of a DNA extraction technique and selection of a STR typing kit.

Armed conflicts in the former Yugoslavia during the 1990s led to hundreds of thousands of deaths with up to 40,000 persons still missing. Most of these missing persons can only be identified through forensic DNA testing for a number of reasons, including: the time lapse since people died, the lack of dental or medical records, unreliable connections between personal effects and the recovered bodies, and commingled remains. To meet the challenge of DNA testing a large number of bone samples, the ICMP has developed a high throughput DNA testing system capable of obtaining STR profiles from up to a thousand bone samples per month.

Producing STR profiles from 8–11 year old bone samples is often challenging because the samples contain only low levels of DNA, the DNA present is frequently degraded, samples usually contain substances that are inhibitory to PCR reactions, and bacterial contamination may create complications. One of the limiting steps in the identification of individuals following mass fatalities is the ability to isolate a sufficient amount of quality DNA from bone samples. The most commonly used technique for isolation of DNA from bone samples involves organic extraction procedures. This method for isolation of DNA from 8–11 year bone samples was attempted. However, subsequent STR typing was only possible in approximately 30%-50% of the cases. While analysis of the DNA extracts obtained via organic extraction indicated DNA was successfully isolated in the majority of these cases, the frequent failure of subsequent STR testing was suggestive of amplification obstacles, such as the presence of inhibitory compounds.

In an effort to increase the success rate of bone samples undergoing STR analysis, a silica based extraction method has been developed. Using approximately 5–6 grams of a bone sample in this modified extraction method has produced a 90%-95% success rate with Promega's PowerPlex®16 STR. An even higher success rate of approximately 99% has been realized when this procedure is used to extract teeth. The silica-based method is faster, cheaper, safer, and easier than organic based extraction methods. Furthermore the silica based extraction method appears to be much better at removing the inhibitory compounds from bone and teeth samples.

Incorporation of the silica-based DNA extraction procedure has led to the development of a high throughput DNA testing system for skeletal remains. The ICMP's DNA laboratory in Sarajevo, Bosnia and Herzegovina currently tests 45 bone samples, in duplicate, per day. The high success rate of obtaining STR DNA profiles from bone samples has resulted in a significant increase in the rate of the identification of the missing in the former Yugoslavia with between 200–300 individuals currently being identified on a monthly basis.

STR, Silica, DNA

B60 NIST Mixed Stain Study #3: Does DNA Concentration Measurement Accuracy Matter?

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The goal of this research project is to present to the forensic community findings from the NIST Mixed Stain Study #3 linking DNA concentrations ([DNA]) measurement accuracy to among-sample STR multiplex analytical signal variability.

Short-tandem repeat (STR) multiplex assays are now the dominant forensic DNA human identification technology. While multi-step and

chemically complex, current commercial STR multiplex assays provide results that are robust to typical among-laboratory differences in sample preparation, polymerase chain reaction (PCR) equipment and protocols, and separation and visualization systems. The National Institute of Standards and Technology (NIST) has coordinated a series of interlaboratory examinations of multiplexed STR systems. In addition to documenting the evolution of STR assays within the forensic community, these studies search for latent analytical difficulties by challenging analysts and assay systems with designedly difficult samples, presented in atypical contexts, and described with minimal instructions. No problem intrinsic to properly performed STR multiplex analyses has been encountered. In the 1999 Mixed Stain Study #2 (MSS2) [*J Forensic Sci* 2001;46(5):1199-1210], linkages between certain STR measurement anomalies and inaccurate DNA quantitation were observed. The 2001 Mixed Stain Study #3 (MSS3) was designed to further explore the performance of high-plexity STR systems and to resolve the DNA quantitation issues raised in the earlier interlaboratory challenges.

Participation in MSS3 was open to all human identity laboratories utilizing multiplex STR systems of five or more loci. Seventy-four institutions returned partial or complete results for the study.

Samples consisted of one control (labeled "R") and six study samples (labeled "S" to "X"). Control R was a single-source material, S to W were two-source materials, and X was a three-source material. With the exception of samples T and V, no source was used in the preparation of more than one material. Samples T and V were prepared from the same two sources to have identical total DNA concentrations, but with reciprocal 5:1 and 1:5 female:male source composition ratios. The MSS3 consisted of two major activities: (1) quantifying the DNA (as ng/□L) in the control and study samples and (2) analyzing all of the samples using one or more STR multiplex. From the first activity, participants were asked to report the [DNA] in each sample and to specify the quantification protocol used. From the second, participants were asked to report the volume of each sample used in each PCR amplification, to report the type and intensity of all observed alleles in each sample, and to assign where possible alleles to major and minor contributor sources. Participants were requested to analyze the control sample as the first and last sample in every set of analyses performed and to report the intensity of all alleles observed in each analysis. Participants were also requested to provide hardcopy of all gel image or electropherogram results. No sample handling, analysis, data analysis, nor result reporting procedures or formats were specified. All results were required to be submitted to NIST no later than 10-Oct-2001.

The consensus medians of the [DNA] agree very well with the design values. The among-participant variability in measuring [DNA] can be estimated from the average interquartile range of the individual distributions. This robust estimate of the among-participant [DNA] standard deviation, expressed as a multiplicative factor, is 1.6x. Since the similarly defined estimate of among-participant [DNA] variation in MSS2 was 1.8x, the [DNA] measurement comparability among the forensic community appears to have improved from 1999 to 2001.

The average signal per ng DNA amplified by one participant is not predictive of the signal observed by other participants. However, the average signal per ng DNA amplified of one sample does predict the signals for the other samples analyzed within a laboratory. The absolute efficiencies of the over-all STR multiplex measurement process (including the amplification, injection, separation, and detection subprocesses) are fairly variable among participants, even when the processes are nominally identical. However, the relative efficiency of each participant's measurement process is quite stable, at least over the days-to-months required by the MSS3 study.

Interlaboratory Study, Measurement Accuracy, STR Multiplex

B61 Optimization of Alternative Mini-Primers for the Amplification of Ancient Mitochondrial DNA

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The goal of this presentation is to identify alternative mini-primers for use in amplification of ancient skeletal remains that may have primer-binding site issues due to polymorphism contained within the primer binding site.

An accepted strategy within the forensic community for the identification of ancient skeletal remains is the isolation and sequencing of mitochondrial DNA (mtDNA) hypervariable regions one and two (HV1 and HV2). The high copy number of mtDNA genomes contained within the cytoplasm allows for identification of individuals where little to no nuclear DNA would be isolated. This strategy allows the mtDNA section of the Armed Forces DNA Identification Laboratory to accomplish its primary mission to aid Central Identification Laboratory, Hawaii, in the identification of human skeletal remains recovered from World War II, the Korean War, and the Vietnam Conflict. Currently HV1 (nt15989-16410) and HV2 (nt15-389) regions are amplified with one of four primers sets (PS1–PS4); or for highly degraded or inhibited case samples one of eight more sensitive mini-primer sets (MPS 1A – MPS 4B) are used (Gabriel et al., 2001). In experiments described below, increased knowledge of mutational hotspot locations within the mtDNA control region is utilized to identify and optimize alternative mini-primers for the amplification and sequencing of mtDNA HV1&2 regions where these hotspots fall within the primer binding sites.

Initially, primer R16237 (MPS1B) was investigated which has mutational hotspots in its binding-site at nt16223 and 16224. In an attempt to detect these polymorphisms, the use of a previously validated PS 1 primer R16251 was used to amplify and sequence. Experiments were carried out using known DNA (200pg/10ul) and several reported case and research extracts that have known nt16223 and 16224 polymorphisms. Amplification and sequencing assays demonstrated that R16251 had equivalent sensitivity to R16237 at 100, 10, and 1 pg of template DNA and that both R16237 and R16251 gave the correct sequence for their respective amplicons. Thus, either primer can be used in amplification and sequencing, however, use of R16251 generates an 11 base-pair longer amplicon that allows conformation of the 16223 and 16224 polymorphisms as well as an overlap with other mini-primer sets.

The authors next examined why, on rare occasions and with certain case extracts, R16322 (nt16303-16322) appears to flip in sequencing reactions to give a forward sequence instead of a reverse sequence. It is believed this flipping event may be a regional issue, not a template concentration issue since an amplification dilution assay of the positive control DNA from 100pg to 1fg with R16322 (MPS2A nt16268 -16322) failed to exhibit the same phenomenon. To address the regional issue, the research department designed a new primer R16353 to be used as an alternative primer for amplification when this phenomenon occurs. Amplification and sequencing reactions comparing R16322 and R16353 showed that R16353 had the same sensitivity and generated the same sequences as R16322, but with an additional 30 base pair read.

Finally, a commonly observed issue was addressed with MPS2B (F16268/R16410) where, in addition to the expected amplicon product, there is also a less prominent higher MW band that can lead to unusable mixed sequencing results. An alternative forward primer [F16222 (nt16222-16239)] was developed and even though it has potential binding-site issues at nt16223 and 16224, case extracts that did and did not contain these polymorphisms showed a reduction in the amount of double banding as well as reportable non-mixed sequencing results.

Therefore, F16222 should be used as an alternative amplification primer for MPS 2B when amplified case extracts demonstrate this higher MW banding.

In addition to addressing mini-primer set amplification issues, sequencing issues with MPS4B (F220/R377), where R377 gave ambiguous base calls along with truncated sequencing reads were also addressed. Previously reported case extracts were amplified with F220 and either R377 or R389 and, depending on the extract, results demonstrated a 2-8-fold increase in product yield when amplified with R389 as well as decreased ambiguous base calls and full length reads when sequenced with R381 instead of R377.

The continued identification and optimization of alternative mini-primers allows the primary mission of identifying human remains to be more efficiently accomplished by increasing productivity and decreasing the turn around time of case samples.

Alternative Mini-Primers, Polymorphism, Ancient DNA

B62 Canvassing the Y-Chromosome: The Identification of Genetically Diverse Y-STR Loci

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The goals of this presentation are to present to the forensic community the identification of new Y-chromosome short tandem repeat (Y-STR) loci with forensic potential. These new loci are distributed over the length of the Y-chromosome. Polymerase chain reaction (PCR) amplification for these new loci occurs exclusively in male individuals without the production of products from related loci elsewhere in the genome. Multiple products can occur as a result of genetic duplication events (on the Y-, X- or autosomal chromosomes) during human genome evolution.

Additional Y-chromosome microsatellite loci may be needed for forensic analysis because of the chromosomal distribution of currently available loci and because of potential typing error caused by the occurrence of duplicated genetic material in the human genome.

Men commit a substantial majority of violent crimes. Therefore, Y-STR loci are valuable tools in forensic science. They are particularly useful in the identification of the male contribution in mixed forensic samples. This is due to the fact that the differential lysis step, in which a limited and/or degraded male component has the potential to be lost, is not necessary for Y-STR analysis. In multiple rape cases, Y-STR loci would aid in the identification of the number of perpetrators. In addition to the benefits associated with the analysis of violent crimes, Y-STRs can aid in the identification of paternity, particularly for cases in which the putative father is deceased, to identify patrilineage. They are also useful for population studies. Paternal migration patterns can be analyzed, as well as relationships within and between populations.

As of August 2002, a number of Y-chromosome STR loci have been identified and examined in several populations. Most analyses were performed using different combinations of the loci characterized by Kayser et al., in 1997. The studies revealed a high number of unique haplotypes. Over the last 3 years, several investigators have described additional loci. A few of the loci identified in 1999 and 2000 were found to be informative, particularly when combined with the most informative of the original set of loci. More recently, two of the loci identified in 2002 were included in a 20-plex system with several loci from previous studies.

There are potential problems with these loci, however. Though several loci are informative, they are located mostly within 2 small regions of the Y-chromosome. The Y-chromosome consists of ~59 million base pairs. The currently available loci make up less than 10% of the chromosome. In addition, several of the existing loci are duplicated on the X- and/or Y-chromosome. In fact, several homologous regions exist between the X- and Y- chromosome, which may have the potential to undergo recombination. Since the current Y-STRs are not dispersed randomly across the Y-chromosome, if recombination is occurring it will go undetected. The utilization of Y-STRs to identify male individuals is a novel approach. However, the use of duplicated loci in forensic cases is less than ideal, particularly during the identification of the number of perpetrators in a multiple rape case.

A large portion of the Y-chromosome remains to be studied. More than 17 million nucleotides of the Y-chromosome, which were annotated and released in the public database, GenBank, have been screened. Outside of the regions that contain the existing loci 465 were identified. These new loci were evaluated by comparison against the draft version of the entire Human Genome Sequence. Of 229 loci examined to date, 72% are duplicated elsewhere in the human genome, mostly on the X- and/or Y-chromosome. Due to the fact that the present version of the Human Genome Sequence is a draft version, the remaining 64 unique tri- to hexanucleotide repeat loci were further analyzed in a racially diverse population of males and females to ensure that amplification occurs at only 1 locus and is limited to male individuals.

The loci were also examined in this sample population to assess their forensic potential. The majority of the loci identified possess more than one allele. As of August 2002, several loci which possess 9 alleles in a small test population of ~30 male individuals have been identified. Results will be discussed concerning the genetic diversity of the loci. The most informative loci will be multiplexed and further examined in a larger population of racially diverse male and female individuals.

Y-Chromosome, Y-STRs, Microsatellites

B63 Validation and Forensic Casework Applications of the Y-STR Genotyping Systems Y-PLEX™ 6 and Y-PLEX™ 5

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The goals of this presentation are to present to the forensic community the utility of Y-STR analysis in forensic casework.

The analysis of Y-chromosome short tandem repeats (Y-STRs) is very useful in resolving sexual assault cases. This is due to the ability to type the male DNA specifically in a sample containing mixtures of male and female DNA. The Y-STR user group has identified 8 loci namely DYS393, DYS19, DYS390, DYS391, DYS389I, DYS389II, DYS392, and DYS385 as minimal haplotype. Y-PLEX™6 and Y-PLEX™5 genotyping systems were used in the present study. These 2 amplification systems together provide results for the minimal haplotype and 2 additional loci namely DYS438 and DYS439. DYS385 locus provides results for two alleles which is a result of gene duplication and mutations. Thus, Y-PLEX™6 and Y-PLEX™5 provides results for 11 alleles.

The validation studies were performed according to the SWGDAM guidelines and included the following experiments: annealing temperature, primer ratio, primer concentration, salts, DNA polymerases, dNTPs, thermal cyclers, denaturation time, annealing time, cycle extension time, final extension time, PCR cycles, reaction volume, female DNA, sensitivity, non-human studies, reproducibility, precision,

additives, inter-laboratory studies, female-male mixtures, male-male mixtures, stutter, DNase degradation, environmental insult, and non-probative casework. A database for 11 alleles is generated for Caucasian, African American, and Hispanic population groups. The haplotype frequency and genetic diversity using these 11 alleles will be presented. The database with a haplotype frequency calculator is freely available for use by forensic community.

The results for 6 forensic cases analyzed using the Y-PLEX™ 6 kit will be discussed. The first case was a criminal paternity case involving a mother, alleged father, and product of conception. Studied was a mixture of DNA in which the mother's DNA was the major component and the male fetus' profile was dropping out using AmpFlSTR® Profiler Plus and AmpFlSTR® COfiler systems. The Y-PLEX™ 6 kit was used to determine if the tested man could be the father of the product of conception. The second case involved a victim who was found strangled to death. The suspect, when arrested, had scratches on his face. Nuclear STR results on the fingernail scrapings showed several alleles consistent with suspect but many alleles were below 75 RFU, producing inconclusive results. The fingernail scrapings were amplified using the Y-PLEX™ 6 kit to obtain single male profile. The evidence in another case was a semen stain found on a bathrobe. AmpFlSTR® Profiler Plus results were consistent with the female victim and there was no indication of a male. A Y-STR profile was obtained, even in the absence of a Y peak with AmpFlSTR® Profiler Plus. Y-STR results were consistent with the male suspect. In this case, the victim was beaten to death. The suspect was the victim's live-in boyfriend. AmpFlSTR® Profiler Plus resulted in an un-interpretable mixture. With Y-STR, the number of male contributors was determined and the boyfriend excluded. The last case that will be discussed was a non-suspect case. The AmpFlSTR® Profiler Plus results for a non-suspect case indicated a mixture of at least 3 people. Y-STR results showed 2 males, present in a 1:1 ratio, in the sperm cell fraction.

Y-STR, SWGDAM Validation , Y-PLEX™ 6 and Y-PLEX™ 5

B64 Highly Discriminating Y-STR Multiplexes Suitable for Forensic Use to Permit the Determination of 42-Loci Male Haplotypes

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The goal of this presentation is to inform the forensic community about novel Y-STR systems to dramatically increase the discriminating potential of Y-STRs currently available to the forensic community.

Most of the Y-STR multiplex systems in current forensic use incorporate the so-called European Y chromosome community's minimal haplotype loci together with a limited number of additional markers. In an attempt to dramatically increase the discriminatory potential of Y-STRs available to the forensic community, an additional 2 novel Y-STR systems have been developed. In order to develop Y chromosome multiplex analytical systems specifically for use in the forensic community, efforts were made to maximize the number of loci able to be co-amplified within the systems (including the introduction of a 5-dye system rather than the 4-dye system frequently used), to ensure appropriate assay sensitivity (1-2ng of input genomic DNA), and to minimize interference from female DNA.

Multiplex III (MP3) and Multiplex IV (MP4), have been developed in addition to the previous 2 Y-STR systems in the laboratory (Multiplex I and Multiplex II). Multiplex I and Multiplex II include DYS 19, DYS 385(a) and (b), DYS 388, DYS 389I and II, DYS 390, DYS 391, DYS 392, DYS 393, DYS 425, DYS 434, DYS 437, DYS 438, DYS 439, Y-GATA-C4, Y-GATA-A7.1, and Y-GATA-H4. Multiplex III and Multiplex IV contain an additional 23 loci to extend the 19 loci included in Multiplex I and Multiplex II to allow the amplification of 42 total Y-STRs. Multiplex III includes DYS 426, DYS 436, G09411 (DYS 462), DYS 441, YAP (Alu insertion), Y-GATA-A10, DYS 288, DYS 435, and DYS 442. Multiplex IV utilizes the new 5-dye capability of the ABI 310 Genetic Analyzer (6-FAM, VIC, NED, PET, and LIZ) that allowed for incorporation of 14 loci in a single multiplex system. Multiplex IV incorporates DYS 443, DYS 444, DYS 445, DYS 447, DYS 448, DYS 449, DYS 452, DYS 453, DYS 454, DYS 455, DYS 456, DYS 458, DYS 463, and DYS 464.

The 2 multiplex systems provide consistent and robust amplification over a broad range of primer, magnesium, and DNA polymerase concentrations. Full male haplotypes can be obtained from picogram amounts of input DNA, making these systems suitable for use in forensic casework. The systems were designed to target only male DNA and to avoid interference from large amounts of female DNA. As such, the Y-STR systems may eliminate the need for differential extractions since only male DNA is targeted and thus eliminate the possible loss of DNA associated with the differential extraction. Also, since these systems provide a male haplotype, the number of male donors within a given sample is easier to discern.

Y-STR, Multiplex, Haplotype

B65 Robust STR Multiplexes for Challenged Casework Samples

James W. Schumm, PhD, and Elizabeth K. Douglas, BA, The Bode Technology Group, 7364 Steel Mill Drive, Springfield, VA*

The goals of this presentation are to teach superior methods to produce STR profiles with challenged samples.

Many casework samples contain amplification inhibitors or degraded DNA and sometimes both. This condition has been particularly common with World Trade Center bone fragment samples that were exposed to high levels of moisture and extreme heat for several weeks prior to processing. Work with these samples motivated the authors to create STR multiplexes displaying more robust results under these trying casework conditions. The successful development and implementation of these systems will be described.

Commercial providers of STR multiplex systems have been motivated to develop systems that generate some alleles greater than 350 or even 400 bases. With the selection of 13 CODIS STR loci, the numerous alleles of each locus, the attempt to include as many loci as possible in each multiplex, and the limitation of the number of instrument-compatible dyes allowing clean color separation, these large amplification products are required.

Researchers observed that locus dropout occurs predominantly with the larger amplicons whether the cause is degradation or inhibition. K. Yoshida et al. (1997) and P. Wiegand et al. (2001) have described improved monoplex STR amplification of degraded DNA using primers that generate shorter amplicons. The multiplex design was built upon the efforts of J. Butler et al. (personal communication) to generate smaller amplification products for loci that were originally designed to generate large amplicons.

Developed were 3 multiplexes. In general, they generate no STR products greater than 210 bases long. The single exception is the FGA locus. The largest alleles of FGA can be 206 bases long in the repeat regions themselves. With additional size required for primer lengths and for quality hybridization site selection, products at this locus can sometimes be larger than 210 bases.

Another goal of the multiplex design was to complement the larger CODIS loci of all commonly employed commercial multiplexes. All the large loci of Profiler Plus, COfiler, and Identifiler are contained in BodePlex 1 and BodePlex 2. The combination of BodePlex 2 and BodePlex 3 contain all the large CODIS loci of the PowerPlex 16 and PowerPlex 16BIO multiplex.

Primary developmental concern was multiplex performance under extreme conditions. The systems were developed to generate approximately ten times the normal signal using 0.25 ng of human DNA template. Great care was taken to adjust primer melting temperature, primer concentration, and primer sequence selection to provide robust amplification while avoiding or limiting artifacts in the multiprimer environment.

The reasoned design and robust nature of the product transferred to success with analysis of the World Trade Center samples. In an initial attempt with these samples, 45% of previously poor quality profiles were improved to the point that they could be accepted for use in the identification project. Additional attributes of validation and implementation of these systems will be discussed.

STR, Small Amplicons, World Trade Center

B66 Development of A Male-Specific, 12-Locus Fluorescent Multiplex

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The goal of this presentation is to present a new assay for analysis of Y-STR markers to the DNA typing community.

Short Tandem Repeat (STR) analysis has become the leading technology for genetic human identification. Frequently, autosomal markers are used for forensic, paternity and anthropological studies. However, some cases can benefit from the analysis of sex-specific Y-STR markers. Y-STR markers consist of polymorphic regions found on the non-recombining region of the Y chromosome. Amplification of these haploid markers occurs only in males and alleles are inherited only through the paternal line. These qualities simplify interpretation of complex male/female mixtures and male kinship studies by removing the female contribution.

Several web-based databases of observed Y-STR haplotypes have been initiated (http://www.ystr.org/). These databases include the so-called "Y-STR minimal haplotype," which consists of nine loci: DYS19, DYS385I/II, DYS389I/II, DYS390, DYS391, DYS392, DYS393. A commercially available, single-amplification assay for these loci has yet to be offered. To this end, a fluorescent multiplex has been developed to include the Y-STR minimal haplotype plus DYS437, DYS438 and DYS439. This new PowerPlex® System uses four-color chemistry allowing analysis on the ABI PRISM® 377 DNA Sequencer, ABI PRISM® 310 Genetic Analyzer and ABI PRISM® 3100 Genetic Analyzer. Amplified samples are labeled with fluorescein, 6-carboxy-4',5'-dichloro-2',7'-dimethoxy-fluorescein (JOE) and carboxy-tetramethylrhodamine (TMR). Fragment sizing is provided by an internal size standard labeled with carboxy-X-rhodamine (CXR). Color deconvolution can be performed with color matrix kits currently available from Promega Corporation. Allelic ladders have been created, following ISFG recommendations(1), to increase confidence in allele designation. A PowerTyper™ macro, operating within the Genotyper® software, has been designed to automatically label fragments from GeneScan® data using the supplied allelic ladder and size standard. Primers have been designed to yield amplification products that are less then 350 bp in length. System sensitivity, specificity, robustness and concordance with previously described primer sets will be discussed.

[1]Gill, et al. DNA Commission of the International Society of Forensic Genetics: recommendations on forensic analysis using Y-chromosome STRs. Int J Legal Med (2001) 114:305-309.

DNA Typing, Short Tandem Repeat (STR), Y Chromosome

B67 STR Profiles From Chemically Processed Fingerprints

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The goal of this presentation is to present to the audience a method for obtaining STR profiles from processed fingerprints that are complete, partial, or smudged. Attendees will understand the use of processed fingerprints for identification beyond standard fingerprint analysis. STR profiles can be obtained from a processed fingerprint and are useful for DNA typing and identification. Modified extraction, amplification and analysis protocols used to obtain the STR profiles will be presented.

Fingerprints are often used in the forensic community to associate an individual with a crime scene. Fingerprints that are smudged or contain partial fingerprint profiles that are non-interpretable cannot be used for fingerprint analysis, however; DNA profiles can be analyzed from these types of fingerprints and provide valuable information for crime scene analysis or for investigative leads. Modified extraction, amplification, and analysis protocols were used to obtain STR profiles from processed fingerprints.

Using the Powerplex 16 STR typing kit, STR results have been obtained from fingerprints. Fingerprints were collected from both porous and nonporous substrates to include photocopy paper, polyethylene trash bags and polyvinyl chloride material. Fingerprints were processed with a variety of chemicals including the following processes: Ninhydrin, DFO plus Ninhydrin, Magnetic Powder, and Cyanoacrylate. For collecting epithelial cells from the processed prints, 3 methods were compared: dry swabbing, moist swabbing, or direct lysis. All 3 collection methods resulted in STR profiles. DNA from processed fingerprints was purified using the Qiagen QIAamp DNA Mini Kit and further concentrated with a Microcon 100 membrane. The amount of DNA obtained from a processed fingerprint corresponds to approximately 0.25 nanograms of genomic DNA. Current quantification methods for measuring DNA below 0.25 nanograms are inconsistent. Additionally, using the whole volume of purified DNA from the processed print is necessary to obtain maximum amplification yield. Therefore, quantification was not performed prior to amplification. Modified amplification protocols were used to amplify the Promega Powerplex 16 loci. Amplified product was electrophoresed on the ABI 3100 and analyzed using ABI Genescan and Genotyper software.

Full 16 locus profiles were obtained from DNA purified from the aforementioned fingerprint processes; however, some fingerprint samples resulted in partial profiles. Inhibition studies with human and non-human target DNA indicated the removal of potential PCR inhibitors. Results also indicate that the partial profiles were due to the variation in the number of cells associated with individual fingerprint samples, not the presence of PCR inhibitors associated with chemical processed fingerprints. Validation studies of STR methods using fresh and aged prints (up to 2 years old) collected from various substrates were performed. Fingerprints used in the validation studies were processed with a variety of chemicals including the processes listed above. Results from the validation study will be presented. Interpretation of STR results regarding peak height ratios, peak height thresholds, and mixture ratios will be also presented.

STRs, Processed Fingerprints, DNA Extraction

B68 An Improved Process for Buccal Cell Collection and Analysis

James W. Schumm, PhD, John C. Fox, BS, and Jangbir Sangha, BS, MA, The Bode Technology Group, Springfield, VA*

The goal of this presentation is to expose the community to a reliable efficient new option in sample collection for DNA analysis.

There is a vital need in DNA testing for a reliable, non-invasive, and efficient method of DNA sample collection that feeds directly into automated downstream processes. Currently blood collection and deposition onto membranes provides a reliable collection method. Generally, less than 10% of these samples processed for typing require re-extraction and analysis. However, buccal cell collection methods involving secondary transfer to membranes can increase re-run requirements to 15% or even 30% of samples.

This shortcoming has been overcome by development of a device specifically designed for direct collection of buccal samples for DNA storage and analysis. All components of the device including a support, handle, and a flat membrane are compatible with oral sample collection. The materials are designed for self-collection under the supervision of an observer. Thus, the procedure is compatible with collection of convicted offender samples as well as samples collected at point of arrest. Several swipes of the back-supported membrane against the inside of the cheek allow collection of sufficient buccal cells for at least 20 DNA analyses. A cap with air holes is provided to protect the sample during drying, transport, and storage.

Once received in the laboratory, the design facilitates simple separation of the membrane and handle from the cap and the plastic support. The membrane thickness was selected to allow insertion into an automated membrane-punching device. A barcode placed on the handle either at the time of collection or the time of manufacture is read by the puncher. The instrument places punches into a well of a 96-well tray and creates an electronic file of the location of the sample. (Note: This step may be performed by hand if preferred.) The steps of DNA extraction and preparation for PCR amplification are rapidly completed with multi-channel pipettors. The puncher output file is used to populate electronic and paper support materials for downstream analytical processes.

Prototype devices were given to 56 individuals along with written instructions. Generally, no individualized or verbal training was provided. In all cases, all 13 CODIS STR loci were obtained from amplification with Profiler Plus and COfiler. Similar results were achieved with the PowerPlex 16 multiplex and aspects of validation will be discussed.

In summary, this DNA collection device is a new effective tool to improve reliability of DNA sample collection and typing, facilitate automated rapid sample processing, and integrate with electronic data management.

Buccal, DNA, Device

B69 Validation of the Qiagen Bio Robot™ 604 for the Extraction of DNA From Buccal Swabs

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The goals of this presentation are to compare the Qiagen BioRobot™ 9604 extraction method with Chelex and Organic extraction methods on buccal swabs and to present this data to the forensic community.

The opinions and assertions expressed herein are solely those of the authors and should not be construed as official or as the views of the U.S. Department of Defense or the U.S. Department of the Army.

The objective was to validate the Qiagen BioRobot™ 9604 for use with Puritan cotton tip and Gibco BRL C.E.P. buccal swabs. The Qiagen BioRobot™ 9604 is designed to automate routine extraction of DNA from buccal swabs. The validation involved the comparison of DNA extracts obtained from the Qiagen BioRobot™ 9604 with DNA extracts obtained using a standard swab Chelex extraction method and a swab organic extraction method. Comparisons were based on quantitation results using the QuantiBlot™ Human DNA Quantitation Kit and on STR analysis of PCR products using the AmpFlSTR Cofiler™ and the AmpFlSTR Profiler Plus PCR Amplification Kits. Experiments were performed according to the Qiagen BioRobot™ 9604 user's manual.

Swabs, 4 cotton type and 4 C.E.P. type, were collected from 10 individuals. The swabs were gently rubbed against the inside of the volunteer's cheek and gum line for approximately 30 seconds. For one individual an additional C.E.P. swab was collected without extensively rubbing it along the cheek and gum line. This was done to test the sensitivity of the Qiagen on a poorly collected sample. A C.E.P. and a cotton type swab was extracted for each individual for each method of extraction that was tested for a total of 60 swabs. An extra C.E.P. type swab was also extracted to test sensititvity as stated above.

The 21 swabs that were extracted using the Chelex method gave visual results on the QuantiBlot™ film upon quantitation. The samples contained approximately .0625- .5ng/ul of DNA. The 21 swabs that were extracted using the organic method also gave visual results on the QuantiBlo™ film upon quantitation. The samples all contained greater than 2ng/ul of DNA. The 21 swabs that were extracted using the Qiagen BioRobot™ 9604 contained .5-2ng/ul of DNA. The sample that was used to represent a poorly collected sample had less DNA (.06125ng/ul) than the swab collected the proper way (.25ng/ul).

Full profiles from the Chelex extracts were generated for 13 of the samples using Profiler Plus and 15 of the samples using Cofiler. All of the organic extracts gave full profiles for both kits. Full profiles were generated for both Profiler Plus and Cofiler for 17 of the swabs that were extracted using the Qiagen BioRobot. The 4 C.E.P. type samples extracted on the Qiagen BioRobot gave no profile with both Profiler Plus and Cofiler. All 4 were amplified with 10 ul of DNA and contained less than .03125ng of template DNA. The sample that was taken to represent a poorly collected specimen gave a full profile for all extractions. All of the samples gave a DNA profile that was consistent with the ones that were on file for the volunteer. No contamination was observed. The 4 samples that did not generate a profile using Qiagen gave full profiles when extracted using the Chelex and Organic methods. It was observed that the C.E.P. swabs were not completely covered by the tissue lysis buffer and pro K. This is believed to be the reason that the four C.E.P. type swabs did not yield DNA.

As a follow up to this study, it was found that sample initially extracted using the Qiagen BioRobot could be reextracted using the organic method. There was between 1 ng/ul and >2 ng/ul of DNA in the reextracted samples when quantitated with QuantiBlot™. The second extraction yielded enough DNA to get a full profile from the swabs.

The Qiagen BioRobot™ 9604 has proven to be acceptable for use with both comb and cotton type Buccal Swabs. The in-house validation experiment shows that the concentrations of DNA obtained from the Qiagen extraction are better than those obtained from the standard Chelex. The Qiagen extraction did not give a DNA yield that was better than the Organic extraction method.

Buccal Swabs, Qiagen BioRobot, STR

B70 The Application of Reduced Size STR Amplicons in the Analysis of Degraded DNA

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The objective of this presentation is to develop STR markers with re-designed primer sequences to produce smaller amplicons. These new markers can be utilized in the analysis of degraded DNA and provide a useful alternative to mtDNA sequencing with the added benefit of complete compatibility with the CODIS STR set. These markers have been combined to produce subsets of 3 to 6 loci and are entitled "Miniplexes." The effectiveness of these miniplex sets was tested on enzymatically degraded DNA and DNA extracted from human skeletal remains from which previous attempts using standards primers had not yielded usable results.

In heavily degraded DNA, poor amplification of the larger sized amplicons in standard multiplex typing kits (300-500 base pairs) is common. This is because as the sample decomposes, the DNA template can become highly fragmented, and the yield of template fragments having a complete target sequence is greatly reduced. Thus in multiplex kits with a wide range of amplicon sizes, a "decay curve" is seen, in which the larger loci have much lower intensity, and often drop out or fall below the detection threshold. The new "Miniplex Primers" have been re-designed so that the target sequence is much closer to the repeat region and will therefore produce smaller amplicons.

The re-designed primers were developed through a collaborative arrangement between Dr. John Butler at the National Institute of Standards and Technology and the McCord research group at Ohio University. The primers include the majority of the 13 CODIS STR loci (TH01, CSF1PO, TPOX, D5S818, D8S1179, D16S539, FGA, D21S11, D7S820, vWA, D18S51, D13S317), as well as 3 non-CODIS loci (Penta D, Penta E, D2S1338). Five sets of loci were designated as miniplexes. To avoid overlap, the markers were amplified with one locus in each dye lane and typically contain only 3 STRs per set. The primers were labeled with 6-FAM (blue), VIC (green) and NED (yellow). Miniplex 1 and Miniplex 3 differed in the size ranges and can be multiplexed together to create a six-loci set entitled "Big Mini." These miniplex sets allow for a reduction in product size up to 299 base pairs, with most amplicons ranging in size from 60-200 base pairs. The allele designation and profile remains unaltered. Because these primers produce small amplicons, they allow for a more complete profile from degraded DNA. Degraded DNA was amplified using these primers and compared to the larger primers from commercial kits.

To determine the effectiveness of the miniplex kits in the analysis of degraded DNA, genomic DNA was enzymatically digested using DNase I. The DNA was incubated with DNase I for a range of time periods: 2, 5, 10, 15, 20, and 30 minutes. The degraded DNA was separated by gel electrophoresis using 2% agarose and stained with ethidium bromide for detection. Different regions of the gel corresponding to different fragment sizes were excised from the gel and purified using the QIAquick Gel Extraction Kit. The different fragment sizes were then amplified by PCR using the "Big Mini" primer set and a commercial primer set. The amplified DNA was analyzed using an ABI Prism 310 capillary electrophoresis with four-channel fluorescence detection and the GS 500 ROX size standard. The Big Mini primer set was capable of producing more complete profiles from the smaller fragment samples.

Bone samples were prepared by extracting DNA from femur sections that had been cleaned with ethanol and distilled water, cut with a rotary tool, cleaned again, and pulverized under liquid nitrogen to produce a powder. The powder (0.1g) was decalcified in EDTA, digested using a stain extraction buffer and proteinase K, and purified and concentrated using the QIAgen MiniAmp Blood Kit. The DNA was amplified by PCR using the miniplex kits and a commercial kit. The amplified DNA was analyzed using an ABI Prism 310 Capillary electrophoresis with four-channel fluorescence detection and the GS 500 ROX size standard. The miniplex primer sets were capable of producing more complete profiles from the DNA extracted from bone samples.

In both types of degraded DNA, the miniplex primer sets were capable of producing more complete profiles. These re-designed primers can provide a new tool for the analysis of degraded DNA and increase the probability of obtaining a usable profile from degraded DNA.

Degraded DNA, STR, Miniplex

B71 Mass Disaster Remains Sample Tracking (World Trade Center and American Airlines Flight 587)

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This presentation will describe how postmortem samples were collected, accessioned, processed, prepared, and packaged for DNA testing. A specific challenge arose through the use of several contract laboratories. This presentation will also describe the staffing needs related to the above.

When the World Trade Center collapsed, 2,823 individuals disappeared and were reported missing. In order to provide closure to their families, all human remains recovered from the site were genetically tested and compared to reference samples. Due to the extreme heat and friction it could not be expected to recover human remains for all victims and most samples were of very poor quality, therefore a decision was made to test even small samples without prior selection.

Sample collection started on the evening of 9/11 and continued in day, night, and weekend shifts. The Forensic Biology Department staff was required to aid in the sample collection in the morgue at all times. In the beginning samples sent to the lab, although barcoded at autopsy, had to be logged into the laboratory by hand. The New York State Police shared their LIMS system ("BEAST" by Porter Lee Company) and provided support by sending State Troopers and Laboratory Personnel already familiar with the system, along with a staff member from Porter Lee to train Forensic Biology personnel in the use of this system. As accessioning/processing needs were identified, the software was modified accordingly.

Sample handling in the laboratory was limited to a small group of Forensic Biology staff who had been trained in the LIMS software. Since the specialized and trained staff was urgently needed during the day, night shifts and weekend personnel was supplemented by support from OCME (Office of the Chief Medical Examiner) staff in the Department of Forensic Toxicology, as well as various agencies, including the Federal Group DMORT (Disaster Mortuary Operational Response Team), New Jersey State Police Scientists, and medical school students from Columbia and New York Universities. Utilizing volunteers was key to the success of the operation in both sample receipt and processing. A reduced number of forensic scientists was available day and night to train and oversee federal aides and volunteers.

After the accessioning was complete, tissue samples were immediately cut for DNA extraction and frozen for storage. Some samples were split upon receipt: for example, if bones were received with tissue adhering to them, the tissue was removed from the bone and the receipt

of two items was recorded. This had two advantages: 1) from now on bones could be stored at room temperature or 4°C, and shipped at room temperature, while the removed tissue was stored at -80°C; 2) both items were tested and concordance of allele calls served as quality control for the process.

The BEAST was used to track samples on various levels: original item received from autopsy, cuttings taken for DNA extraction, DNA extracts in microtiter plates, aliquots prepared to be shipped to different contract labs, release of these aliquots, final release of the original item to a funeral director, applicable only if the sample received by forensic biology was not a cutting of a larger set of human remains but the whole "body part."

Most DNA typing of samples was outsourced due to the volume of samples (almost 20,000 at this writing), and the need for the department to avoid a backlog of regular casework.

Tissue extracts were processed robotically and stored in 96 well microtiter plates; the final extract is split into 3 aliquots in 3 plates with each plate sent to a contract laboratory for specific high through-ut DNA tests. Myriad, Bode Technology Group and Celera have received thousands of extracts so far; Orchid Genescreen will be added to this group. This way the OCME controls samples and DNA extracts which are shipped to four different contract labs, each with different requirements for the sample manifest. Bone samples, clean of tissue, are packed in groups of approximately 100 (50 mLconical vials) and shipped to Bode Technology group. All of the above is tracked utilizing the BEAST.

In the near future, all samples and sample extracts will return to the laboratory, and the actual samples as well as the results will be tracked to ensure that each sample has been tested in each of the required systems. Software for this purpose is currently being written.

It is hoped that this presentation will illustrate the need for a comprehensive teamwork approach and computer tracking capabilities in connection with the receipt and testing of remains from Mass Disasters.

Tracking, LIMS, Outsourcing

B72 Terror in the Skies After the World Trade Towers: The Identification and Reassociation of Remains From the Pentagon and Somerset Plane Crashes

Kimberly B. Murga, MFS, Demris A. Lee, MSFS, James J. Canik, BS, and Brion C. Smith, DDS, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Rockville, MD*

The goals of this presentation are to present issues of concern beyond the processing of DNA, including suitable reference material and data management and the successful utilization of DNA in two simultaneous mass disasters.

Shortly after the World Trade Center Towers One and Two were hit by aircraft on the morning of September 11, 2001, American Airlines Flight 77 crashed into the side of the Pentagon killing all 64 passengers (including 5 terrorists) on board and 125 Pentagon employees. Within minutes thereafter, United Airlines Flight 93 crashed into a field in Somerset County, PA, killing all 44 passengers (including 4 terrorists) on board. Prior to September 11, 2001, AFDIL (Armed Forces DNA Identification Laboratory) had never faced the challenge of managing and processing DNA samples for the identification and reassociation of individuals from two mass disasters simultaneously.

Remains from the Pentagon incident were collected and brought to Dover Air Force Base in Dover, DE, where specialists in the fields of forensic pathology, odontology, anthropology, and DNA worked for over two months to identify the remains of 188 people killed. Some of the remains from the Pentagon employees were relatively intact, while remains from the plane crash victims were completely disarticulated. Approximately 938 evidence specimens were submitted for DNA analysis to include bone, tissue, hair, and teeth. Approximately 348 reference specimens were submitted for testing to include both indirect references from immediate family members and direct references such as bloodstain cards, paraffin blocks, histological slides, hairbrushes, worn clothing, and toothbrushes. All samples were processed in a matter of two months. Of the Pentagon Crash victims (excluding the 5 terrorists) 177 were identified. Never identified were 1 child passenger from American Airlines Flight 77 and 4 Pentagon Employees. Through the process of elimination, 5 male profiles were generated and unable to be matched to any of the references, and were therefore assumed to be those of the 5 male terrorists on board the plane.

Remains from the Somerset County, PA, plane crash were collected and brought to a mobile morgue set up in an area nearby the crash site. Experts in DNA collection and a DMORT (Disaster Mortuary Operational Response Team) team comprised of odontologists and anthropologists were staffed for two weeks in an attempt to identify remains. Due to the severe fragmentation of all 44 passengers, a limited number of individuals were identified using odontology and fingerprints. Approximately 592 evidence specimens were submitted for DNA analysis to include bone, tissue, hair, teeth, and finger- and/or toenails. Several hundred reference specimens were submitted for testing to include both indirect references from immediate family members and direct references. With the help of the FBI (Federal Bureau of Investigation), approximately 102 references were tested to include bloodstain cards, hairbrushes, worn clothing items, razors, dental pieces, toothbrushes, a hair clip, and a bag of skin. All samples were processed within 3 months. Through DNA analysis, fingerprints and odontology, all 44 passengers (including the 4 terrorists) were identified.

The evidence specimens gathered from both crash sites had been exposed to a wide variety of DNA degradation factors to include water, fire, extreme heat, jet fuel, and the general lapse of time. Due to the explosive nature of both incidents, there was also severe co-mingling of specimens during the events. Despite the difficult nature of DNA analysis for the evidence, STR analysis from the Pentagon evidence yielded an approximate 98% success rate while STR analysis from the Pennsylvania plane crash evidence yielded an approximate 92% success rate. The greatest area of concern for the identification of individuals is to establish suitable references for each victim. With the collective coordination of agencies to include the FBI, the Department of Defense, the Somerset County Coroner's Office, and United Airlines, suitable references were obtained for all victims from both mass disasters. If direct references such as personal effects or bloodstain cards are not available for DNA analysis, references from immediate family members such as parents and/or offspring were obtained to establish familial trees.

Testing over 2,000 specimens in the span of a few weeks required the immediate focus of about 60 lab personnel and 40 support staff coordinating efforts. Using an automated mobile evidence collection program at both Dover and Somerset collection sites, and a paperless laboratory case management system for both mass disasters alleviated many of the problems associated with collecting hundreds of specimens, and employing 60 lab personnel to work on the same two mass fatalities. The STR profiles generated from thousands of specimens were imported into either an evidence or reference database for each case. Search functions of the databases include the ability to select specimens that show full allele sharing for direct comparisons and half allele sharing for parentage comparisons, as well as the generation of statistical weight for each identification.

The opinions and assertions expressed herein are solely those of the authors and are not to be construed as official or as the views of the U.S. Department of Defense or the U.S. Department of the Army.

Mass Disaster, Direct References, Indirect References

B73 The Bombing of the USS Cole: The Role of DNA in Sending Seventeen Heroes Home

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The goals of this presentation are to present the use of DNA in the identification and reassociation of remains from the USS Cole bombing.

On October 12, 2000, at 11:18 AM, a 40 X 40-foot hole was blown in the side of the USS Cole by a small harbor craft packed with explosives as it stopped in Aden, Yemen to refuel. The blast injured 39 crewmen and killed 17 U.S. sailors.

Five bodies were recovered October 12, six bodies were recovered on October 17, two bodies were recovered on October 18, and the remaining four bodies were recovered on October 19, 2000. The bodies were relatively intact; however, there were some disassociated remains from a few of the sailors. The bodies and disassociated remains were flown to Dover Air Force Base following each recovery. Specialists in the fields of forensic pathology, odontology, fingerprints, and anthropology examined all remains at Dover Air Force Base. Approximately 28 evidence samples were submitted for DNA analysis to include bone, tissue, and skin (finger stalls). Each of the 17 sailors had a reference bloodstain card stored at the AFRSSIR (Armed Forces Repository of Specimen Samples for the Identification of Remains) for comparison. Of the 17 sailors, 9 were identified via fingerprints, 14 were identified via forensic odontology, and all 17 sailors were identified via DNA analysis. Of the 28 pieces of evidence submitted for DNA testing, 22 were reassociated back to 17 sailors, 3 specimens yielded no results or insufficient data to render a conclusion, and 3 specimens were not tested due to the fact they were duplicate submissions.

In November of 2001, the Armed Forces DNA Identification Laboratory initiated DNA testing on an additional 65 pieces of disassociated remains that were turned over to the Office of the Armed Forces Medical Examiner (OCME) from the Federal Bureau of Investigation (FBI). These specimens were discovered over a period of months as the USS Cole was dry-docked and repairs to the ship were underway. These specimens included bone, tissue, and teeth. Specimens were compared to the DNA results obtained from the bloodstain reference cards pulled from the Repository in October of 2000. Of the 65 additional specimens tested, 42 were reassociated back to 5 sailors, 13 specimens produced mixtures that could not be resolved, and 10 specimens tested yielded no results or insufficient data to render a conclusion. Extraneous DNA profiles that could have originated from 1 of the 2 terrorists during the attack were not discovered by AFDIL.

The opinions and assertions expressed herein are solely those of the authors and are not to be construed as official or as the views of the U.S. Department of Defense or the U.S. Department of the Army.

Mass Disaster, References, STRs

B74 Examination of Personal Effects as Reference Samples for Victims of a Mass Disaster

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The information in this presentation will serve as a guideline for collection and DNA extraction of victims' personal effects for DNA comparison in the event of a mass disaster.

During the recovery efforts following the World Trade Center attack on September 11, 2001, and the crash of American Airlines Flight 587 in Rockaway, Queens on November 12, 2001, a large number of personal effects were turned in to the OCME (Office of Chief Medical Examiner) to aid in DNA identifications. These items included those traditionally collected during mass disasters such as toothbrushes, hairbrushes, razors, and clothing. Testing on reference items from Flight 587 victims was performed at the OCME in New York City. Results indicate that the most successful samples (the best DNA sources based on the average number of STR loci reported) are toothbrushes, followed by razors, hairbrushes, and combs. While toothbrushes were an excellent source of DNA, in several instances, there appeared to be PCR inhibitors present in the extracts. The effects of different extraction and purification methods on this PCR inhibition will be discussed.

In addition, there were several unusual reference samples from World Trade Center disaster victims tested in-house. The samples were generally medical specimens received from diagnostic laboratories and hospitals and included 8 pap smears, 8 paraffin-embedded tissue biopsies, 2 semen samples, 1 DNA extract, 1 lyophilized DNA sample, 2 fingernail clippings, 1 set of (2) kidney stones, 2 serum samples, and 1 blood smear. Extraction procedures and treatment of these samples will be discussed. All of these medical specimens are valuable references since there is no question about the source of the DNA in the sample (barring any mix-ups at the hospital or laboratory). With other personal effects, a family member may inadvertently turn in a toothbrush or hairbrush which belongs to someone other than the victim. This type of mix-up was found, through kinship analysis, to have occurred with at least 3 toothbrushes during the identification process for American Airlines Flight 587. Additionally, DNA mixtures were detected on some personal effects, possibly because someone else in the household had shared the victim's hairbrush or toothbrush. Detection of mixtures was not an issue when medical specimens were used as references. The medical specimens also proved, with the exception of the kidney stones, to be a valuable source of DNA for STR testing. The information in this presentation will serve as a guideline for collection and DNA extraction of victims' personal effects for DNA comparison in the event of a mass disaster.

DNA, STR Testing, Mass Disasters

B75 Identification of Panamanian Victims: Mitochondrial DNA Analysis

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The goal of this presentation is to present to the forensic scientists the mitochondrial DNA analysis methods for over 25-year-old and degraded bone samples.

Mitochondrial DNA analysis has been utilized in many forensic cases for the identification of victims whose bodies have been subjected to harsh and severe environments such as extremely high temperatures, humidity, and burials in shallow graves. This environment, which leads to the extreme degradation of the DNA from the bodies, has made mtDNA the method of choice for analysis of these cases.

Hundreds of individuals in Panama have been victimized during the decades of military dictatorship that ended in 1989 with the ousting of Manuel Noriega. Today, Panama is a democracy, and the country has formed a "Comision de la Verdad" (a "Truth Commission") to locate and identify the missing bodies. Extensive efforts in Panama involving canine and anthropology disciplines led to the excavation of numerous remains. Early in 2002, ReliaGene received 52 remains, including teeth and bone fragments and 28 known saliva samples, to be analyzed for mtDNA. The saliva samples were obtained from maternal relatives of

the missing individuals. An attempt to isolate DNA from each sample was made and compared to DNA from known reference saliva samples. Samples analyzed by ReliaGene included remains mixed with cement and discovered in the walls and foundations of old army barracks, remains found in creek beds in the Panamanian rainforest, and remains embedded in the bark of a tree.

Sample processing techniques used to overcome PCR inhibitors will also be discussed. These include the use of an ultrasonic cleaner to remove any contaminating surface debris, the determination of DNA quantities and any protein contaminants or inhibitors in the sample, and the subsequent Qiagen column cleaning procedure used to rid the samples of inhibitors. Alternate PCR approaches, such as the use of mini primer sets, will be presented. Success rates of the remains will be discussed as well as rare mtDNA sequences that had never been observed in the available database beforehand. Identical sequences between remains obtained from different physical locations, and the implications of this finding, will be analyzed. Positive identifications made to date will also be discussed.

Mitochondrial DNA Analysis, Panama, Victims

B76 Fire and Death - Working Together to Get the Right Answers

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The goals of this presentation are to correct misunderstandings about fire and present current knowledge as to the character and intensity of the fire environment as a fire develops in a room or building and to emphasize how the interaction of the victim with that environment determines their postmortem condition.

This paper will discuss the reconstruction of a wide variety of fatal fires using current knowledge of the fire process (including the intensity of fires produced by modern materials and the postmortem combustion of remains). Case examples will illustrate the benefits of cooperation between fire investigators, police, fire scientists, medical specialists, and forensic scientists.

Fire is a process that many people take for granted because it has been part of the human experience for so long, but it is in fact so complex that it is only now becoming well understood by fire scientists. While the basic principles are widely known, specifics such as temperatures, intensities, and speed of spread are not appreciated by those involved in its aftermath (especially where modern synthetic furnishings are involved). Fires can be very localized (one chair, one wastebasket) or generalized throughout a room (post-flashover). Similarly, the hot, toxic gaseous products may be localized in a hot gas layer with fresh cool air beneath or may completely fill a room. Videotaped room fires will demonstrate the location and distribution of heat, flames, and smoke as room fires develop under various scenarios. Data will be presented on temperatures and heat fluxes in rooms as well.

When human victims are involved, there are many complications that make the interpretation of physical, clinical, and toxicological evidence very uncertain. Human behavior in fires is not readily predictable and exposure to a "fire" can range from prolonged exposure to cool but toxic smoke to nearly instantaneous death from intense heat or direct flames. To determine whether a fire death is a murder or a tragic accident requires accurate reconstruction of fire events. This requires accurate knowledge of fire chemistry, dynamics, and behavior and appreciation of the effect of fire on subjects – both living and postmortem. Physical evidence such as impression evidence and blood spatter may also play a role in establishing what activities took place prior to death. Case studies will be presented to emphasize the multidisciplinary approach needed to solve the puzzles when fire and death occur.

Fire, Death, Burns

B77 Computerized Fire Simulations for Use in Fatal Fire Investigations

Daniel Madrzykowski, PE, National Institute of Standards and Technologies, 100 Bureau Drive, MS 8661, Gaithersburg, MD*

The goals of this presentation are to develop a conceptual understanding of fire modeling, model capabilities and the application of fire models to investigations.

In conjunction with NIOSH (National Institute for Occupational Safety and Health), NIST (National Institute of Standards and Technology) has developed computer based fire simulations to assist in the understanding of the fire behavior in a number of line of duty death (LODD) incidents. The fire simulations provide insight into the fire growth and the spread of fire and hot gases through the structures.

The Building and Fire Research Laboratory at NIST has developed a computational fluid dynamics (CFD) fire model using large eddy simulation (LES) techniques. This model, called the NIST Fire Dynamics Simulator (FDS), has been demonstrated to predict the thermal conditions resulting from a compartment fire. A CFD model requires that the room or building of interest be divided into small three-dimensional rectangular control volumes or computational cells. The CFD model computes the density, velocity, temperature, pressure, and species concentration of the gas in each cell. Based on the laws of conservation of mass, momentum, species, and energy the model tracks the generation and movement of fire gases. FDS utilizes material properties of the furnishings, walls, floors, and ceilings to compute fire growth and spread.

A scientific visualization program, Smokeview, has been developed by NIST to display the results of a FDS model computation. Smokeview produces animations or snapshots of FDS results.

A new feature of Smokeview allows the viewing of FDS output in 3-dimensional animations. An iso-surface is a three dimensional version of a contour elevation often found on topographic maps. Animated iso-surfaces are used to visualize the movement, spread, and leading boundaries of the fire. Both models are available at no cost from www.fire.nist.gov.

This presentation will include a discussion on the type of information and material that should be collected at the scene in order to use FDS, a discussion of the uncertainties in the model, and methods for evaluating the model results. A case study will be presented to show how FDS/Smokeview can be used successfully in an investigation.

Fire, Computer Modeling, Death

B78 Role of the ATF Fire Research Laboratory in Fatal Fire Investigations

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The goal of this presentation is to educate the forensic community about the fire testing and research capabilities that the ATF (Bureau of Alcohol, Tobacco and Firearms) FRL (Fire Research Laboratory) can provide to fire investigations.

The FRL is the first scientific research laboratory in the U.S. dedicated to supporting the unique needs of the fire investigation community. Research is crucial to understand the scientific principles associated with fire ignition, growth, and spread. This information is critical for accurate fire scene reconstruction and to develop reliable scientifically valid theories for effective criminal prosecutions. At the present time, there are no fire research facilities in the U.S., or elsewhere, dedicated to the specific needs of the fire investigation community. The FRL will

provide the necessary facilities, equipment, and staff to work on important fire investigation issues such as fire scene reconstruction and modeling, flashover studies, validation of fire pattern analysis indicators, impact of accelerants on fire growth and spread, ignition studies, and electrical fire cause analysis. This presentation will focus on the capabilities of the FRL, the lab's state-of-the-art facilities and equipment, and the benefits that the FRL can provide to fire investigators and the forensic fire research community.

Fire Testing, ATF Research Lab, Fire Investigation

B79 Field Assessment of the World Trade Center Collapse

Robert Duval, Senior Fire Investigator, National Fire Protection Association, One Batterymarch Park, Quincy, MA*

The attendee will better understand the engineering aspects of the events that took place at the World Trade Center in New York City on September 11, 2001.

This program will outline the incident(s) and the findings of the FEMA (Federal Emergency Management Association) BPAT (Sponsored Building Performance Assessment Team). The presenter was a member of the BPAT team that analyzed the collapse of the World Trade Center Towers and the subsequent damage to several surrounding buildings. The program will review the engineering aspects of the construction of the involved buildings, the damage that occurred as a result of the attacks as well as the resulting observations and recommendations made in the FEMA BPAT report.

The FEMA BPAT report serves as the preliminary observation into the World Trade Center disaster and as the foundation for the NIST (National Institute of Standards Technology) comprehensive study of the incident.

Collapse, Structures, Fire Protection

B80 The Application of NIST's Fire Dynamics Simulator to Tenability Analysis and Fire Death Investigations

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The goal of this presentation is to demonstrate to the forensic community the features of FDS (Fire Dynamics Simulator) that can be applied to hazard analysis and potentially to ongoing fire death investigations.

Hazard analysis with regard to fires involves estimation of the effects of a specified fire, usually by measurement of the toxic components in thermally produced smoke and gases. Of particular importance in such analyses are the conditions for tenability, or the ability to occupy a fire prior to incapacitation and/or death. Human tenability characteristics include: elevated temperature (65°C at a layer height of 1.5 m), smoke obscuration (OD ^{3} m -1 at a layer height of 1.5 m), convected heat (Purser hyperthermia equation), and toxic gases (fractional incapacitating dose from Purser for CO, HCN, O2, and CO2).

Several fire modeling programs, beginning with HAZARD I (the first comprehensive application of fire modeling in the world), quantify hazards to occupants of burning buildings through a combination of expert judgment and calculations. The aim of HAZARD I was to be able to calculate the development of hazardous conditions over time, calculate the time needed by occupants to escape under those conditions, and estimate the resulting loss of life based on assumed occupant behavior and tenability criteria. Applications of fire modeling include a wide range of problem sets from single-family dwellings to industrial conditions such as control rooms at electrical power plants. Such programs provide fire protection engineers with an invaluable tool for predicting the consequences of fires in order to improve public fire safety, strategies for reducing fire losses including building design and arrangement, detection technology, and fire safety education.

While the benefits of quantitative hazard analysis with regard to product assessment, fire prevention, and cost savings are widely recognized, few have considered the potential of applying such models to actual fire death investigations. Here, the possible applications of fire modeling programs are explored, specifically the National Institute of Standards and Technology's Fire Dynamics Simulator, to ongoing fire death investigation cases.

Fire Dynamics Simulator consists of two programs, FDS and Smokeview. FDS is a computational fluid dynamics (CFD) model that solves a form of the Navier-Stokes equations and is appropriate for low-speed, thermally driven flows of smoke and hot gases generated in a fire. It predicts smoke and/or air flow movement caused by fire, wind, ventilation systems, etc. Smokeview visualizes FDS computed data by animating time dependent particle flow, 2D slice contours and surface boundary contours.

FDS is frequently applied to issues of fire spread and development. However, the features of this program applicable to hazard analysis and tenability appear to be less frequently used. The application of this modeling program to hazard analysis (specifically carbon monoxide levels) will be demonstrated and applications to fire death investigations will be discussed. This will be done with specific reference to a case study where FDS was used to corroborate a witness' timeline based on observing CO levels produced by the model.

The parts per million of carbon monoxide can be visualized in Smokeview for any particular coordinate within the modeled structure by specifying a carbon monoxide slice file in the data. If the structure is properly modeled to reflect known specifications from an actual structure fire, the slice file data can provide insight into the CO intake experienced by occupants of that structure. In a recent arson case, for example, it was crucial to be able to verify a witness' timeline of events in order to include or exclude this witness as a suspect in the arson that resulted in the deaths of 3 individuals. The medical examiner was able to provide blood carboxyhemoglobin levels of the deceased individuals. This data, in conjunction with the modeled CO levels, provided investigators with an estimate of how long the individuals occupied the structure in order to sustain the observed carboxyhemoglobin levels.

Note that great care should be taken when using information from a modeled fire to verify witnessed events to such a specific degree. The success of the model depends largely on the expertise of the user, and improperly modeled fires (that is, those that do not sufficiently resemble the actual fire) can provide misleading results. Moreover, even when used by the most experienced engineers, fires are exceptionally difficult to replicate and predict. However, this example demonstrates the potential for fire investigators and engineers to work together to help solve death investigation cases by using state-of-the-art fire modeling programs. While it should not be considered an accurate and widely applicable technique at this time, the potential and the success of the application of FDS to fire death investigations could likely increase as more engineers become proficient at using fire modeling techniques, and modeling programs become increasingly accurate.

Forensic Science, Fire Modeling, Tenability

B81 Burning Observations of the Body: Sequencing Soft and Hard Tissue Destruction

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The goals of this presentation are to identify effects of heat to the human body; to recognize progressive stages of thermal breakdown in skin, muscle, fat, and bone; to understand the dynamics of pugilistic posture; to be familiar with anthropological analysis of burned human remains; and to appreciate the reconstruction of the body in the context of a fire scene.

Discovery of burned human remains creates a challenging dimension to fire investigation involving houses, vehicles, or large structures. In addition to evaluating structural and physical properties of fire scenes, the human component requires similar standards of analysis. Specialists trained in forensic pathology, anthropology, and odontology serve as excellent resources for recovery and interpretation of human remains. Collaborative works by arson and forensic investigators approach problems of the scene and circumstances similarly by understanding the dynamic process of how the human body reacts to heat during a fire. Unless extinguished during early phases, burning obliterates identifiable personal soft tissue features. Cessation halts the destructive process but leaves nothing short of speculation, even in advanced forensic texts, about how and why bodies actually burn. While there are many assumptions based on subsequent charred remains, none stem from actual observation.

In an effort to better understand this process, burning simulations were conducted using three unembalmed human bodies from anatomical gift donations. Although crematorium resources are available, it is important to utilize open-air fires mimicking forensic casework in order to accurately observe and record subtle changes as they occur, rather than intermittently collect information via the door of a kiln. Subsequently, a range of materials were selected to contain and maintain heat with combinations of wood, metal, charcoal, and accelerants, while allowing free movement of soft tissue structures and thermal shielding for the observer. Documentation of time, duration, delicate reactions of skin, sequences of pugilistic posture, anatomical degradation, and origins of anatomical burn patterns, became crucial to understanding the processes responsible by which the human body is consumed by fire, particularly bone. This snapshot approach provides invaluable information when trying to reconstruct a fire event based on the pattern and sequence of burning to soft and hard tissues.

Destruction of organic material from combustion is fundamental to the entire burning process for soft tissues and bone. Once placed in the context of heat, the skin becomes waxy, glossy, tightens, blisters, blackens from charring, and begins to split into transverse, longitudinal, and stellate patterns to expose underlying layers of fat, muscle, tendon, and finally bone. Dehydration of muscles from heat causes shortening and produces the predictable "pugilistic posture" by contracting the robust flexors. Gradually arms become flexed, rotated, and drawn away from the body, while fingers tuck into the palm of the flexed wrist. Legs bend at the hip and knee under the influence of massive muscles of the leg while the calves induce plantar flexion at the ankle. Patterns of the skull and face advance from superior to inferior due to thicker muscle layers lower toward the cranial base. Skeletal degradation follows as muscle burns away, leaving bone exposed to dehydration, charring, calcification, and fragmentation. Concurrently, predictable anatomic sites will to undergo varying rates of thermal destruction determined by soft tissue thickness, body mass, orientation to the heat source, and relative body position.

In extreme cases where partial to complete incineration occurs, intense reduction of soft tissue leaves skeletal remains as the primary material for analysis. In addition to recording soft tissue changes to experimentally burned bodies, it became equally important to examine and reconstruct fragments of the remaining burned bones. Color changes and in some cases, heat-induced fracture patterns, are indicators that record progression and extent of burning to the body. Continuous documentation during each experimental burn episode captured details of body position, combustion rates of anatomical regions, and periods of localized heat fluctuations. By incorporating these rich layers of data along with physical evidence of solitary burned bone, a foundational understanding of each stage of burning can begin. Translation of this information for use by forensic investigators aids in reconstructing the burning event and incorporates the contextual relationship of the victim to the scene. A photographic essay illustrating progressive stages of burning and subsequent methods for body reconstruction will be presented along with examples of preexisting trauma and cautionary exemplars.

Fire Investigation, Burned Bodies, Burned Bone

B82 Fire as the Terrorist's Weapon

John E. Malooly, BA, Bureau of Alcohol, Tobacco and Firearms, 300 South Riverside Plaza, Chicago, IL*

Weapons used by terrorists are often thought of as bombs, rockets, and mortars. The attacks of 9-11 have demonstrated that fire can be used as a very effective weapon of mass destruction. This presentation will focus on the potential effects and effectiveness of fire as it could be used against a variety of targets.

Fire has been used as a weapon of war through all of recorded history from the "Greek fire" reportedly used effectively against warships and cities alike, through flaming oil and sulfur (poured or catapulted) rockets, and heated iron shot to flame-throwers, and aerial bombardment. Fires, large and small, were set during wars to destroy crops and other sources of income, deny shelter, deter pursuit, block harbors, interrupt commerce, and dissuade or drive off supporters by intimidation if not outright massacre. The same goals apply to terrorist-based warfare and have an even more widespread target base because innocent citizens are deliberately targeted. As a result of recent incidents such as Oklahoma City, many public buildings and monuments have been "hardened" against car bomb type attacks but those same buildings are susceptible to attacks using flammable liquids and incendiary timing devices. The large car bomb attack against the World Trade Center in 1993 failed to destroy the building (although it did induce some structural damage and cause casualties and considerable disruption). The attack of 9-11 resulted in the complete destruction of the complex along with thousands of fatalities.

Accidental fires have demonstrated to fire safety professionals, public officials, and to potential attackers how vulnerable public facilities are to fire. Fire in subways and underground transport (such as Kings Cross, London, 1987) disrupted a major city for weeks. A fire in industrial property closed (and seriously damaged) a major freeway in Philadelphia. Accidental fires in high rises such as First Interstate Bank (Los Angeles, 1988) and Meridian Plaza (Philadelphia, 1991) showed the weaknesses (or total absence) of fixed fire protection systems, critical electrical and fire pump systems, and even the inadequacies of fire suppression tactics. Both fires resulted in major structural damage and financial disruptions that required months to repair.

The materials required to carry out incendiary fire attacks are readily available in bulk (gasoline, paint thinners, wax strippers, and cleaning solvents) and easily and casually transported into the target building. Timing devices can be small and simple, and devices can even be triggered remotely. The flammable liquids need not be the major fuel

load to create a destructive fire. Major structural damage to First Interstate and Meridian Plaza was induced merely by the complete involvement of the furnishings of an entire floor of offices. It is also being realized that the sustained heat needed to trigger the collapse of the World Trade Center fires was supplied by the burning of the normal fuel load in the floors involved, ignited by the aircraft's fuel.

Fires can be employed by any stripe of terrorist for any ulterior motive. Large fires in computer, data storage, communications or power distribution facilities could disrupt business across the economic spectrum. Fires set in wild lands could threaten and harass citizens of rural, suburban, and even urban areas (as the Denver area fires of 2002 demonstrated). With the aid of current drought conditions such fires could also destroy massive areas of agricultural and timber crops, pollute waterways, and compromise vital watershed for years into the future. Eco-terrorists have already used fire as a weapon against timber, development, and power companies (fortunately, until now, focusing on the buildings and corporate resources rather than natural resources).

This paper will focus attention on the potential role of fire as a weapon in the hands of foreign and domestic terrorists and on the knowledge that must be cultivated and shred to minimize the threat.

Fire, Death, Terrorism

B83 Products of Microbial DNA Amplification: Risks of False Results During DNA Typing of Decomposed Bodies and Skeletal Remains

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This presentation will discuss the observation of bacterial STR artifacts during DNA testing of skeletal remains and methods to overcome the problems associated with such peaks.

DNA extracted from decomposed human remains frequently contains not only fragmented human DNA but also microbial DNA. Human DNA specific extraction techniques, especially for very low quantities of DNA, are not available and so the presence of microbial DNA in extracts is unavoidable. Some widely used human forensic multiplexes have the ability to amplify various microbial DNAs and thus generate non-specific PCR products. As a result, it is necessary to have a tool for identification of these "microbial peaks" in order not to assign false allele numbers. By testing thousands of bone samples, the ICMP (International Commission on Missing Persons) has become aware of several noticeable patterns that are associated with various bacterial strains. These recognizable patterns are a clear signal of the presence of bacterially induced peaks. In addition, the resulting GeneScan® profiles of suspected bacterial peaks display an absence of artificial repeat slippage, sometimes called n-4 bands, stutter, or shadow bands. Even if there were described repeat sequences in bacterial, yeast and fungi DNAs, the detection of a "microbial peak" with a loss of a repeat unit has not yet been witnessed in the ICMP DNA laboratories.

It is beneficial to clone and sequence "microbial peaks," especially those that display peak patterns that have not been previously observed. Once the bacterial strain has been identified, it can be cultivated and tests performed on that corresponding microorganism to verify the observed patterns. Tests performed with microbial DNAs of a discrete species can enable the creation of a table of the most commonly found "microbial peaks" with highlighted "dangerous sizes" that have the potential of interfering with calling true alleles. Obtained values are continuously added to a special Genotyper® macro that flags possible problem peaks.

Studies of mixed ratios of microbial DNA and human DNA shows that microbial DNA present in a sample of human DNA can influence the characteristics of the resulting electrophoretogram. The level of influence is strongly connected with a primer 's complementarily to the binding site of a particular strain. Some of microbial DNAs generate artificial peaks only in very high quantities. It has been observed that the presence of microbial DNA in a sample of human DNA can lead not only to allelic drop-out (primers used for the amplification of microbial DNA) but also to the appearance of false alleles that are not generated while amplifying only microbial DNA. On the other hand, the presence of microbial DNA in a low quantity sample of human DNA (0.1ng) can help to "visualize" alleles that disappeared due to the stochastic effect.

Changing primer sequence would seem to be a reasonable approach in overcoming the appearance of the observed "microbial peaks" but it is difficult to predict how the changed sequence would affect the robustness of the kit. It would also require considerable testing of degraded and bacterially infested samples to determine whether different bacterial peaks would appear. However, once characterized, the bacteria species and their STR amplification patterns can be documented and steps taken to compensate for the presence of such bacteria.

STR, Bacterial DNA, ICMP

B84 Screening of Phenoxy Acid Herbicides in the Everglades and Biscayne Bay National Parks: A Concern of Environmental Forensics

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The goal of this presentation is to present to the forensic community the capabilities and advantages of using a combined SPE/LC/MS method as an analytical tool for monitoring the presence of phenoxy acid herbicides in sediments with high content of organic carbon.

Environmental forensic scientists and investigators have the challenge to answer questions such as: Who caused the contamination? When and how did the contamination occur? Was it an accidental spill or a series of routine releases? Is there a chronic source responsible for the background concentrations observed? Are the results reliable both in terms of the detection limits and identification of the contaminants? However, none of these questions can be satisfactory answered with the lack of validated and sensitive analytical and statistical methods as well as a preliminary knowledge of the baseline levels of the analytes of interest.

The presence of pesticides in the environment has created an increased concern over potential health hazards associated with its exposure in different environmental matrices such as air, water, sediments, and in some instances fish tissue samples (which can be used as an indicator of the bioaccumulation of toxic chemicals through the food chain).

Based on limited published information it appears that sediment/soil, water, and biota in South Florida often contain low concentrations of a variety of inorganic and organic contaminants including formerly and presently used pesticides. However, there are still large data gaps regarding the occurrence and distribution of these contaminants in particular along sensitive ecosystems such as the Everglades, Biscayne, and Florida Bay despite their close proximity to places such as the Homestead Agricultural Area.

As a response to that need, and in preparation for the major changes that will be introduced by the CERP (Comprehensive Everglades Restoration Plan), selected sections of Everglades National Park are currently being surveyed for a series of organic and inorganic contami-

nants. The data presented here is focused in the development of a sensitive method for the analysis of phenoxy-acid herbicides with particular emphasis in complex sediment matrixes such as organic rich sediments (i.e., peat).

The chlorinated phenoxy acid herbicides were introduced in U.S. in the mid 50s as defoliants mainly to eradicate weeds. Since that time, some of these pesticides have been prohibited or restricted or reformulated because of their linkage with more toxic substances like chlorinated dioxins and furans.

The analytes of concern are: 2,4-D, 2,4,5-T, acifluorfen, 2,4,5-TP (silvex), Picloram, Mecoprop (MCPP), 2,4-DB, Bentazone, Dicamba, Dichlorprop, Dinoseb, and MCPA.

The method presented here is a combination of solid phase extraction over graphitized carbon of a water extract of the sediment sample. Key advantages of the method over regular liquid-liquid extractions are the reduction of organic solvents used as well as the natural compatibility of aqueous samples with LC/MS.

The cleanup procedure was as follows: the sediments samples were extracted using 100 mL of NaOH 0.3 N, and sonicated for 30 minutes. They were filtered using a Buchner funnel in vacuum and then transferred to a 1 L flask. The pH was adjusted and deionized water added *qs* to 1000 mL. In order to avoid the precipitation of fulvic/humic acids, an additional filtration step was performed using 0.45 um filters. The samples were loaded in the pre-conditioned Carbon-based SPE cartridges at a flow rate of 20 mL/min. Two fractions were collected during the elution step, using 1.5mL of MeOH and 13mL of a fresh solution of CH_2Cl_2:MeOH:TFA (80:20:0.2%) respectively. The fractions were concentrated up to 200uL under nitrogen and then mixed prior to injection into the LC/MS system.

A Finnigan Navigator LC/MS from Thermo Quest was used with SIR mode for all analytes. The ESI source was operated in negative mode (ESI-), with an optimized cone voltage of 15 V. The gradient elution was performed in a Zorbax XDB C_{18} Column (250 x 4.6 mm x 5 υm) using MeOH and HOAc 1% as modifier from t = 0-15 min at 75:25 (MeOH:HOAC 1%) through 82:18 until 25 minutes as total run time. A linear response for the quantitation (r^2=0.99 or better) was obtained at the concentrations of interest using 2,4-diclorophenoxy-acetic-acid as internal standard. The limit of detection (LOD's) for the aforementioned pesticides in spiked sediments ranging from 100 ng/g to 300 ng/g.

Sediment samples from different zones of interest in the Everglades and Biscayne Bay National Parks were analyzed and the results are also presented.

Herbicides , Environmental Forensics, LC/MS

B85 Coordinating the Identification Efforts of the Missing From the Former Yugoslavia

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The efforts to develop an Identification Coordination Program that coordinates and integrates a large-scale DNA testing effort for the missing from the area of former Yugoslavia, and the results of this effort, will be described.

As a result of the armed conflicts in the former Yugoslavia during the 1990s, an estimated 35,000-40,000 persons remain missing with the majority of these located in Bosnia and Herzegovina (25,000-30,000). Once the various conflicts ended, local commissioners, expert teams, and the international community began the long and arduous recovery and identification process of mortal remains. At the beginning of these efforts, approximately 80% of exhumed bodies were identified via "classical" methods, i.e., those methods based upon anthropology, clothing, witness testimony, etc. However, with the passage of time these more traditional identification methods became increasingly unreliable and all parties involved in the identification efforts were faced with increasingly discouraging results. The biggest forensic puzzle in the world, the identification of the missing from Srebrenica, resulted in only 73 identifications during the three-year period from 1996–1999. This is despite the fact that over 4,500 body bags containing the remains of some of the estimated 7,500 missing from Srebrenica had been amassed during this time.

It became apparent that thousands of missing would never be able to be identified without the development of a rapid and large-scale DNA testing program. This is the reason ICMP (International Commission on Missing Persons) began in 2000 to design and implement a strategy of establishing a large-scale DNA testing capacity within the former Yugoslavia. The ultimate goal of this DNA testing program would be to help bring names back to the thousands of nameless bodies that had been, and would be, recovered. (From the beginning of recovery process in 1996 until now, more then 12,000 bodies were recovered more than 7,000 of which are still unidentified).

Paramount to the success of the DNA based identification efforts has been the establishment of the Identification Coordination Center (ICC). The primary task of ICC is the collection of blood samples from living family members who reported a missing family member(s) in order to create a Family Reference Database of DNA profile. From July, 2000 until August 1, 2002, 11 mobile teams from 7 centers located the former Yugoslavia have, collected more then 31,000 blood samples representing more than 18,000 of the missing. It is estimated that an average of three donors will be needed for each missing person. While blood samples are being collected from family members, information regarding the basic information about donor, any additional related missing persons, and contact information regarding other donors is taken. A computerized database containing all collected information is maintained at the ICC headquarters located in Tuzla, Bosnia-Herzegovina.

In order to avoid any charges of favoritism and to gain full support of the ethnically diverse family organizations, the ICMP has developed a bar-coding system for all blood samples. A set of four identical bar code numbers is associated with each blood sample. A barcode is placed onto bloodstained card, another on the Chain of Custody Form, another on the Donor's Form with the fourth kept in reserve. In order to be STR profiled, bloodstained cards are removed from their individual storage pouches and their barcodes scanned. This information is entered into computer controlled automated puncher which then punches the bloodstained card into a 96-well tray which then automatically adjusts to the next well. This method eliminated the need for potentially error prone human punching and tracking of samples. The entire 96-well tray is subsequently given a bar code and submitted to the DNA laboratory for DNA testing. Once the STR profiles have been obtained from the 96-well tray, those results are stored onto a computer disk and returned to the ICC where the information is downloaded into the Family Reference Database.

The ICC also receives bone samples from exhumed but still unidentified bodies from forensic experts in the region. This has permitted a standardization of bone collection and submission techniques as well as a uniform, computerized system of archiving bone samples. Once a bone sample is received, 4 digital photos are made: 1 of the original container and any markings, 1 of the bone sample on the submission container, 1 by the bone sample with its original case number and its new bar code designation, and finally 1 the bone sample in its bar coded container. All bone samples are submitted to the DNA laboratory as bar coded specimens. It is not possible for DNA analysts to determine the location or potential ethnicity of the bone samples. Once again, all DNA profiles obtained from bone samples are submitted to the ICC headquarters in Tuzla for entry into the centralized computer program.

During 2001 the ICMP developed a DNA Matching Program that compares the DNA profiles from the Family Reference Database to the DNA profiles obtained from bone samples. Since virtually all the missing has either a parent or child as a donor, the initial screening mechanism is to search for all samples which half band share with a bone specimen. To account for mutational events, the program is also capable of searching for samples that have a half band share except for 1 or 2 loci. Since many of the families have multiple family members missing, DNA profiles from bone samples are also compared to the DNA profiles obtained from other bone samples. Once it has been determined that a bone and blood sample exhibit half band sharing, it is determined whether other relatives are available for a blood donation. Since there have been several instances of 1 bone sample half band sharing with multiple, unrelated individuals, either extended DNA testing, i.e., additional STR loci, mitochondrial or Y-chromosome is required for all single donor 'matches' or additional related donors are profiled before a DNA match is reported. Once sufficient data has been produced, a DNA report is generated. This report includes a digital photo of the submitted bone sample and is given to the pathologist who is in charge of that particular case.

On November 16, 2001, ICMP made the first DNA assisted identification of a 15-year-old boy missing from Srebrenica. This was a "blind" match in that there was no assumption of identity, no idea who this person was, and no hope of identification without DNA testing. From the November 16, 2001, until August 1, 2002, the ICC has made more then 600 "blind" DNA Matches. The vast majority of these blind matches have occurred since the DNA laboratories began high throughput operations in March of 2002. Due to the success of this system, the ICMP is waiting with high expectations until the end of 2002, when more than a thousand DNA assisted identifications in the former Yugoslavia by the ICMP system will be revealed.

DNA, ICMP, Human Identification

B86 The Forensic Comparison of Cut Edges in Intact Newspaper Sheets

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The goal of this presentation is to examine and compare the factory-cut edges of tabloid and broadsheet newspaper sheets and to ascertain the possibility of connecting separated intact newspaper sheets to the original copy of newspaper.

Most paper webs in a newspaper press are either approximately 30 inches wide (single width press) or 60 inches wide (double width press). For a 30-inch web, a maximum of either four broadsheet pages or eight tabloid sheet pages can be printed, front and back. Twice these numbers can be printed if a 60-inch web is used. In a printing press unit, a newspaper usually requires more than one paper web. The printed paper webs are stacked on top of another and brought together across the RTF (Roller Top of Former) into formers. To produce tabloid sheets from a 60-inch web, two sequential longitudinal slittings are necessary: the first slitting at the RTF cuts through the center of the web, producing two broadsheet webs; the second slitting at two separate formers cuts through the canter of each broadsheet web, resulting in a total of two pairs of tabloid-sized webs. Each pair of the webs is next folded back-to-back at the formers to re-form a single web. The two single webs are then combined into one (cross-association). This resultant web is guided and pulled through a folder by pins on cutting cylinders and cut transversely by a cut-off knife resembling a toothed saw. The final folding step results in copies of tabloid signatures.

To produce broadsheet newspaper, the first slitting is sufficient to separate the 60-inch web into two broadsheet-sized webs. A second slitting is not required, and the broadsheet webs are folded longitudinally to form two folded broadsheet webs at the formers. The two folded webs may be combined to form two newspaper sections before being cut transversely at the folder. When the press is running in *collect* mode, the copy is kept on the cutting cylinder by pins for one revolution while the next copy is being cut. Both copies are then released together as a single copy of broadsheet signature (4-section newspaper). In a high-speed production press, extra formers are added in the folder (as upper former & triple former) to allow incorporation of more than 4 sections in a copy of newspaper.

The authors have previously reported on the usefulness of tabloid newspaper sheets as crime scene evidence. The crucial requirement for linking intact tabloid newspaper sheets is the physical fitting of factory-cut edges of two "head-to-head" complementary sheets from the original copy. The cut edges are due to the second slitting at the former. These random edges fit like a jigsaw puzzle because the sheets are printed on the same paper web and adjacent to each other before the slitting. In contrast, for broadsheet newspaper production on 60-inch width web, a folded broadsheet web coming out from the former may not be cross-associated with its complementary folded broadsheet web. "Head-to-head" complementary sheets are not, therefore, linked in an original copy. Furthermore, additional formers introduced in a high-speed production press may result in combinations of paper webs from different locations of slitting steps.

This project also studies the factory-cut edges on the tabloid and broadsheet newspaper sheet due to the transverse cut by cut-off knife in the folder unit. The cutting cylinders consist of a knife cylinder and folding cylinders. The folding cylinder contains a fixed set of pins to pull the paper web out of the former while a series of saw-toothed knives on the knife cylinder cut the paper almost simultaneously while it is rotating. Preliminary examination of newspaper edges cut by the cut-off knife shows a series of saw-toothed edges. The saw-toothed edges are found along both widths of a newspaper. Newspaper copies are examined for all the sheets to compare the similarity of cut edges from the top sheet where the cutting starts to the bottom when the cutting ends. Similar sheets of neighboring newspaper copies are also examined for repeatability of the cut edges. It was observed that even when a few paper webs are combined together, the stack of papers still has a small degree of flexibility and mobility. Initial penetration of the knife into the top few sheets produces cut edges that are more uniform; further penetration into bottom sheets creates more uneven and jagged edges. There are, therefore, variations in the cut edges of the similar sheets from one copy to another copy of newspaper. Adjacent stacking sheets in the same copy were examined and found to be similar in their profiles of cut edges. This feature can be used as basis for comparing the newspaper sheets and linking them to their original copy.

The preliminary finding of this project is that the matching of intact broadsheet newspaper sheets may be possible if the sheets are adjacent to each other. The printer of the particular newspaper should be consulted for the *imposition* of the newspaper on the day of the production. The newspaper sheets seized from suspected sources must be as complete as possible.

Tabloid Newspaper, Broadsheet Newspaper, Cut Edges

B87 Validation and Implementation of Y-Plex™ 6 for Forensic Casework

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The goal of this presentation is to discuss the validation of the Y-PLEX™6 (ReliaGene Technologies, Inc.) and its implementation for forensic casework.

Many sexual assault cases require the testing of intimate samples that are a mixture of male and female body fluids. In some cases, only the female profile is detected using standard autosomal STR systems even when sperm/semen are identified.

A Y-chromosome STR system significantly overcomes the problems associated with large female to male DNA ratios that can lead to poor/no amplification of the perpetrator's DNA. The ability to selectively target the male contributor(s) can be a substantial tool for the DNA analyst in these cases.

ReliaGene Technologies, Inc., has developed a multiplexed Y-chromosome STR system (Y-PLEX™6). This system amplifies 6 Y-STR markers (DYS393, DYS19, DYS389, DYS390, DYS391, and DYS385) in a single multiplexed reaction.

DNA from blood samples (CT Sex Offender Database) was extracted using the QIAmp Blood Kit (QIAGEN). The extracts were quantitated using the QuantiBlot Kit (Applied Biosystems, Inc.). Optimally, ~1 ng of DNA was amplified for 30 cycles according to the manufacture's protocols. The amplification reaction (total volume 25 ul) consisted of DNA (50pg->100ng), 5.0 ul of primer set mix (ReliaGene Technologies, Inc.), and 0.5 ul of AmpliTaq Gold (Applied Biosystems, Inc.). Reducing the reaction volume by ½ did not significantly affect the performance of the kit. The addition of BSA (1 ul of 1.6 mg/ml) improved the amplification efficiency of many field samples, especially mixtures. BSA was generally not necessary for the amplification of known samples. Amplifications were performed using standard thermocylers (Applied Biosystems, Inc., models 2400 and 9700). The amplified products were separated on a 377 DNA Sequencer (Applied Biosystems, Inc) and analyzed using Genescan and Genotyper software. A custom Genotyper macro is supplied with the Y-PLEX™6 kit.

To evaluate the discrimination power of the Y-PLEX™6 STR markers, a population database was generated for standard Connecticut populations (Caucasian, African American, and Hispanic). Overall, out of 787 males, 55% of the haplotypes (435) were unique, with the most common haplotype detected in 32 males (4.10%). Within populations, 54%-74% of the haplotypes were unique (African American-74%, Caucasian-65%, Hispanic-54%). The most common haplotypes ranged from ~2%-6% (African Americans-1.87%, Caucasians-6.17%, Hispanics-5.78%—see tables below).

The Y-PLEX™6 validation study also examined the following issues: species specificity (common domestic animals (males & females), reproducibility, the effects of environmental degradation, sample mixtures, stutter, peak balance at DYS385, kit sensitivity, and nonprobative casework samples. These results along with the success of the method with casework samples are discussed.

CAUCASIAN

	ALLELE	# OF TIMES	%
DYS393	12	30	12.35
	13	**175**	72.02
	14	31	12.76
	15	7	2.88
		243	100.00
DYS 19	12	1	0.41
	13	23	9.47
	14	**144**	59.26
	14.2	1	0.41
	15	43	17.70
	16	21	8.64
	17	10	4.12
		243	100.00
DYS 389	27	3	1.23
	28	38	15.64
	29	**104**	42.80
	30	70	28.81
	31	19	7.82
	32	9	3.70
		243	100.00
DYS 390	21	2	0.82
	22	30	12.35
	23	68	27.98
	24	**100**	41.15
	25	41	16.87
	26	2	0.82
		243	100.00
DYS 391	9	10	4.12
	10	112	46.09
	11	115	47.33
	12	5	2.06
	13	1	0.41
		243	100.00
DYS 385	8	1	0.21
	10	5	1.03
	11	130	26.80
	12	35	7.22
	11,12,14	1	0.21
	13	42	8.66
	14	**150**	30.93
	15	51	10.52
	16	32	6.60
	17	20	4.12
	17.3	1	0.21
	18	11	2.27
	18.3	1	0.21
	19	4	0.82
	20	1	0.21
		485[1]	100.00

AFRICAN AMERICAN

	ALLELE	# OF TIMES	%
DYS393	12	13	4.87
	13	**134**	50.19
	14	89	33.33
	15	29	10.86
	16	1	0.37
	17	1	0.37
		267	100.00
DYS 19	12	0	0.00
	13	8	3.00
	14	58	21.72
	14.2	0	0.00
	15	**96**	35.96
	16	61	22.85
	17	43	16.10
	18	1	0.37
		267	100.00

* Presenting Author

DYS 389	27	5	1.87
	28	21	7.87
	29	53	19.85
	30	**102**	38.20
	31	63	23.60
	32	19	7.12
	33	4	1.50
		267	100.00
DYS 390	20	2	0.75
	21	**156**	58.43
	22	30	11.24
	23	21	7.87
	24	32	11.99
	25	23	8.61
	26	3	1.12
		267	100.00
DYS 391	9	10	3.75
	10	198	74.16
	11	59	22.10
	12	0	0.00
	13	0	0.00
		267	100
DYS 385	8	0	0.00
	10	2	0.37
	11	37	6.93
	12	9	1.69
	13	16	3.00
	13.2	1	0.19
	14	70	13.11
	15	76	14.23
	16	**118**	22.10
	17	115	21.54
	18	58	10.86
	19	26	4.87
	20	6	1.12
		534	100.00

HISPANIC

DYS393	**ALLELE**	**# OF TIMES**	**%**
	12	31	11.19
	13	**202**	72.92
	14	34	12.27
	15	10	3.61
		277	100.0
DYS 19	12	0	0.00
	13	46	16.61
	14	**153**	55.23
	15	45	16.25
	15/16	3	1.08
	16	16	5.78
	17	14	5.05
		277	100.0
DYS 389	26	1	0.36
	27	5	1.81
	28	30	10.83
	29	94	33.94
	30	**99**	35.74
	31	37	13.36
	32	11	3.97
	33	0	0.00
		277	100.0
DYS 390	20	1	0.36
	21	37	13.36
	22	33	11.91
	23	59	21.30
	24	**121**	43.68
	25	24	8.66
	26	1	0.36
	27	1	0.36
		277	100.0
DYS 391	8	1	0.36
	9	30	10.83
	10	145	52.35
	11	97	35.02
	12	4	1.44
		277	100.0
DYS 385	8	0	0.00
	10	5	0.90
	11	100	18.05
	12	28	5.05
	13	90	16.25
	14	**146**	26.35
	15	55	9.93
	16	44	7.94
	17	33	5.96
	18	39	7.04
	18.3	1	0.18
	19	11	1.99
	20	2	0.36
		554	100.0

1. Three band haplotype detected in one individual-considered a single allele for statistical purposes.

Most Common Haplotypes (Overall 787)

	DYS 393	DYS 19	DYS 389	DYS 390	DYS 391	DYS 385	%	N
1	13	14	29	24	11	11,14	4.10	32
2	13	14	29	23	11	11,14	2.16	17
3	13	13	30	24	9	13,14	1.91	15
4	13	14	30	24	11	11,14	1.52	12
5	13	14	29	24	10	11,14	1.40	11

Most Common Haplotypes (African American - 267)

	DYS 393	DYS 19	DYS 389	DYS 390	DYS 391	DYS 385	%	N
1	13	15	31	21	10	16,17 1	.87	5
2	13	14	29	24	10	11,14	1.50	4
3	14	15	30	21	10	16,17	1.12	3
4	13	14	28	25	11	14	1.12	3
5	14	17	30	21	10	18	1.12	3

*3 other haplotypes were detected three times each in CT African American males.

Most Common Haplotypes (Caucasian - 243)

	DYS 393	DYS 19	DYS 389	DYS 390	DYS 391	DYS 385	%	N
1	13	14	29	24	11	11,14	6.17	15
2	13	14	29	23	11	11,14	3.70	9
3	13	14	29	24	10	11,14	1.65	4
4	13	14	29	25	11	11,13	1.65	4
5	13	15	29	24	11	11,15	1.23	3

**5 other haplotypes were detected three times each in CT Caucasian males.

Most Common Haplotypes (Hispanic - 277)

	DYS 393	DYS 19	DYS 389	DYS 390	DYS 391	DYS 385	%	N
1	13	14	29	24	11	11,14	5.78	16
2	13	13	30	24	9	13,14	4.69	13
3	13	14	30	24	11	11,14	2.89	8
4	13	14	29	23	11	11,14	2.17	6
5	13	14	31	21	11	16,18	2.17	6

Y-PLEX 6, STRs, PCR

B88 National Forensic Laboratory Information System

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Attendees will learn about the NFLIS (National Forensic Laboratory Information System), a DEA (Drug Enforcement Administration)-sponsored project that systematically collects results from solid-dosage analyses conducted by state and local forensic laboratories. The results present approximate drug evidence seized by law enforcement agencies and sent to forensic laboratories for analysis, although variation in local policies can influence whether evidence will be submitted to a laboratory and subsequently analyzed.

The DEA and RTI (Research Triangle Institute) began implementing NFLIS in September 1997. To date, approximately 60% of state and local laboratories that perform solid-dosage drug analyses have joined NFLIS. This includes 32 state laboratory systems and 41 local laboratories, comprising a total of 170 individual forensic crime laboratories throughout the U.S. In the next several years, the NFLIS partnership will be enhanced to include federal laboratories such as those operated by the DEA and other agencies. With the goal of a census of all forensic laboratories in the U.S., the sustained recruitment of non-enlisted state and local forensic laboratories will continue as well.

NFLIS seeks to serve the laboratory community. The Interactive Data Site (IDS), which was first made available in January 2001, is of high value to both participating and potential laboratory recruits. The IDS combines timely and detailed analyses with a flexible, user-friendly system. It allows participating laboratories to run parameterized queries against the NFLIS database in a near real-time capacity. Labs can run queries for their own data at the individual case-level or can calculate aggregate regional and national results. IDS users can specify the time period, region, type of laboratory, and drug type in order to customize these queries.

NFLIS provides results of drugs identified and reported by participating laboratories. Aggregate data from the 170 NFLIS laboratories representing the period October 2001 to September 2002 will be presented. Highlighted findings will include the frequency of some selected "drugs of interest" and analyzed items by drug category that will show, by census region, the distribution of items by number and percent of total analyzed items in the state and local forensic laboratories. The number and percentage of analyzed items for the twenty-five most frequently reported drug items, as well as the major drug categories such as narcotic analgesics, benzodiazepines, "club drugs," stimulants, and anabolic steroids, will also be detailed in tables and graphics. Select data will be presented on commonly identified drug combinations, special study analyses on drug purity, and drugs identified in strategic geographic locations.

NFLIS is assisting the drug enforcement community in several ways: supporting drug control/drug scheduling, highlighting variations in distribution of controlled substances across geographic areas and over time, improving estimates of drug availability, providing timely information about the diversion of licit drugs into illicit channels, identifying emerging drugs of abuse, increasing the understanding of the nation's drug problem, and linking the drug enforcement and forensic laboratory community across the nation.

Drug Analysis, National Forensic Laboratory Information System, Drug Database

B89 Potential Contamination When Wearing Sterile Gloves During PCR Preparation: Pass-Through Contamination From Skin

Miguel Lorente, MD, PhD, Carmen Entrala, MS, PhD, Esther Martinez-Espin, Javier Fernandez-Rosado, Jose A. Lorente, MD, PhD, Javier Oliver, Margarita Rivera, Encarni Gracia, and Enrique Villanueva, MD, PhD, Laboratory of Genetic Identification, Department of Legal Medicine, University of Granada, Avda, Madrid, 11, Granada, Spain*

Contamination during DNA analysis based on PCR is a serious concern that usually happens in genetic labs. Although protocols are developed to avoid this issue, it still happens and in most of the cases it is not possible to determine the source of contamination. This paper demonstrates how, even while wearing sterile gloves, contamination from the user can occur. The attendee will learn that some extra-safety measures should be considered.

Mitochondrial DNA (mtDNA) analysis has became a routine procedure in human identification and in anthropological studies. One of the advantages of analysing mtDNA is the enhanced sensitivity afforded with the technique. Contamination can affect the final results of a study, therefore, this feature must be considered. Quality control and quality assurance procedures are enacted to minimize and monitor contamination. However, sometimes it is not easy to identify the source of spuriousness or inconsistency. One vector for contamination is the gloves worn during experimentation. It is imperative to wear sterile gloves and change the gloves as needed. Clinical and epidemiological studies have demonstrated that bacterial and viral contamination can occur on the surface of sterile gloves after being worn for a period of time. Thus, DNA may get on gloves and be transferred during handling (i.e., cross contamination). It is also possible for DNA to leach from the user's hand through the glove (i.e., pass through contamination). While contamination of this nature is not a routine concern, it may explain rare circumstances of undefined contamination. Therefore, a set of experiments was designed to determine if gloves could be conduits of contamination.

To study pass-through contamination, gloves were worn for different time periods compatible with labs tasks. Gloves were worn without touching anything for 5, 10, and 20 minutes by different users. Only intermittent gentle rubbing between the thumb and index finger was carried out to mimic general manipulations.

After each time frame a sample was taken from the areas usually in contact with the tubes using a wet cotton swab and a negative control was taken from a zone where no manipulations occurred. After the swabbing the gloves were discarded.

All the swabs were extracted using an organic method (PCIA) and amplified for HVIB and HVIIA according to Wilson et al.; also included were some nuclear DNA amplification. Post-amplification of the nuclear and mtDNA product was carried out using capillary electrophoresis as previously described.

The experiments show that the length of time gloves are worn is an interesting factor to be considered. In some samples even after five minutes some DNA leached through the gloves, even in the apparent negative controls. These results are compatible with the clinical studies which have shown that after a time, even with careful washing, bacterial and virus contamination on the surface of the gloves can occur related to time and user.

These findings do not suggest that new practices in contamination control are warranted. They do suggest possible sources for contamination when it occurs. If gloves are not changed between cases, cross contamination may occur and explain why DNA types from unknown sources may be observed. However, cross contamination is not a serious concern under current practices. Pass through contamination may explain the presence of the operators mtDNA in a sample. Sensitivity of

mtDNA analysis requires special care during the handling of samples and reagents, and particularly in extreme situations where sample manipulation is for prolonged times. If contamination persists, one may consider changing gloves every five-ten minutes or using double gloves. Also, washing the hands prior to putting on gloves could remove dead cells or their products from skin surface.

DNA, Contamination, Gloves

B90 Comparison of Powerplex® 16 Bio With DNA IQ or Chelex 100 Isolation Procedures

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The goal of this presentation is to compare the efficiency and reproducibility of Powerplex® 16BIO with DNA isolated samples by Chelex 100 and DNA IQ.

Different DNA isolation methods are used worldwide in forensic and paternity testing laboratories. The amount of template and the absence of PCR inhibitors are crucial factors in order to obtain efficient and reproducible results.

The isolation of DNA by Chelex 100 is one of the most popular methods for DNA isolation. However, the presence of PCR inhibitors and the difficulty to determine the amount of DNA in a sample represent some drawbacks for this method. The DNA IQ method has been recently introduced. The virtual absence of PCR inhibitors and a known quantity of DNA at the end of the extraction procedure represent major advantages for this method. The performance of Powerplex® 16 BIO (FGA, TPOX, D8S1179, vWA, Penta E, D18S51, D21S11, THO1, D3S1358, Penta D, CSF1PO, D16S539, D7S820, D13S317, D5S818, and Amelogenin, Promega Corporation, Madison, WI) on DNA isolated samples by either Chelex 100 or by DNA IQ has been evaluated.

For Chelex samples, 10 ul of whole blood were incubated in 1 ml of distilled water at room temperature for 30 minutes, spun down 3 minutes at 13000 rpm, and the pellet resuspended in 180 ul of Chelex 100 at 5%, vortexed, boiled for 8 minutes, vortexed and spun down before use.

For DNA IQ samples, 10 ul of whole blood were used following manufacturers recommendations (Promega Corporations). Samples were resuspended at 1 ng /ul according to the instructions.

The amplification of Powerplex® 16 BIO was carried out as recommended and the PCR amplification products were resolved in Long Ranger Gels (Biowhittaker) for 1 hr. 50 min. in a 20 x 43 SA32 gel electrophoresis box at 2000 volts (50 Watts) in 1X TBE.

The results showed a decrease in the intensity of signals for the TPOX and THO1 loci with Chelex isolated samples when compared to the signals obtained with DNA IQ. In addition, the amplification failure rate was higher in Chelex isolated samples (2.3%, 11 out of 480 samples analyzed) compared to 0.57% with DNA IQ isolated samples (4/700).

Results underline the importance for the proper amount of DNA template and the absence of PCR inhibitors in order to obtain balanced and reproducible results with PCR megaplex systems such as Powerplex® 16 BIO.

DNA, Paternity Testing, Powerplex®

B91 DNA-Typing of Sperm Collected From Skin and Clothes After Washing

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The goals of this presentation are to call the scientists' attention to traces of sperm on the victim's skin or clothes, which might still be useful for DNA typing even after showering or machine-washing, respectively.

Sexual assaults are some of the most frequent criminal cases nowadays that the forensic DNA analyst that has to deal with. Fortunately, the perpetrator often leaves strong evidence from seminal fluid. Thus, many cases can be solved, if the evidence is collected carefully, taking every trace and every possible piece of evidence into account. However, and understandably, the victims of rapes feel the urge to take a thorough shower and clean themselves and their clothes as soon as possible. If this is the case, most of the biological traces are lost and, at this point, the investigators have discontinued sampling and DNA-typing since these data may no longer be considered useful.

In an experimental study, female volunteers took swabs from different areas of their bodies after having had sexual intercourse followed by a shower. DNA-typing was done by STR analysis using the AmpFlSTR Kit SGM+ (Applied Biosystems).

In the second part of the study, seminal fluid was applied to pieces of cotton cloth that were air dried and then cleaned in a washing machine using different programs.

The results of DNA-typing of samples from either experiment show that neither showering nor laundering by washing machine removed all of the sperm cells. Most of the samples from the skin were typed successfully and even showed high amounts of male DNA. Similarly, most of the samples of laundry showed full DNA profiles of the sperm donor. Depending on the temperature program used, DNA stayed on the pieces of cloth more or less. The highest amounts of DNA were found when using the 60°C program.

The findings suggest reassessing some of the routines practiced in rape investigation when collecting evidence. Obviously, it might be worthwhile to take swabs from victims even after showering and to collect pieces of laundry such as underwear or bed linen even after machine washing.

DNA-Typing, Sperm, Sperm After Washing

B92 Detection of Condom Residues by Microscopic and GC/MS Examination

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Attendees will understand the development of methods to provide evidence from the use of condoms during sexual intercourse and to distinguish between condom brands.

The increasing number of sexual assault cases, where the uses of condoms were reported, lead to the necessity of condom residue analysis. The currently available microscopic techniques can provide evidence for the use of condoms; however, the identification of a specific condom brand is rarely achieved. The aim of this study was the development of methods to distinguish between condom brands.

Examined microscopically were 30 condom brands available in Germany (1 from the US, 3 from Sweden, 26 from Germany). The surface of the condoms was swabbed with cotton tips and the swabs were spread on microscopic slides. After staining with HE and Sudan 3,

27 of the 30 samples showed numerous starch granules and 12 contained few lycopodium spores. Thus, detection of these particles might indicate the use of condoms. In rare cases, further types of surface particles (besides starch granules and lycopdium spores) can be observed. In such cases, even the microscopic examination might provide evidence for a special condom brand.

In a further experiment, 6 volunteer couples were asked to provide vaginal swabs in defined intervals after sexual intercourse using condoms. In one case, lycopodium spores could be detected up to 4 days after the intercourse. In the other cases, the spores could be detected only during the first day. In 2 of the 6 cases, many cornstarch granules could be found during the first day post coitus. These particles could be found up to the fourth day.

These experimental data support findings during casework examinations. If the victim claimed the use of a condom by the perpetrator, starch granules and also lycopodium spores were observed in some cases during the microscopic examination of the vaginal swabs.

Since cornstarch granules are found on powdered latex examination gloves as well, we would recommend the use of non-powdered gloves during the examination of rape victims.

In addition to the microscopic investigation, the surfaces were washed with ammonia buffer solution (pH 8.9). After a liquid-liquid extraction with an ether/ethyl acetate mixture, the organic phase was evaporated under nitrogen and the residue was derivatized with BSTFA. One □L of this solution was examined by GC/MS. Characteristic chromatograms were obtained for every condom brand. A library was established by storing the spectra of each chromatogram. The data collected could be used as a reference for comparison with spectra obtained from vaginal swabs collected in cases of sexual assaults. In an experimental set up, a vaginal swab was extracted 24 hours after an intercourse using a condom. The spectra obtained from the swab matched the reference spectrum in the library for the respective condom brand. The retrievals system calculated the match with 95%.

Thus, this data demonstrate that a combination of microscopic investigation and GC/MS analysis may provide not only evidence for the use of condoms but also a tool for the identification of a condom brand. Further experiments will be necessary to increase the reference library and to evaluate the chromatographic method with casework samples.

Condom Residues, Microscopic, GC/MS

B93 Identification of Skeletal Remains From Mass Graves: Ten-Year Experience of Our Work

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Significant efforts are currently underway to identify missing individuals discovered in mass graves situated throughout Croatia and southern Bosnia and Herzegovina.

By the end of 1992, more than 15,000 persons were missing in the Republic of Croatia as a result of the war. According to the authors' records, 9,000 persons were killed. To date, 3,353 bodies have been exhumed and 2,745 bodies identified. However, another 608 bodies have to be identified.

During the last ten years, more than 900 bodies found in several mass graves in Croatia, Bosnia, and Herzegovina have been identified by the Laboratory for Clinical and Forensic Genetics using standard forensic methods. Unfortunately, common methods for human identification, like direct facial recognition or recognition of special features, such as scars or marks, matching of fingerprints, dentition, and detailed examination of the clothing and belongings of the dead, were not sufficient in approximately 30-35% of all cases and DNA identification was requested. The ability to analyse trace amounts of human DNA from old teeth and bone samples offers the opportunity to identify unknown skeletal remains by a comparative genetic analysis with their presumptive relatives. However, DNA degradation and DNA contamination are encountered frequently with DNA extracted from bone and teeth samples recovered from mass graves. Furthermore, the quality of DNA obtained from femur and teeth was higher than that obtained from other types of bone samples. DNA isolation was performed, in addition to some advanced methods, using standard phenol/chloroform/isoamyl alcohol procedure. Some samples that failed to give results after a second phenol/chloroform/isoamyl alcohol extraction were subjected to additional procedures such as decalcification method with EDTA (ethylenediamine-tetraacetic acid) prior to extraction of DNA and a NaOH repurification method. Recently, new procedures for DNA extraction (DNA IQ System) and DNA quantitation (AluQuant Human DNA Quantitation System) were successfully tested in the laboratory.

During the last ten years, the following DNA identification systems were used: AmpliType®PM+DQA1 PCR Amplification and Typing Kit, AmpFlSTR Profiler™ PCR Amplification Kit, AmpFlSTR Profiler Plus™ PCR Amplification Kit, PowerPlex™ 16 System, AmpFlSTR Identifiler™ PCR Amplification Kit, immobilized SSO (sequence-specific oligonucleotide) probes for the mitochondrial DNA control region, and Y-Plex™6.

At the beginning of the identification process, AmpliType® PM+DQA1 PCR Amplification and Typing Kit was used; however, it proved unsuccessful in 75% of all cases. Common problems with this kit were either amplification difficulties or nonspecific hybridization that caused ubiquitous data. At the current time, two multiplex short tandem repeats systems (PowerPlex™ 16 System and AmpFlSTR Identifiler™ PCR Amplification Kit) are being used which amplify 16 loci including all CODIS core loci in a single reaction with great success. Up to date, 406 samples have been analyzed by DNA technology and obtained full genotypes in 355 samples (87%) with DNA matches confirmed in 55 cases.

Identification, Mass Grave, STR

B94 Identification of a Cooked Meat Sample By 12SrRNA Sequence Analysis

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Attendees will learn how the sequence of 12SrRNA gene adapted in this study proved to be usable for animal identification.

The trade in endangered animals requiring conservation is a problem in many parts of the world, particularly in Asia. Forensic science laboratories frequently encounter tissue or meat samples of wild animals lacking any morphological detail for identification purposes.

Identification methods such as blood grouping and biochemical polymorphism have proved useful but the discriminating power of these techniques is less than that of DNA markers. The fact that primers of broad utility could be found for the fast evolving mitochondrial DNA makes it likely that **universal primer** can also be designed for identification purposes.

Sequence information and comparison of the rRNA gene can be used as a tool in identification and classification of organisms. The maternal origin of mitochondrial markers makes this method preferable for analysis. Additionally, heteroplasmy does not exist in most of the organisms. As the copy number of mt-DNA is high and the test involves PCR amplification, only a few cells are required to carry out the analysis.

In the present study the knowledge regarding the sequence variation in ribosomal RNA gene was used and an attempt made to identify a meat sample.

A partial DNA sequence of l2SrRNA was used to identify the cooked meat. Genomic DNA was extracted from the tissue and blood samples using standard Phenol:Chloroform extraction procedures were followed in the laboratory. The samples were kept overnight and DNA was purified by precipitation with salt and washing with alcohol. The control species used included such domestic animals as cats, dogs, cattle, pigs, and humans. The universal primer of 12SrRNA region was used to amplify the sequence from the animal species. The sequence of the forward primer to amplify 12SrRNA region was: AAAAA GCTTC AAACT GGGATTAGATACCCCACTAT. The sequence of the reverse primer for the same region was: TGACT GCAGA GGGTG ACGGG CGGTG TGT. The MJ Research Thermal Cycler was used to amplify the samples. The conditions for amplification were: Initial denaturation at 95°C for 2 minutes. Denaturation at 95°C for 1 minute. Annealing at 58°C for I minute. Extension at 72°C for 1 minute. Number of total cycles was 30. Final extension was at 72°C for 10 minutes.

The PCR produced a single amplification product for each genomic template. The size of all PCR products tested showed no obvious differences when separated on a 2% Agarose gel with size being approximately 386 bp. Products were purified by treating the samples with shrimp alkaline phosphatase; exonuclease sequencing was performed with forward primer and Big Dye Terminator; and, cycle sequencing products were purified by salt precipitation, followed by three washes with 70 percent alcohol, and, final wash with absolute alcohol. Products were dissolved in 4.5 microlitre of sequencing dye. Finally, products were separated on 5 percent denatured polyacrylamide and were detected using a PE Applied Biosystems 377 DNA Sequencer.

Blast Software aligned the sequences. Identity of the meat sample with that of known sequence of 12SrRNA gene of s*us scrofa* was found to be 97%. The Genus s*us* is the Latin word for "pig" and Species name *scrofa* is also Latin for "breeding sow." The sequence of 12SrRNA gene adapted in this study proved to be usable for animal identification.

Finally, the case with which homologous sequences can be gathered will facilitate a synergism between molecular and evolutionary biology, which will lead to insight into genetic structures and phylogenetic history.

12SrRNA, Mitochondria, Blast

B95 The Forensic Implications of Shoelaces: Can Handedness be Determined by Shoe-Tying Method?

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The goal of this presentation is to present to the forensic community the notion that there is no statistical significance between handedness and the methods used to tie one's shoelaces.

While the act of tying one's shoes stirs neither controversy nor excitement, the question has been posited as to whether the handedness of an individual can be determined, or at least seriously suggested, by the appearance of an individual's tied shoelaces. This presentation, information that may be helpful in a forensic setting, features the results of a study aimed at evaluating the correlation between handedness and the specific technique employed in tying shoelaces.

An extensive survey was undertaken (n=1000), in which participants were asked their age, sex, and handedness. Each was then asked to demonstrate the technique used to tie his/her shoelaces. The authors approached a random sample of males and females representing all ages over the course of several weeks on various days of the week. All sampled individuals were approached at various locations within the same community of over 60,000 residents. Participation in the survey was voluntary, with participants receiving no rewards or considerations.

It is noted that the proportion of the world population represented by left-handed individuals has been reported to be between 10% and 13%. In this study it was determined that left-handed individuals were represented by 11% of the total participants. The authors equally polled males and females; 50.4% of the participants were female and 49.6% were male. While specific age was recorded for each participant, ages were later grouped into ten-year ranges for the statistical analyses. Because the study was limited to observations only upon adults, 18 and 19 year-olds were lumped in the youngest age category; 20-29 year-olds, the next; 30-39 year-olds, the next; and so on, to include an 80-89-year-old group. Age distribution followed a relatively normal curve. The largest group was composed of 20 to 29 year-olds, (n=366).

Twelve methods of tying shoelaces were noted and labeled 1-12. Each of the 12 methods was further noted to be composed of three tying stages. Stage one began by first crossing the left lace over the right (exhibited in methods 1-6), or the right lace over the left (exhibited in methods 7-12). These data were referred to as "tie-style." Stage two was determined by the loop being created either on the right or left side. Stage three of the process was determined by whether the right or left loop is set on top of the other loop, when the tie was completed. The result knot was designated as method 1-12. For each participant the three stages were documented on a form and completed by the authors in the field.

A statistical analysis of the data was conducted using SPSS. Initially, it appeared that there was a difference in the way left-handed individuals tied their shoes. However, such was not the case. As an example, method #1 (a left-over-right tie-style) was used by 38.9% (n=337) of all right-handed individuals, and only 10.6% (n=11) of all left-handed individuals. Conversely, 31.7% (n=33) of all left-handed individuals used method #9 (a right-over-left tie-style), while only 6.8% (n=59) of right-handed individuals used this method. This initially appeared important, although it was later determined to be statistically insignificant. While left-handed individuals chose this method most frequently, a greater number of right-handed individuals also chose it, thereby creating the inability to distinguish handedness. It was determined that tie-style is a more accurate indicator of left versus right-handedness.

In conclusion, because both an overwhelming proportion of the general population is right-handed, and there is greater variation in the way right-handed individuals tie their shoelaces, it is inappropriate to infer handedness from tied shoelaces. We could not reject the null hypothesis that there is no difference between left and right-handed individuals and the way they tie their shoelaces.

Handedness, Shoelaces, Criminalistics

B96 Establishing the rDNA IGS Structure of *Cannabis Sativa*

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The educational objective of this presentation is to establish the rDNA IGS structure of *Cannabis sativa* as a means of both classification and identification.

The rDNA IGS structure was established for the use of classification and identification of *Cannabis sativa* in this study. DNA fragments of rDNA IGS were amplified by PCR from four Cannabis samples and two fragments, 1kb and 1.5kb, were obtained. After cloning

and sequencing analysis, 2 regions dispersed and 6 different repeat units were found in 1.5kb DNA fragment. There are 3 repeat units with 2 copies of each in the first region, the first half of IGS sequences. The sequences of repeat units are CTCTTTCCCTTTGGGACTTGATATG, CCAAAGTGTTGGTCGGGTTCAACAAAAGACTTA and CCGAAAATAATTTTTTTCTGTGGTGTTG. The second region is composed of another 3 different repeat units but with different copies of each. The sequences of repeat units are CTAAGAGTGGGTGCACA, GCCCTTGTTGTGCCTTGGTGCA and CTGCACCCACACGTGAGGTTAACTGAC. In the repeat sequences there are point polymorphisms observed in this study. In the sequence comparison of 1 and 1.5kb fragments, the sequences of 1kb fragment were found highly consistent with the 5' end sequence of 1.5kb DNA fragment including the first repetitive DNA region. There are, however, one 9bp insertion/deletion and 14 point polymorphisms observed in the relevant position. The DNA sequences of this 1.5kb were compared with all the plant sequences registered in GenBank by Fasta program of GCG software. The result showed that this DNA fragment was significantly different from any other DNA sequence so far recorded. These specific and complex variations of IGS may be related to the species and geographic distributions.

***Cannabis sativa*, rDNA IGS, Species Identification**

B97 Detection of Pyrolytic Products of Amphetamine and Methamphetamine by Differential Scanning Calorimetry

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The goal of this presentation is to develop a method for characterizing thermal degradation products of smoked drugs of abuse.

Differential scanning calorimetry (DSC) is a thermal analytical technique used to characterize changes in the state of a material. Because DSC operates under tight temperature controls, the authors applied this technique to studies on the thermal decomposition of drugs. A number of physical and chemical changes can occur in a material as its temperature is increased, and methods for characterizing these alterations upon heating or cooling a sample of the material is referred to as thermal analysis. In this technique, sample and reference material are maintained isothermally to each other by proper application of electrical energy as they are heated or cooled at a linear rate. The difference in energy input required to maintain the sample and the reference at exactly the same temperature is plotted as a function of the sample temperature.

Sample sizes of 0.6-1.0 mg of amphetamine sulfate and methamphetamine hydrochloride were analyzed using a Perkin Elmer Differential Scanning Calorimeter 7 (DSC7). The sample was placed into an aluminum sample pan. The pan and sample were covered with a lid that was crimped so that the sample was encapsulated in an airtight container. The pan with the sample was placed in the sample holder, while an empty reference pan with a cover was placed on the reference side. The analysis was begun after dry nitrogen was passed through the instrument for 10 min. Scanning rates of 20^{o} and 40^{o}C/min were evaluated in the temperature range of 25^{o} to 500^{o}C. Samples were eluted with 100 µL of ethanol and 5 µL portions were injected onto a C-18 reverse phase HPLC column with 90:10 MeOH:H_2O mobile phase at a flow rate of 1 mL/min. Samples were also analyzed by GC-MS on a DB5 capillary column with oven temperature 50^{o}C held for 1 min then programmed at 15^{o}C /min to 280^{o}C.

Both amphetamine and methamphetamine degraded when heated in the DSC instrument. At least 5 decomposition products were observed by HPLC and GC-MS analysis.

DSC can be used to study the thermal instability of amphetamine and methamphetamine in a sealed, temperature-controlled environment. The profile of degradation products formed can be compared to the products formed by other pyrolytic methods.

Amphetamines, DSC, Pyrolysis

B98 Differentiation of Gel Pen Inks by Thin Layer Chromatography, Fourier Transform Infrared Spectroscopy, and Energy Dispersive X-Ray Spectrometry

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The goals of this presentation are to illustrate an examination methodology for the differentiation of gel inks.

The analysis of writing inks has been an integral part of the field of Questioned Document examination for many years. Early attempts to differentiate writing inks relied upon either physical methods such as microscopic examination or the use of filters and various light sources, or the use of chemical spot tests, requiring application of the appropriate chemicals directly to the document. In the early 1970's extensive work was done by governmental laboratories in both the U.S. and Switzerland in the use of thin layer chromatography as a method to differentiate writing inks. These studies led to the approval of 2 ASTM standards for the examination of commonly found writing inks for the purpose of either differentiation or identification by comparison with a standard collection of ink formulations. In the late 1980's, a new class of writing inks was introduced: gel inks. These inks were applied to the paper surface by a ball mechanism similar to ballpoint pens, but the ink was not the "oil" based ink commonly found in ballpoint pens. Gel ink is a mixture of colorant, dyes, or pigments, and water based gel or carrier. Due to these differences, water gel vs. solvent and containing pigments and dyes vs. dyes alone, a different examination methodology is required to differentiate adequately gel inks.

In this work, a collection of 43 different gel ink samples was examined using thin layer chromatography, Fourier Transform Infrared Spectroscopy (FTIR) and Energy Dispersive X-Ray Spectrometry. The physical characteristics of the inks were noted, including color, reaction to ultraviolet light, and solubility in several common solvents. Thin layer chromatographic analysis was conducted using a variety of solvent systems and the color and placement (Rf) of components were noted. The solubility characteristics and TLC results allowed for differentiation of many samples of similar color and different manufacture. Due to the presence of some pigment only based ink systems, there remained a segment of the collection that could not be differentiated by TLC. The use of both FTIR and X-Ray spectrometry allowed for further differentiation through the identification of elemental composition due to the pigments present or by the presence of different spectroscopic results due to the use of different gels from one manufacture to another. A correlation could be made in some instances between elemental content and ink color or appearance, as well as between molecular structure and ink manufacture.

Future work will include the incorporation of a larger collection of gel inks from additional manufactures, as well as the use of Raman Spectroscopy to investigate further the molecular structure of the gel.

Questioned Documents, Gel Inks, Ink Analysis

B99 Laser Desorption Mass Spectrometry: Part I. LDMS as a Tool for Investigating the Authenticity of Items of Historical and Archaeological Interest

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At the conclusion of this presentation, attendees will understand the basics of laser desorption mass spectrometry (LDMS), and how it can be a tool for the selective characterization of color components in a wide variety of samples. They will also gain some insights into the kinds of materials that can be characterized and the information that can be extracted from laser desorption mass spectra. Finally, they will learn that LDMS may be a versatile tool in a forensics laboratory for a variety of solid samples.

Laser desorption mass spectrometry can be performed with instruments that are now commonly sold to characterize biomolecules - matrix-assisted laser desorption/ionization (MALDI) mass spectrometers. These instruments use pulsed UV lasers and time-of-flight mass spectrometers for analyzing ions desorbed from solid samples during laser irradiation. In this work, a tabletop instrument from PE Biosystems is used. This research focuses on the direct desorption and ionization of compounds that provide colors to samples, from a variety of solid supports and matrices. The analytes include organic dyes, inorganic pigments, and materials known as lakes, which are organic dyes attached to inorganic supports. In LDMS, samples are placed on a metal plate and introduced into the vacuum system of a mass spectrometer for analysis. Methods for securing the sample depend on the type of sample. A variety of approaches will be discussed for introducing small samples, such as single threads or paint chips, into the instrument.

Items of historical and artistic interest are frequently valuable because of their vibrant colors. If the authenticity of such an item is questioned, one factor that must be considered is whether the chemical components are consistent with the alleged date of its creation. The chemical composition of decorative colorants, paints, and writing inks also provides useful archaeological and historical insights into the technological skills and trade routes of the people who created them. Even in fairly recent paintings, there is considerable interest in the changing artist's palette, what paints were available, how certain effects were created, and how colors in a painting originally appeared at the time it was created.

An overview of the basic concepts associated with laser desorption mass spectrometry will be provided, followed by a demonstration of how it can be used to characterize colorants from a variety of samples. These include inks on written and printed documents, dyes and pigments used in paintings and historically significant manuscripts, dyes used in coloring fabrics (including single fibers), and printed collectables such as currency and stamps. For each type of sample, information must be collected on what colorants were available and used during a specific time period at the location where the item was made. Next, laser desorption mass spectra must be obtained for these materials, to determine what ions may be formed when the material interacts with UV laser light. Also, similar information must be collected for modern dyes and pigments that may be found if the item under study is not authentic, but a modern "recreation." Finally, positive and negative ion LDMS spectra obtained from the sample are compared with spectra of standards. At this point, data interpretation can begin, with the goal of identifying the colorants present, and possibly their age.

Many aspects of a specific "historical" item must be considered when attempting to establish authenticity. One part of such puzzles is establishing that materials used to create the item are consistent with the presumed time of origin. LDMS shines in this regard.

Dyes and Pigments, Mass Spectrometry, Art Authentication

B100 Laser Desorption Mass Spectrometry: Part II. A Tool for the Analysis of Inks and Pigments on Written and Printed Documents of Historical and Archeological Interest

Donna M. Grim, MS, and John Allison, BS, PhD, Michigan State University, Chemistry Building, East Lansing, MI; and Jay A. Siegel, PhD, School of Criminal Justice, Michigan State University, East Lansing, MI*

At the conclusion of this presentation, the participant will understand how laser desorption/ionization mass spectrometry (LDMS) can be used to distinguish between contemporary and historical inks, as well as how isotopic distribution pattern analysis in mass spectrometry aids in the LDMS identification of inorganic pigments.

LDMS can be used to detect dyes found in inks and pigments found on illuminated old manuscripts directly from a paper substrate. In these experiments, a PE Biosystems matrix-assisted laser desorption/ionization (MALDI) mass spectrometer was used to perform direct LD experiments, without using a matrix. Old documents were analyzed as part of investigations concerning authenticity. The documents include a page of the Koran (17th century), currency (18th century), and publications (late 19th century). The samples were introduced into the MALDI source using a modified sample plate, which is typically designed to hold electrophoretic gels. The instrument is equipped with a pulsed nitrogen laser (337nm, 2ns, 3Hz), which can be focused directly onto the width of a pen stroke. Positive and negative ion spectra were obtained and calibrated using dye solutions on paper (Rhodamine 6G and an ink containing Solvent Black 29, respectively).

A page of the Koran, allegedly from the 1600s, served as the primary target for this project. The manuscript was written with black ink, calligraphy style, and was illuminated with gold, red, and possibly green pigments. The goal is to determine whether or not the document could have been created in the 1600s. Colorants used at this time were primarily inorganic pigments or organic dyes from vegetable or insect matter, precipitated onto an inorganic substrate, such as alum. The latter are referred to as lakes. Red pigments used at this time for illuminating manuscripts included vermilion (HgS), madder lake (alizarin), and red lead (Pb_3O_4). Expected yellow ("gold") pigments included orpiment (As_2S_3), lead tin yellow (Pb_2SnO_4), and a variety of yellow lakes. After subjecting the document to both positive and negative ion LDMS analysis, the red and "gold" pigments were identified as containing vermilion and orpiment, respectively. The positive identification of these two pigments was accomplished by comparing theoretical isotopic distribution patterns to the isotopic patterns present in the mass spectra, generated by the red and gold samples. Both vermilion and orpiment were used during the 17th century to illuminate Islamic calligraphy, lending support to the authenticity of the manuscript. LDMS has previously been used to detect organic dyes, such as methyl violet and copper phthalocyanine, commonly found in contemporary ink formulations. Historical inks, including carbon black, iron gallotannate, and sepia, have very different compositions, and are not detected as easily. The LDMS spectra produced from both contemporary and historical ink are very different, enabling one to easily distinguish between the two. The positive and negative ion spectra of the black ink on the manuscript indicate that the ink is not contemporary, lending support to the authenticity of the document.

LDMS serves as a minimally invasive analytical tool for the *in situ* analysis of inks and pigments on printed and written documents. The ability of LDMS to detect a variety of colors, both organic and inorganic in nature, demonstrates the importance of this analytical technique in the analysis of both ancient and contemporary documents and works of art.

Inks and Pigments, Mass Spectrometry, Art Authentication

B101 Forensic Identification of Vehicle Fluids

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The attendees will learn what different fluids are found in a vehicle and their respective function. They will understand their chemical characteristics and the proper manner to identify them through chemical analysis.

On some occasions, forensic laboratories are requested to identify a fluid extracted from a vehicle. This situation is often encountered when a mechanical failure resulting in an accident or a fire may involve the contamination of a given fluid. Presently, there are multiple tests and methods developed to analyze and check the physical properties of different automotive fluids, but there is a lack of available literature regarding the chemical composition and characteristics of these fluids. Therefore, there is a need to develop an analytical scheme, using common instrumentation that will allow the forensic chemist to identify correctly an unknown fluid. Furthermore, it is also important to create a database of the different chemical properties of the fluids that may be useful to other forensic laboratories.

Various neat samples of engine coolants (EC), engine oils (EO), automatic transmission fluids (ATF), gear lubricants (GL), brake fluids (BF), power steering fluids (PSF), and washer fluids (WF), were obtained through automotive shops. First, a differentiation and classification on the visual inspection was performed and colors recorded. Second, gas chromatography-mass spectrometry (GC-MS) was used to analyze these samples. One percent solutions of each fluid were prepared in diethyl ether. Analyses were performed on a Hewlett-Packard 6890-5973 GC-MS with a column HP 5 (30 m, 0.25 mm, 1.0 um). The instrumentation used for this analysis is very similar to the one used for fire debris analysis and may, therefore, be accomplished by the same scientist with few changes. Third, Fourier transformation infrared analysis of neat fluids using a diamond cell was carried out. Finally, fluids were mixed by pair and the miscibility recorded. Analysis of fluids coming from a mixture was also done in order to check if their chemical properties were changed.

ATF are usually of a red color, EC are usually green and WF show different colors such as blue or pink. BF, GL, BF, and EO are more difficult to differentiate due the fact that they present a similar yellow tint. GC-MS of the different samples show that BF is mainly composed of glycols and alcohols from 120 amu. EC contains mainly ethylene, diethylene and/or propylene glycols while WF usually does not show any compounds besides methanol in some samples. ATF, PSF, GL, and EC are mixtures extracted from petroleum distillates and, therefore, show a wide range of hydrocarbon compounds usually starting around C18.

Different automotive fluids were collected and analyzed and their chemical characteristics recorded. It was possible to develop an analytical scheme that allows the clear discrimination and identification of vehicle fluids. This scheme includes three main steps: visual examination, GC-MS, and FTIR. Mixtures of these fluids have also been investigated and it has been shown that despite some interfering phenomena, it is still possible to identify the proper fluids.

GC-MS, Vehicle Fluids, Oils

B102 Comparison of the Elemental Profiling Techniques of Laser Ablation-Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) and Laser Induced Breakdown Spectroscopy (LIBS) for Forensic Automotive Paint Samples

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The goal of this presentation is to present to the forensic community elemental profiling data from the analysis of forensic automotive paint samples.

Automotive paints are frequently encountered forms of trace physical evidence in forensic science laboratories and represent a portion of the elemental analysis study of trace evidence underway in the Florida International University laboratory. The laser techniques of Laser Ablation-Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS) and Laser Induced Breakdown Spectroscopy (LIBS) have been developed to better characterize these samples for forensic purposes.

LA-ICP-MS has been used on forensic samples such as glass, plastic automobile lenses, pen inks, and tapes. This study has extended its potential uses to automotive paints. The advantages of this technique over existing techniques include minimal sample preparation and minimal destructiveness, the ability to examine all paint layers simultaneously, and its improved sensitivity and limits of detection over Scanning Electron Microscopy –X-Ray analysis, the current elemental analysis technique of paints in forensic laboratories.

The ICP-MS system used for this work was an Agilent (HP) 4500 Plus Shield Torch System (Agilent, Palo Alto, CA, USA) equipped with a LSX-200 Plus laser ablation system (CETAC Technologies, Omaha, NE, USA). Additionally, an LSX-500 Plus laser ablation system was used and the results from this laser are compared to the LSX-200 Plus results. The comparison between the energy density differences (nominal 5 mJ output for the LSX-200 and 9mJ for the LSX-500) and the effect of the energy differences on the elemental analysis results are also presented.

Since its initial use in 1962, LIBS has become a well-known atomic emission technique that allows for rapid elemental analysis. A laser pulse is focused on a sample surface and excites a sample's atoms, light is emitted, and the emission is detected and analyzed spectroscopically. The emission spectrum is then used to determine the elemental components of the sample. LIBS has previously been used in the identification of pigments in works of art and for determination of lead in house paints. Due to the nature of artwork and forensic samples, it is desirable for a potential technique to be non-destructive or nearly non-destructive, and the LIBS technique meets this criterion. In addition to speed and versatility, other advantages of LIBS are minimal sample preparation, affordability in comparison to LA-ICP-MS and the potential for portability. In this way, LIBS could be used for on-site analysis to potentially reduce operator and instrument time in the laboratory and allow for faster results.

For the LIBS analysis, the laser systems mentioned previously are used in conjunction with the CETAC Endpoint 2000 Spectrometer (300 nm range, 0.5 nm resolution).

A sample set of casework-like automotive paint samples is analyzed by the LA-ICP-MS and LIBS techniques. The optimal laser parameters such as ablation method, spot size, laser power, and frequency of the laser pulse are discussed. Homogeneity studies have been conducted with the developed method. Due to a lack of matrix-matched standards, no true quantification can be calculated for most elements of interest, but quantification results and detection limits for the

measurement of lead (Pb) are reported based on NIST (National Institute of Standards and Technology) Standard Reference Materials 2570-2575 (lead paint films) manufactured for portable XRF analyzers. Additionally, the elemental profiles of some real automotive paint samples and an evaluation of the utility of these techniques to discriminate between different paint samples are presented. LA-ICP-MS and LIBS both show great promise for the detection and analysis of trace and minor metals in forensic automotive paint samples.

Automotive Paint, LA-ICP-MS, LIB

B103 An Overview of Chemical Imaging in Forensic Sciences

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The goal of this presentation is to demonstrate the use of chemical imaging in the examination of various types of forensic evidence.

Chemical imaging has been successfully applied to various types of forensic evidence such as fingerprints, questioned documents, fibers, paint, tape, and drugs. This presentation focuses on examples of these specific applications as well as the use of chemical imaging as a universal tool for forensic scientists.

Chemical imaging combines molecular spectroscopy and digital imaging for the chemical analysis of materials by recording images of the sample as a function of wavelength using a liquid crystal imaging spectrometer – where a fully resolved spectrum unique to the material is recorded for each pixel location in the image. Contrast in the resulting chemical image is indicative of the varying amounts of absorptions, emissions or scattering that occurs at a given wavelength of light. This provides structural, quantitative, and compositional information.

Raman chemical imaging, fluorescence chemical imaging, and visible reflectance chemical imaging (color analysis) provide many benefits and increased capabilities to forensic scientists. Chemical imaging is a non-destructive technique requiring little to no sample preparation, thus, decreasing the potential of contamination and increasing the efficiency of sample analysis. In addition, Chemimage™ software (ChemIcon, Inc.), used to process and interpret chemical imaging data, far exceeds routine spectral interpretation. Statistical strategies coded in the software may be utilized to extract and summarize key discriminating information, providing a simple-to-interpret graphical interface for powerful spectroscopic analyses.

Visual information is critical in most cases for a forensic scientist to articulate scientific information to a lay juror. Chemical imaging allows the chemical information of materials to be displayed in images as well as spectra, making the results of technical information easier to understand.

Chemical Imaging, Trace Evidence, Fingerprints

B104 PTM—A New Way to Image Surfaces

Susan E. Morton, BA, San Francisco Police Crime Laboratory, 850 Bryant Street, San Francisco, CA; and Tom Malzbender*, Department Manager, Visual Computing Department, Hewlett-Packard Laboratories, 1501 Page Mill Road, Palo Alto, CA*

The attendee will learn about and see a demonstration of a new photographic method to image surfaces in very fine detail.

As a way to create critically clear images of surfaces, Tom Malzbender and Dan Gelb of the HewlettPackard Laboratories developed polynomial Texture Mapping (PTM). Its initial purpose was to enhance computer graphics, but it was soon used by archeologists to render eroded clay cuneiform tablets legible. That success has inspired inquiries from other fields such as dermatology and engineering. The purpose of this presentation is to describe the method to forensic scientists in hopes that more applications may be discovered. Like many innovations, PTM is basically a simple idea. Light striking a surface at an angle will reveal texture on that surface. Light coming from different angles and directions will disclose different parts of the texture. In PTM the light sources are precisely placed to cover a lighting hemisphere. The point sources impinge from near the horizon to near vertical and from all points of the compass. Mathematically, one needs at least six lights, with more lights providing more detail. The current prototype has fifty light sources. The PTM prototype currently in use consists of a hemisphere about a meter in diameter. This dome sits on a table and the subject object is placed underneath. An opening at the top gives access to a digital camera. The light sources are electronic camera flashes arranged around the hemisphere. A black cloth is placed around the base of the unit when it is in use to exclude extraneous light. A computer program activates each camera flash individually and a digital image is downloaded to the computer. With this procedure, 50 images of a static object are acquired under 50 separate lighting conditions. These images are then digitally processed into a PTM. PTM software then allows the user to vary the light source continuously to any location. Multiple light sources may be interactively established to highlight certain features. Light source positions not physically achievable may also be simulated yielding renderings that often reveal more information than may be seen with the human eye directly. Additionally, one may change not only light source direction, but also reflectance properties of the material itself. For instance, a clay object may be made to look metallic, and the extra specular reflections introduced are often helpful in the recovery of surface inscriptions or details. All of the manipulations are electronic. PTM is completely nondestructive to the surface it is imaging. PTM has been tested on indented writing on paper. It does not work as well as the existing electrostatic instruments currently in use, but it will work on substrates where those instruments perform poorly. Thick notebooks and paper previously processed for fingerprints which yield poor results with IMED and ESDA may respond well to PTM. PTM has also been used with excellent results to recover a shoe print in soil. Is PTM of use to forensic scientists? The authors would very much like input from the audience, so please bear in mind these limitations:

- The subject must be small enough to fit under the dome.
- Only one prototype currently exists. It can be taken out of the laboratory, but has limited portability. A portable model could be devised with enough demand.
- The surface must be fairly flat, although some curvature is permissible.
- The HP R&D staff is a bit squeamish. PTM is a brilliant solution; help find a problem for it.

PTM, Imaging, Polynomial Texture Mapping

B105 Comparison of Lipstick Smears Using Attenuated Total Reflectance FTIR Microspectrophotometry

Carissa Stark, BS, and Jay A. Siegel, PhD, School of Criminal Justice, Michigan State University, East Lansing, MI*

The goal of this presentation is to evaluate ATR/FTIR as a technique for differentiating lipstick smears.

Lipstick smears are sometimes found at crime scenes in the form of imprints on drinking glasses or as blots on various types of paper.

Lipsticks consist of organic dyes that are suspended in an oily or waxy matrix. There are other additives also added for gloss, brightening, etc. Some forensic methods of analysis involve extraction of the dyes and analysis to determine the color components. Infrared spectrophotometry provides a method for characterizing not only the dyes but also all of the major organic components. This has the potential of better differentiating among lipsticks that may have the same dyes but different matrices.

Lipstick blots may be especially difficult to handle, as they may be difficult to remove from the paper. Unless the smear is dry, it may be difficult to prepare for FTIR analysis. Attenuated total reflectance FTIR was evaluated to determine if it could be a useful technique in differentiating among lipsticks on paper because this method does not involve removing the lipstick from the surface upon which it was deposited.

Attenuated total reflectance (ATR) employs a crystal (zinc selenide) that is in contact with the lipstick. The IR radiation is reflected through the crystal many times, and each time some light is absorbed by the sample. This multipass reflection permits high sensitivity. The paper itself is used as a background that is subtracted from the IR spectrum.

Thirty-seven lipsticks were used. Standard bond paper was the substrate. Smears of each lipstick were made on the paper and then 3-8 spectra were taken of each smear as a check on uniformity. After each spectrum, the crystal was gently wiped with methanol. One hundred scans were obtained for each spectrum. The spectra were baseline corrected using the algorithm resident in the software.

After all spectra were obtained, representatives of each lipstick were converted into a spectral library. The library was then tested for internal consistency by running samples of members of the library. The exact match was obtained in one-third of the cases and the rest, with a couple of notable exceptions, were in the top 5 of the results.

The results indicated that ATR/FTIR may be used as a method for determining if two samples of lipstick could have a common source without having to remove the smear from its substrate.

Cosmetics, FTIR, Reflectance

B106 The Current Status of Microscopical Hair Comparisons

Walter F. Rowe, PhD, Department of Forensic Sciences, The George Washington University, Samson Hall, 2036 H Street, NW, Washington, DC*

Upon completion of this presentation the participant will have an understanding of the limits of microscopical hair comparisons.

Although the microscopical comparison of human hairs has been accepted in courts of law for over a century, recent advances in DNA technology have called this type of forensic examination into question. In a number of cases, postconviction DNA testing has exonerated defendants who were convicted in part on the results of microscopical hair comparisons. A federal judge has held a *Daubert* hearing on the microscopical comparison of human hairs and has concluded that this type of examination does not meet the criteria for admission of scientific evidence in federal courts. A review of the available scientific literature on microscopical hair comparisons (including studies conducted by the Royal Canadian Mounted Police and the Federal Bureau of Investigation) leads to three conclusions: (1) microscopical comparisons of human hairs can yield scientifically defensible conclusions that can contribute to criminal investigations and criminal prosecutions, (2) the reliability of microscopical hair comparisons is strongly affected by the training of the forensic hair examiner, and (3) forensic hair examiners cannot offer estimates of the probability of a match of a questioned hair with a hair from a randomly selected person. In order for microscopical hair examinations to survive challenges under the U.S. Supreme Court's *Daubert* decision, hair microscopists must be better trained and undergo frequent proficiency testing. More research on the error rates of microscopical hair comparisons should be undertaken, and guidelines for the permissible interpretations of such comparisons should be established. Until these issues have been addressed and satisfactorily resolved, microscopical hair comparisons should be regarded by law enforcement agencies and courts of law as merely presumptive in nature, and all microscopical hair comparisons should be confirmed by nuclear DNA profiling or mitochondrial DNA sequencing.

Comparative Microscopy, Hair, DNA

B107 Report of Results From an Interlaboratory Study of the HVI/HVII mtDNA Linear Array Assay

Cassandra D. Calloway, MS, Michael Grow, BS, Natahsa Stankiewicz, BS, Jim Chou, BS, Rebecca Reynolds, PhD, and Henry Erlich, PhD, Roche Molecular Systems, 1145 Atlantic Avenue, Alameda,CA*

The participant will gain knowledge of results from an interlaboratory study of the HVI/HVII mtDNA linear array assay.

Over the past several years, the authors have been developing a rapid method of analysis of sequence variation in HVI and HVII utilizing the established technologies of PCR amplification and immobilized probe hybridization. The original linear array for mitochondrial DNA sequence analysis was comprised of 17 sequence-specific oligonucleotide (SSO) probes. To increase the value of this assay, a primer pair for the HVI region was incorporated into the PCR amplification reaction and added 18 additional probes to detect sequence variation in four regions of HVI and at 2 additional heteroplasmy hotspots (16093 and 189). The "C-stretch" probe and the intensity control probe from the original array were removed. The final version of the HVI/HVII linear array assay consists of 2 primer pairs for co-amplification of HVI and HVII PCR products and 33 probes immobilized in 31 lines for detection of sequence variation at 18 positions spanning both hypervariable regions. This assay was sent to 10 laboratories for beta site testing and the results from this testing will be presented here.

The beta study was designed as a 3 part initial training study and followed by independent study whereby up to 1,000 arrays and reagents were provided. For study 1A the participant was provided 11 DNAs and PCR products and asked to amplify the DNAs, compare the yields on a gel to the provided DNAs, and type them with the linear arrays. The goal of this part of the study was to ensure the participant could amplify DNA without introducing any contaminants and successfully type and interpret the arrays. For study 1B the participant was provided 15 DNAs varying in concentration and including some samples with mixtures. The goal of this study was to demonstrate the participant could successfully quantitate the amount of PCR product, dilute the product, or increase the yield by further amplification cycles if necessary, and successfully type and interpret the arrays. This study included several heteroplasmic samples as well as samples which were intentionally mixed to look like contamination in order to be a challenging interpretation test. For study 1C the participant was provided with 2 hairs from a single individual and was asked to extract the hairs, amplify the DNA, and compare the yield and mitotype to a provided extract from the same individual. This study was designed to test the participant's ability to successfully extract hairs without introducing contamination. For further practice, the participant was asked to extract 5 hairs from 2 additional individuals. Results from the initial training studies will be presented as well as data from the independent studies.

mtDNA, HVI/HVII Linear Array, Beta Testing

B108 Validation Study of the TrueAllele™ Automated Data Review System

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The goals of this research project are to compare an automated data review method (TrueAllele™, Cybergenetics, Inc.) to the established STR analysis software (GeneScan® and Genotyper®, ABI) for use in DNA databank laboratories.

The stated goal of the TrueAllele™ system for databank laboratories is to alleviate the shortage of skilled data reviewers by automating most of the steps in the review process. Theoretically, this would decrease the amount of time needed to analyze scores of profiles, thereby increasing efficiency. To be useful for databank laboratories, the system must handle high throughput with minimal error. The New York State (NYS) Convicted Offender DNA Databank is the first U.S. laboratory to conduct an internal validation of this software for the purpose of generating profiles from ABI 3700® capillary data for upload into the state convicted offender database.

TrueAllele™ detects, quantitates, and types allelic peaks, thereby combining the tasks of the GeneScan® and Genotyper® software (ABI) currently used by the NYS Convicted Offender DNA Databank. TrueAllele™ also prioritizes the allele calls based on several user-defined rules. As a result, the user should only review low quality data. Profiles that meet all rule requirements are automatically accepted without being examined. A sub-program within TrueAllele™, AutoValidate, checks for extraction, amplification, or pipetting errors by comparing shared loci between STR panels and multiple runs of a given sample.

The validation consisted of an extensive optimization phase and a large concordance phase. During optimization, the rule settings were tailored to minimize the amount of high quality data viewed by the user. To accomplish this, the users reviewed nearly 42,000 allele calls and made desired changes in rule firings to dictate future software behavior. Cybergenetics programmers adjusted thresholds based on the frequencies of these User rule firings. The software went through three rounds of threshold optimization, at which point it was decided that TrueAllele™ satisfactorily assigned low quality scores to all questionable calls and higher scores to acceptable calls. The end result was a set of parameters that the NYS Convicted Offender DNA Databank could confidently use to generate accurate and reproducible DNA profiles.

Because the TrueAllele™ expert review system operates very differently from GeneScan® and Genotyper®, an extensive concordance study was performed to ensure that the output of each analytical technique was equivalent. More than 2,000 samples were typed with ABI software and TrueAllele™. Allele designations were identical for 99.8% of samples. Concordance in sample state assignment (accept or reject) was greater than 93%. The remaining differences largely stemmed from disagreements regarding sample rejection.

TrueAllele™ differs from the widely used ABI software in significant ways. The biggest adjustment is that profiles are displayed in a locus-based format rather than in toto. The context of the whole profile has been removed from the primary user interface. Second, sample prioritization means that not all data are reviewed. Consequently, many profiles could be loaded in the state database without human evaluation. Third, editing of erroneous calls is permitted under certain conditions such as cases of dye bleed-through and the occurrence of spikes (specific to capillary electrophoresis). While possibly introducing a certain amount of subjectivity, editing serves as an important time-saver compared to the current NYS Convicted Offender DNA Databank protocol. Finally, TrueAllele™ uses a different method of size standard calculation and display than Genotyper®. Again following guidelines, users can modify the precise location of internal size standard peaks in cases of dye bleed-through and overlap that distort the peak shape.

Editing of allele designations and size standard placement under controlled circumstances will eliminate the need to re-run a significant amount of samples. Other issues will likely require different samples to be rejected, however. First, baseline activity tends to be greater in TrueAllele™ than in Genotyper®. In some cases, the presence of "unexplained peaks" might raise the suspicion of contamination unnecessarily. Second, peak height values differ between software systems. Peaks that are below the set minimum threshold in TrueAllele™ may be above the same threshold value in Genotyper®. This will necessitate the rejection of more samples due to low signal. Finally, confirmation of off-ladder alleles in TrueAllele™ is more consistent than in Genotyper®. Every off-ladder allele will be brought to the reviewer's attention for confirmation, whereas Genotyper® might use either a numerical label or the "OL allele" label. As a result, alleles with numerical labels may not be confirmed with a second run.

Overall, TrueAllele™ and Genotyper® generated comparable results. However, the reasons for rejecting samples changed slightly due to the issues mentioned above. This led to the discord regarding sample rejection. TrueAllele™ reliably brought to attention questionable calls while permitting high quality profiles to pass.

TrueAllele™ was designed to save time by focusing the review on poor data and by eliminating the need for complete re-analysis technical review. This thorough validation project, which included a large concordance study, proved TrueAllele™ to be dependable for use at the NYS Convicted Offender DNA Databank.

STR Analysis, DNA Databank, Data Review

B109 Development and Application of a Linear Probe Array for the Analysis of Sequence Variation in the Control Region of the Mitochondrial Genome

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The participant will learn the potential value of the HVI/HVII linear array used as a screening tool for casework samples.

Analysis of sequence variation in the two hypervariable segments (HVI and HVII) of the mitochondrial genome has been applied to the study of human populations and used to resolve questions of human identification. The most widely used method of analysis for forensic and human identification applications involve PCR amplification of mitochondrial DNA (mtDNA) extracted from biological samples followed by direct sequence analysis. Over the past several years, the authors have been developing a rapid method of analysis of sequence variation in HVI and HVII utilizing the established technologies of PCR amplification and immobilized probe hybridization. The current version of the HVI/HVII linear array assay consists of two primer pairs for co-amplification of HVI and HVII PCR products and 33 probes immobilized in 31 lines for detection of sequence variation at 18 positions spanning both hypervariable regions. The linear array assay can be performed in approximately 6 hours, including amplification time, on up to 48 samples. Positive signals are detected as blue lines following a color

development reaction and interpretation of the probe reactivity patterns (mitotypes) can be done either visually or by scanning. In addition to being rapid and informative, the linear array assay consumes only one-half to one-quarter the amount of extracted sample as sequence analysis because the HVI and HVII regions are amplified simultaneously rather than in 2 or 4 separate reactions. Also, the PCR products amplified for the linear array assay can be used for sequence analysis.

To determine the value of the expanded HVI/HVII linear array assay as a screening method, 689 samples from four different populations were typed as well as 105 Croatians and 200 U.S. Georgians. Additionally, the HVI and HVII regions of many of the samples were sequenced. The authors found that this panel of SSO probes captures a significant level of genetic diversity within the control region in all of these populations. In addition to the samples from the Georgia population database, samples from multiple cases submitted to the GBI (Georgia Bureau of Investigation) also were typed using the SSO linear array and sequence analysis. Cases in which the suspect had been excluded by STR typing were chosen for this study to allow the value of the mtDNA linear array assay to be assessed as a screening tool for the exclusion of individuals. In all but 1 case, linear array typing was sufficient to exclude the suspects who had been excluded by STR analysis. In this particular case, the suspect excluded by STR analysis had the same SSO mitotype as well as the same HVI and HVII sequence as the donor of the semen stain. Prior to mtDNA typing, it was thought that the suspect was a brother of the donor of the semen stain based on STR analysis. The mtDNA analysis was consistent with this conclusion. Several additional cases will be summarized, along with the mitotype frequencies of the individuals in these cases obtained from the Georgia database and the U.S. database.

An initial version of this assay analyzing only the HVII region also has been tested on over 200 samples taken from more than 20 cases in Sweden. Using the HVII region probes alone, over 70% of these samples could be excluded greatly reducing the number of samples that needed to be sequenced. Sequence analysis of HVI and HVII of these samples resulted in the exclusion of only seven additional samples as originating from the suspects and showed that further exclusions could have been made using the current HVI/HVII linear array. More recently, the current HVI/HVII linear array has been used in cases and the results will be summarized. Clearly, as a result of using the linear array assay to screen samples, the sequencing effort in this Swedish laboratory could be directed toward the most probative samples, resulting in a significant decrease in casework turnaround time. From these studies, it is concluded that the linear array assay is a simple, rapid screening tool for casework analyses because it is robust and provides a high degree of discrimination in a relatively short period of time.

mtDNA, HVI/HVII, Linear Arrays

B110 Quantitation and Characterization of Spectral Overlap Observed in Data Obtained From the 310 and 3100 Genetic Analyzers and the Use of These Data in Formulating Interpretation Guidelines

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The goal of this presentation is to provide a methodology by which one can apply specific diagnostic criteria to differentiate pull-up peaks from true alleles and/or other artifacts that commonly appear in data analyzed on the 310 and 3100 Genetic Analyzers (ABI).

Virtually all DNA analysis of forensic casework is performed using fluorescent detection. Typically, STR primers are labeled with fluorescent dyes allowing the detection of one strand of the denatured PCR product. For the AmpFlSTR Profiler Plus® and COfiler® PCR Amplification Kits (ABI), the FAM, JOE, NED, and ROX fluorescent labels emit at wavelengths that correspond to the blue, green, yellow, and red regions of the spectrum. Spectral overlap between adjacent dyes can lead to the detection of extraneous peaks within a sample. To correct for this overlap, matrix standards are run to calculate the degree of spectral overlap between the dyes. The matrix file then subtracts this overlap resulting in analyzed data that does not contain extraneous peaks caused by spectral overlap. When the matrix fails to remove fluorescence detected from adjacent dyes, "pull-up" or "bleed through" peaks are observed on the electropherogram. One characteristic of pull-up peaks is their close correspondence in base pair size to the size of the causal peak, which customarily has a significantly higher peak height and usually originates from a spectrally adjacent color(s).

Data analysis would benefit from guidelines that indicate when and where a pull-up peak would most likely occur, particularly when the nature of these peaks varies between instruments (377, 310, 3100). This information can be critical in forensic casework due to the extensive overlap between loci labeled with different dyes. This is particularly important when a pull-up peak is labeled with an allele designation that corresponds to ladder allele. Interpretation errors can result in the inclusion of pull-up peaks or the exclusion of small, but true peaks from a profile.

For this study, data has been compiled from samples run on the 310 and 3100 Genetic Analyzers to establish an RFU (relative fluorescent unit) value below which pull-up is unlikely to occur. The 310 data reflects peak heights obtained from samples run on five different instruments, each with a unique matrix file. The 3100 data were obtained from a single instrument. When the data between the two instruments were compared, it was observed that pull-up occurs at relatively lower peak heights then on the 310. The data further characterizes pull-up in terms of the amount of "drift" between the base pair size of the pull-up peak vs. that of the causal peak. When both instrument platforms were compared, the amount of drift observed between the pull-up peak and its corresponding true allele was not only greater on the 3100 but was also directional in nature.

The quantitative information provided in this study will provide the analyst an additional tool with which to analyze fluorescent-based forensic casework data. It is anticipated that this information could further lead to the development of a diagnostic hierarchy for differentiating true alleles, pull-up peaks and spikes.

STR Analysis, Bleed Through, Interpretation

B111 SNP Analysis of the Y Chromosome Using SNaPshot™

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Attendees of this presentation will learn about design and development of an assay for Y SNP analysis.

Analysis of single nucleotide polymorphism (SNP) markers is a valuable tool that offers a mechanism to augment conventional forensic DNA analyses, such as tandem repeat and mitochondrial DNA typing. Moreover, SNP analysis may be useful for evaluating DNA from substantially degraded samples. In addition, SNP analysis is amenable to automation and could enable higher sample throughput. It is predicted that approximately 10,000,000 polymorphisms are dispersed throughout the genome on the nuclear chromosomes and mitochondrial DNA molecule. This presentation will focus on SNPs that are located on the Y chromosome. Since the Y chromosome is uniparentally inherited and has a large non-recombining region, Y chromosome analysis could be valuable for forensic analysis in some cases of paternity, missing persons, mass disasters, and violent crimes.

Several platforms are available to perform SNP analysis, including a variety of single base extension reactions, microarray analysis and pyrosequencing. The focus of this presentation will be analysis of Y SNPs using the SNaPshot™ system. After PCR, single base extension of primers is performed using dideoxynucleotides that are differentially labeled with fluorescent dyes. The single base extended primers are resolved using capillary electrophoresis and detected using laser induced fluorescence. The SNaPshot t™ kit has been designed to be analyzed using ABI Prism 310 or 3100 instrumentation already in use by a large portion of the forensic community. The SNaPshot t™ system can be a rapid, multiplex, high-throughput platform for SNP analysis but requires careful planning for SNP selection and assay design at the onset.

Before beginning SNP analysis, it is important to identify markers that will be useful in forensic analyses. More than 250 SNP sites on the Y chromosome have been discovered. Because of the population substructuring associated with genetic markers on the non-recombinant portion of the Y chromosome, the Y SNP markers can be evaluated using phylogenetic analysis. The phylogenetic tree has been examined for SNP sites that potentially could be useful in forensic identity analyses. The approach that has been used in this study is to 1) identify the Y haplogroups that predominantly comprise relevant, major U.S. population groups and 2) select markers that facilitate differentiation between individuals within haplogroups. The markers lie within haplogroup defining branches of the tree rather than at the base branch points. A preliminary set of 20 Y SNP markers has been selected to provide discrimination of individuals within each forensically relevant haplogroup.

Multiplex SNP assays are needed in order to obtain the most information from limited amounts of DNA in as few assays as possible. Since the degree of multiplexing directly impacts the ability to generate a sensitive, high-throughput system, primer-target and primer-primer interactions must be considered in primer design. Initially, amplification primers were designed to have similar thermal melting temperatures (Tm). The second step in the design of the amplification primers included evaluations of potential primer-primer interactions and possible interactions of the primers with non-target areas of the genome. Primers that had the potential to interact significantly with other primers or with other non-target chromosomes were modified or have not been included in further studies. In addition to Tm compatibility, G/C content was a critical factor in designing the primer extension primers. For research purposes, both forward and reverse primer extension primers were constructed when molecularly feasible. This provides a redundant control at each site, allows the effect of G/C content to be tested, and provides data on which primer is more effective. For example, at a given SNP site, the forward and reverse primers may have substantially different G/C contents but, due to length differences in the primers, will have similar Tm. Analysis of these extension primers will enable a deeper understanding of effective primer design that can be applied to subsequent studies. The effect of primer length, Tm, and G/C content on the effectiveness of primer extension primers will be presented.

Studies involving singleplex SNP analysis also will be presented. Using DNA purified from cell lines as well as evidentiary-type sources, amplification and sequencing were used to determine the correct sequence at each SNP site. Data will be shown confirming that primer extension using the designed primers provides the correct typing of the SNP site. Critical positive and negative controls will be described. For example, DNA isolated from female sources was considered as a potential negative control.

Y chromosome analysis may become an importance source of information to complement STR analysis and mitochondrial DNA sequencing. Selection of Y-chromosome SNP sites, primer evaluation and SNaPshot t™ primer extension results will be discussed as well as the applicability of this system for use in forensic analyses.

Y Chromosome, Single Nucleotide Polymorphism, Primer Extension

B112 Y-SNP Analysis by Pyrosequencing

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The goal of this presentation is to inform the forensic community about Y-SNP analysis and the use of pyrosequencing.

Y chromosome specific typing systems are increasingly being employed in forensic science to augment or, in some cases, supplant the use of autosomal STR markers. For example, they may be the only means of obtaining the genetic profile of the male donor in mixed male/female stains in those instances where the female component is present in overwhelming quantities. Most Y chromosome typing systems currently use STR loci due to their good discrimination potential, ease of analysis and ability to incorporate into multiplex assays.

STR loci suffer from one serious drawback that may limit their long-term use. Future genetic typing systems are likely to require the ability to perform massively parallel, automated analysis and to be miniaturized for incorporation into point-of-use devices. STRs are extremely difficult to automate or to incorporate into micro-electrical mechanical systems (MEMS) devices or lab-on-a chip format. This is in contradistinction to single nucleotide polymorphism (SNP) loci, which due to their abundance in the genome and pivotal importance for gene discovery are currently the subject of a massive capital investment program to improve their analytical efficacy by automation and miniaturization.

The applicability of SNP systems in forensic analysis remains to be demonstrated. One particular disadvantage of autosomal STRs is the perceived difficulty in resolving and interpreting body fluid mixtures, which are often encountered in forensic casework. Since SNPs are biallelic in nature, an individual who is heterozygous at a number of loci may be difficult to distinguish from a mixture of DNA from 2 individuals. The situation with Y-SNPs is simplified due to hemizygousity (lack of heterozygotes) and these SNP loci are excellent candidates for exploring their potential use in forensic science, particularly from the technological standpoint. Studies are also needed to determine whether Y-SNP loci possess sufficient discriminatory ability for forensic utility. The non-independent segregation of Y-SNPs in which a haplotype of widely spaced but physically linked markers are transmitted unchanged from father to son, results in reduced genetic diversity.

Through a variety of public sources, including the SNP consortium, dbSNP (National Center for Biotechnology Information, NCBI) and the primary literature, a number of candidate Y-SNP loci have been identified for further evaluation as to their forensic suitability. Primer extension assays were developed for the candidate loci and used to confirm or, in some cases, determine the degree of polymorphism in African-American and Caucasian populations using DNA from 20 individuals from each racial/ethnic group. Suitable loci were then subjected to pyrosequencing analysis, which is a novel, semi-automated mini-sequencing method for SNP typing. Pyrosequencing employs an enzyme cascade to detect the release of pyrophosphate that occurs when the appropriate complementary dNTP is incorporated into the newly synthesized polynucleotide. Appropriate SNP pattern recognition software facilitates the detection and typing of the polymorphism.

This presentation will describe the forensically relevant Y-SNP loci identified so far, their individual degree of polymorphism and the overall haplotype diversity of various SNP loci combinations in different racial/ethnic groups. For example, as few as 5 of the characterized Y-SNPs are able to distinguish 6 different haplotypes in 32 African-American and Caucasian individuals. Results indicate the potential use of Y-SNPs for the racial/ethnic differentiation of individuals and the implications thereof will be discussed. The potential general utility of pyrosequencing technology for SNP analysis in forensics will also be described.

Y-SNP, Pyrosequencing, Y-Chromosome Haplotype

B113 Developments in SNP Analysis via Quadrupole MS for Forensic Applications

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The goals of this presentation are to present an approach to DNA SNP genotyping for forensics that is based on specific and mass adjustable molecular tags with APCI quadrupole MS detection.

As the field of forensic DNA analysis advances and genetic complexity is further defined, there will be a need for instrumentation and methods that can both accurately genotype novel genetic systems in individuals as well as provide this information in a timely and cost-effective manner. The determination of a single-nucleotide polymorphism (SNP) or a set of SNPs located within the mitochondrial or nuclear DNA can prove useful in a variety of forensic applications including mass disaster situations where substantive degraded DNA is present, cases involving paternal or maternal family lines for missing persons, or mixed samples from multiple male donors in the case of rape or abuse. Many SNPs that may prove beneficial for these forensic applications are becoming evident. In addition, there are several different contending approaches for assessing SNPs. Some of the current approaches include DNA microarrays both suspension/solution based and solid support based, fluorescence tagging, mass spectrometry, pyrosequencing, and direct sequencing. One potential high-throughput approach identifies SNPs and the allelic state by labeling with small molecular weight tags, i.e., Masscodes. This allele specific discrimination assay will be explored and presented, primarily in regard to forensic applications.

The current casework mtDNA assay analyzes approximately 610bp of mtDNA by sequencing the HVI and HVII regions of the control region. However, currently between 4 and 11% of mtDNA analyses in Caucasians yield identical DNA sequences. Analysis of regions of the mitochondrial genome outside of the HVI and HVII could improve resolution. A mtSNP analysis system could analyze SNPs from the remainder of the mitochondrial control region, as well as polymorphic sites outside of the control region. A proof-of-concept study of the Masscode assay utilizing known mitochondrial DNA (mtDNA) sequenced samples and Y-chromosome SNP (Y-SNP) determinations have been initiated. A mtSNP or a Y-SNP analysis may provide discrimination information not currently available and can also provide a method for rapidly excluding samples.

The Masscode assay employs cleavable mass spectrometry tags (CMSTs) that are conjugated at the 5' end with a SNP specific oligodeoxynucleotide. The CMST includes a photolabile linker, a mass spectrometry sensitivity enhancer, and a variable mass unit, all connected through a scaffold constructed around a central lysine. Each tagged oligonucleotide has a different cleavable mass unit that can be uniquely associated with the specific DNA sequence being interrogated. Identification of the polymorphic state is determined by photolytic cleavage of the tag from the amplicon, followed by detection with a standard single quadrupole mass spectrometer using positive-mode atmospheric pressure chemical ionization (APCI). The assay provides a high level of sensitivity (femtomole range), can be designed for multiplex analyses, can be completely automated, and can be scaled from high-throughput to medium-to-low throughput which may be more applicable to forensic analyses.

Three groups of mtDNA-sequenced samples were selected for this pilot study: 25 Caucasian, 25 African American, and 25 Hispanic samples. A few samples were purposely mixed to test the assay in another dimension. Ten mtSNPs were probed: 73A, 16126C, 16069T, 16270T, 16298C, 16223T, 16189C, 16311C, 204C, and 195C. In addition, forensically important Y-SNPs were investigated.

Genotyping, SNP Analysis, Mass Spectrometry

B114 The Oxford Incident: Anthrax in Connecticut

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The goal of this presentation is to review the procedures and outcomes of a coordinated approach to the investigation of a confirmed case of inhalation anthrax.

In November 2001, an elderly female was presented at the local community hospital. She had a high fever and difficulty breathing. Since she had a history of COPD (Chronic Obstructive Pulmonary Disease), standard treatments were given and X-Rays taken. Attending physicians took additional samples when her condition worsened. The decision that led doctors to investigate was based partly on the woman's medical status and partly on the raised awareness after the Florida and New York anthrax cases. Gram-negative rods were found, confirmed as inhalation anthrax by Connecticut Public Health and the CDC (Centers for Disease Control). Unfortunately, this woman died as a result of her anthrax infection. How could an elderly woman, who usually only left her old farm once a week to attend church services, have contracted anthrax? The subsequent investigation and its aftermath required the interaction of several community, state, and federal agencies. Coordination with the media was also necessary to prevent panic among the residents of the state and to provide appropriate information to the citizens.

Because of the limited scope of the victim's travel, the potential sources of infection were very limited. The normal incubation time of anthrax is approximately 60 days. This information and the routine followed by the woman provided additional support for the theory that the source of the anthrax was mail that had passed through New Jersey, as with the other anthrax cases in the Northeast. The CDC, FBI, State Police Emergency Services, Division of Scientific Services, and the Deptartment of Public Health began a coordinated search of the decedent's home. A thorough search of the home showed no areas or materials positive with the "screening test" for anthrax. However, no mail from the appropriate time for infection was found in her home. Mail that tested positive with the antibody test was found at another location in a nearby town, lending further support to the theory for disease transmission. Although the particular source of the anthrax in the decedent's home was not identified, spores were found at a Connecticut postal distribution center. This information, combined with the other case histories, led investigators to hypothesize that a small number of spores were probably on a piece of mail at the decedent's house. The relatively small number of spores that were likely inhaled had previously not been thought to be sufficient to cause infection.

The absolute identification of anthrax in the state also resulted in a large amount of suspect mail and other materials being submitted to Public Health and the forensic laboratory. The forensic laboratory worked closely with that DPH to train personnel and develop chain of custody procedures for physical evidence. When these myriad submissions were found to be negative for anthrax, samples were forwarded to the DSS Toxicology Laboratory and the Forensic Science Laboratory for further instrumental analysis and substance identification. In addition, tests for trace materials, fingerprints, and DNA were conducted on many of these items in efforts to identify a potential source of the physical evidence.

Well-coordinated scene efforts and outreach to community leaders and health officials were effective in determining that no major source of anthrax was in the area. Quick response and sequential laboratory testing allowed the laboratories to reassure a concerned public. Forensic laboratory testing also provided valuable information to support legal action when false threats against state facilities and officials were made.

Anthrax, Bioterrorism, Crime Scene Investigation

B115 Hematoporphyrin Fluorescence as a Test for Blood—Alternative Methods and Potential Interferences

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The goal of this presentation is to present the results of recent research in the area of hematoporphyrin fluorescence utilizing alternative methods of conducting this blood identification test with modern instrumentation. This presentation will have the purpose of illustrating newly recognized potentials of this currently dormant technique.

The research presented in this paper aims to clarify some of the questions currently surrounding the hematoporphyrin fluorescence test (HPF), and explores the possible advantages that the test can offer over catalytic presumptive tests for the identification of blood. The history and mechanism of the test will be presented, along with the conditions utilized, and details of problems that one may encounter when the fluorescence from a blood sample is examined instrumentally.

Hematoporphyrin fluorescence is a test with a long history. It has been under-utilized in forensic laboratories where it is considered to be merely another presumptive means of identifying an unknown material as blood. This lack of utilization can be attributed to the limitations of the standard method by which the test is normally conducted and uncertainty surrounding potential false positives. This is an unfortunate situation given the benefits the test may offer with regard to the small sample size required for an analysis coupled with the specificity that can be attained with it.

Historically, when this test was properly employed, a positive result was based upon visual detection of the orange red fluorescence that developed after a suspected stain was treated with a reagent, most commonly sulfuric acid, and exposed to long wave UV light. It has been argued that other porphyrin containing materials, namely chlorophyll, bile, feces, and meconium, will react in a similar manner and provide fluorescence that is identical to that obtained with blood when observed visually.

Other techniques utilizing different reagents and experimental procedures were evaluated along with the application of concentrated sulfuric acid on samples consisting of whole blood and protoporphyrin IX, the porphyrin found in blood. The resulting red fluorescence was examined instrumentally for spectral characteristics which could be used to distinguish blood from the other materials. Following this preliminary examination, porphyrin compounds similar to those found in the materials reported as false positives were tested and examined for differences in the fluorescence spectrum. Based on this spectral examination, all were differentiated.

All three techniques were then slightly modified and utilized on samples of dried blood, both alone and on a cotton substrate. This was accomplished with a fluorescence microscope equipped for microspectrophotometry. When carried out in this manner a small portion of a bloodstained thread was sufficient sample for analysis. With some methods, a result was even obtained from a single bloodstained fiber. The collective results of these trials will be presented along with a discussion of the advantages and disadvantages of each technique.

Blood Identification, Fluorescence, Microscopy

B116 A Simple Method for Comparing Difficult Prints and Stains

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The goal of this presentation is to introduce the reader to a simple tracing method to complement conventional methods of print evidence comparisons in cases where the prints are difficult to decipher or include confusing detail or background. The method will also be applied to stains, and will be illustrated through case examples including shoeprints, ear prints, and stains on carpet and fabric.

Transparent overlays have enjoyed wide use in the comparisons of shoeprints, fabric impressions, and other patterns such as ear prints. Because the value of this method is intuitively obvious, it is rarely questioned. However, the overlay method alone is insufficient when the very ability of the human brain for pattern recognition becomes a source of error in interpreting patterns. The brain infers shape from even discontinuous elements of form, so that a triangle is perceived when observing three isolated "Vs" which would be the apices. This could be a source of error if the object responsible for a print includes three separate "Vs" in its design, or one "V" deposited three times. Conversely, if there are pattern elements that are not readily inferred as a shape, the brain may disregard them. To control for these types of error, we propose a simple method to render the comparison process more objective: manually tracing the observed detail of the evidence print onto a piece of clear plastic, then comparing the tracing with exemplars.

The success of this method depends upon tracing each discrete dot, line or shaded area as it appears in the print. This should include each mark in the area being traced, regardless of whether it appears to be part of a pattern. Instead of "connecting the dots", one should record the "dots" themselves, because that is the actual data. If some of the data points appear to be from the background or from a stray twig or other object, they can be traced in a different color. Several reference points that can be easily recognized, such as the corners of a tape lift or photograph bearing the print, should also be recorded on the tracing.

This method is useful for the following classes of prints: 1) an evidence print with much less detail than exemplars; 2) a print with intermittent or overlapping detail; 3) a print with a strong background or substrate pattern; 4) smeared prints or prints produced in a liquid or suspension; 5) prints, or photographs of prints, having evidence of distortion or motion; and 6) prints on, or produced by, a flexible material such as fabric. Tracings can also be used to compare stains on an item with stains that may have soaked through it to another item that is now separate.

When an evidence print has much less detail or much less area than exemplars, the pattern of the evidence print may fit completely within the pattern of the exemplar. Any differences between the two may be missed because the set of data that constitutes the pattern with less detail appears to overlap completely with the other. However, there may be differences in angles, curvature, or spacing of minute detail. This is not always resolved by producing fainter exemplars, but can be seen in a tracing.

On the other hand, a wealth of detail may be rendered in a tracing of a print that initially appeared to exhibit only the most general class characteristics. A tracing of the data points may yield disconnected elements of a pattern, visible in a conventional overlay, but not readily perceived as significant. When rendered in a tracing, the data points

may nevertheless exhibit good spatial correspondence with an exemplar.

A similar situation is encountered when a patterned background interrupts the pattern of the print. If Fourier transform software is available, a scanned image of the background can be subtracted from a scan of the print on the substrate. However, this can also be done manually, by tracing the evidence pattern in one color and the background pattern in another then comparing the tracing with the exemplar.

In the case of a print deposited in a liquid or suspension such as mud or blood, the liquid may collect in some of the spaces between the design elements. If the entire print were like this, it would appear to be a reverse print with little detail. However, when a print is partly produced by the design elements, and partly by runoff between those elements, the result can be confusing and not easily interpreted using conventional overlays. A tracing can allow the examiner to make an interpretation and to find detail that would otherwise have been lost.

A series of tracings can be made when there appears to be displacement of design elements due to movement of the imprinting object relative to the substrate. This allows the examiner to evaluate whether differences between a print and an exemplar are due to motion, or to a different object that produced the print. When it is not possible to distinguish between those options, both conclusions can be presented and their basis documented. At least one tracing should be made of the print as a whole.

Sometimes a print is made into a soft surface such as soft soil or snow. The shoe or other object may curve or bend while producing the print, producing local distortion. Similarly, the object that produced the print may have been curved or bent while producing it, for example, a shoe sole with upturned toe during a kick. The best practice is to produce exemplars under conditions that can mimic the distortion. In the few situations when this cannot be done, the area of distortion can be traced separately for comparison to an exemplar. This also applies to prints made by, or onto, flexible materials such as fabric. The fabric may not have been lying flat, yielding a print produced onto, or by, stretched, twisted or folded material.

An additional application involves stains rather than prints. When a liquid is seeping through a porous item onto whatever is beneath it, the pattern of stains can be used to compare the porous item with a suspected substrate. Because the top item may retain more of the fluid than the one beneath, the size and shape of the stains may not be the same even if two items were in direct contact. It is the areas of heaviest staining that may be more significant to compare. Tracings of the item with lighter deposits can be overlaid onto the suspected "parent" item to accomplish this.

A record of comparisons made with the assistance of a tracing should include photocopies of several overlays for each print: 1) the tracing overlaid onto the source print to record the fidelity of the tracing; 2) the tracing overlaid onto an exemplar, and in the case of a dissimilar print, onto a series of exemplars taken with different degrees of contact, pressure, motion, or impact (e.g., a kick vs. a step); and 3) if a series of tracings is used, the several tracings overlaid onto a tracing of the print as a whole; and 4) when more than one superposition can be made between the tracing and exemplar, a photocopy of each superposition.

Summary: Overlaying hand-drawn tracings of evidence prints onto exemplars can render the comparisons of difficult prints both more objective and more successful, and can also be used to evaluate stains soaked through from one garment to the next. This method is especially useful with prints having hard-to-decipher or confusing detail or background. Tracings complement, and can be used together with, scans or photographs of prints printed onto transparencies, as well as with the older method using calipers to triangulate points of comparison.

Forensic Science, Shoeprints, Ear Prints

B117 Ear Print Evidence: State of Washington vs. Kunze

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The attendee will be able to understand the need for caution in reaching conclusions from comparisons of ear prints with exemplars, and the need for studies incorporating range of variation.

This paper has several objectives: 1) to stimulate thinking about the actual data constituting an ear print, and evaluating sources of error in comparisons of the print with exemplars; 2) to demonstrate the effects of technique on comparisons; 3) to propose criteria for studies to evaluate whether ear prints have the potential for unique attribution; and 4) to present preliminary experimental data about the formation of partial ear prints.

Ear print evidence came to the attention of the criminal justice system in the U.S. in *State of Washington v. Kunze*, a homicide case where an ear print was the only physical evidence offered as a link between a defendant and the crime. Although ear prints have been in use in European courts, and had previously been proffered in the U.S., *State v. Kunze* was the first case in the U.S. where the evidence was challenged in a *Frye* hearing. It survived the challenge, and was presented in trial.

The ear print was found on the outside of the door to the murder victim's bedroom, where he was found bound and bludgeoned. It was dusted, photographed, then lifted by the latent print examiner. The lift was sent to the crime laboratory, where a forensic scientist examined ear prints from 70 individuals, including elimination prints from individuals who might have been at the house under normal circumstances. He concluded that "David Kunze is a likely source for the earprint and cheekprint which were lifted from the outside of the bedroom door at the homicide scene." The prosecution then contacted a police evidence technician from the Netherlands with experience in ear prints, who compared the ear print from the door with exemplars from the defendant, as well as with a database of photographs of 600 ears, He concluded that "the unknown earprint . . . has been placed by the left ear of the suspect David W. Kunze." In trial testimony, he said, "I think it's probable that it's the defendant's ear is the one that was found on the scene." It should be noted that both examiners worked with the ear print that had been dusted and lifted, and did not report examining either the door itself, or photographs of the print on the door. The defendant was convicted and the conviction appealed. The Washington Court of Appeals, in reversing the trial court, stated: "We conclude that the trial court erred by allowing [the two experts for the prosecution] to testify that Kunze was the likely or probable maker of the latent, and that a new trial is therefore required."

The authors were retained by the defense to review the physical evidence, and independent examinations of the ear print were conducted. The door itself was examined, and it was concluded that a portion of the pattern on the lift was not from the ear, but from loose black powder. The surface of the door was a textured paint, so the print was a discontinuous pattern of dots where the ear touched the tiny "peaks" of the paint; the loose powder added extra dots. *In situ* photographs of the dusted print corroborated this conclusion, as the feature in question did not appear in photographs.

Comparisons using overlays were difficult because the print on the door was faint, and was overwhelmed by the exemplars. The two simple techniques used to compensate for this: 1) photocopying the exemplars in red and yellow onto transparencies, with the evidence print photocopied in darker colors; and 2) tracing each dot that constituted the evidence ear print onto a transparency, then overlaying the tracing onto exemplars. This allowed the authors to notice a curved portion of the print on the door that was entirely within that of the exemplars, but with different degree of curvature. If the defendant's ear produced the print, it would have skipped slightly during the deposit (a not unlikely occurrence), as one part of the

print was slightly displaced from the other when compared with his exemplars. Despite the differences, the authors were not able to exclude the defendant as the source. The prints did not include all the parts of the ear, and there were no systematic studies to provide information about how a print could be expected to vary from other prints from the same person. It was known and documented that ear prints vary with pressure and when eyeglasses are worn, but there was no predictive information that would allow one to expect a specific type of variation from specific features.

In order to better evaluate the evidence print with respect to exemplars, whether to arrive at an exclusion or a strong association, additional information about ear print variation would be needed. Specifically, interest lay in the range of variation within the set of prints that can be produced from the same ear. The known and documented types of variation in ear prints (from pressure and wearing eyeglasses) are analogous to the variation of microscopic characteristics in hairs within a scalp. In the scalp hair of two individuals, there can be an overlap of characteristics even though most of the hairs between the two persons are distinguishable. Similarly, with ear prints, there may also be an overlap in the set of possible prints from the ears of one person, with the set of possible prints from the ears of another person. This subject was not found in the literature. Until the appropriate studies are done to find out, it is the opinion of the authors that strong conclusions about ear print comparisons are premature. The studies should include not only ears that are similar in outward appearance, but also those that may produce similar partial prints. Other factors that might influence variation include different angles of the head and ear to the surface, and the effect of earrings, hair ornaments, braids, hats, headscarves, etc.

In preparing for the second trial, additional exemplars were examined, including one from the murder victim's ex-wife, and two exemplars of their young son who lived with his father. The son was eliminated as a source of the print on the door during the initial examination by the crime laboratory. He could not be eliminated conclusively, but differences between the son's exemplars and the evidence print were observed. The ex-wife had also been eliminated during the crime laborabory examination, based upon gross features of the ear: her exemplar exhibited a prominent earlobe, but the print on the door did not. Complete prints of the ears from this individual and from the defendant exhibited grossly different shapes, but when each was compared with the ear print from the door, neither could be eliminated. The exemplar print from the victim's ex-wife could explain almost all the features found in the print on the door, whereas the prints from the defendant did not. However, there was no evidence in the print on the door of the prominent earlobe of the ex-wife.

A limited study was performed demonstrating that some individuals with prominent earlobes could produce prints that did not include the earlobe. The prints were obtained by asking subjects to listen for sounds on the other side of a door in whatever stance felt natural to them. When subjects wore even small earrings, the earlobe was less likely to appear in the print than when they did not, even when structures directly above the earlobe did appear. This study, while small and far from definitive, does indicate that any study of ear print comparison with ears should be conducted using direct comparison of every ear, and that elimination not be based upon gross differences in shape. It also indicates that the same caution be applied in comparisons of evidence prints in casework. Lastly, it demonstrates that variation among ears, as studied from photographs, can answer only some questions about variation in ear prints.

Ear print comparisons, while showing promise as supporting evidence linking individuals with crime scenes, should be approached with caution. Although ears themselves may well be unique, there is no evidence as yet that ear prints can be uniquely attributed to specific ears. Studies of sets of prints from individual ears are needed to establish a range of variation and to ascertain whether there is an overlap of characteristics that would preclude unique attribution. Partial ear prints merit special attention, as ears that are grossly different in shape may yield partial prints that are not readily distinguishable, and that may not even be recognized as partial prints. Lastly, criteria must be developed for determining whether a given evidence print includes sufficient information to permit adequate comparison.

Forensic Science, Ear Prints, Comparison

B118 History of Identification Criteria in Firearms and Tool Marks Examinations

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The goals of this presentation are to present to the forensic community a discussion of the historical development of identification criteria for the firearms and tool mark identification discipline, including qualitative and quantitative criteria.

Along with all other disciplines within the forensic science community, the firearms and tool mark identification discipline is coming under much closer scrutiny within the courtroom. The primary concern appears to be the ability to articulate one's criteria for identification. The purpose of this presentation is to provide the audience with a thorough discussion of the historical development of identification criteria for the firearms and tool mark identification discipline, thus providing a foundation for those seeking to better articulate their own criteria for identification. In addition, this presentation seeks to examine the current state-of-the-art in context of recent court decisions and to provide better education with regard to the oft-misunderstood concept of consecutive matching striations (CMS).

The foundational question within all identification disciplines seeks to discover the basis for any identification that was effected. A recent court decision, *Ramirez v. Florida* (December 2001), has made it apparent to the end-users of forensic services that there are no standard criteria for identification. Further, what criteria that does exist is subjective and differs from examiner to examiner. This presentation will work from this foundational question to demonstrate that there is a basis for standardized criteria for identification, and that it is not as subjective as it may appear to the end-user.

One of the relevant historical debates that will be addressed in this presentation is the question of whether firearms and tool mark identification is an art or a science and whether it is objective or subjective. It will be demonstrated that rather then being mutually exclusive of one another, each word has a place and a role within the discipline and that there is nothing about the four terms that should cause one to look askance at the discipline, provided that their place and role is properly articulated.

There is a current, accepted standard criterion for identification offered by the Association of Firearm and Toolmark Examiners (AFTE), published in 1992. A committee that was formed in 1985 by the Association formulated this criterion for identification. It is based on a plethora of studies performed in the discipline, fifty-two that are summarized in the presentation. Published in the forensic science literature since 1942, these articles deal in some part with the ability of the examiner to identify the tool responsible for producing a particular tool mark. These articles deal with a variety of tools including bullets and barrels (qualitative and quantitative studies), cartridge case markings, screwdrivers, bolt cutters, knives, pliers, and others. In addition, several articles deal with mathematical and computer models along with statistical concerns.

Within this selection of articles, several deal with the concept of consecutive matching striations (CMS) as a basis for developing identification criteria for striated tool marks. This approach simply describes the pattern that is being observed and this quantitative description is then compared against a threshold that has been established through repeated testing under different circumstances and test variables. It is important to understand that CMS is not an alternative to what has been referred to as the traditional pattern matching approach, but simply permits a more standardized means of communicating and articulating the basis for an identification, inconclusive or exclusion.

First proposed in 1997 by Biasotti and Murdock (*Modern Scientific Evidence: The Law and Science of Expert Testimony, Volume 2*, Chapter 23, pages 131-151, 1997), the minimum criterion for identification was based on cumulative data gathered during CMS exercises with students and other casework and studies published between 1957 and 1997. This criterion states that for three dimensional tool marks, when at least two different groups of at least three consecutive matching striae appear in the same relative position, or one group of six consecutive matching striae are in agreement in an evidence tool mark compared to a test tool mark, then an identification as to a single source may be declared. For two dimensional tool marks, when at least two groups of at least five consecutive striae appear in the same relative position, or one group of eight consecutive matching striae are in agreement in an evidence tool mark compared to a test tool mark, then an identification as to a single source may be declared. They do indicate that in order to apply such criteria, the possibility of subclass characteristics must be ruled out.

Extensive testing has supported the use of the conservative criterion for identification, in that use of this criterion would not permit even a single false identification in any of the work published to date, which includes 2,908 known non-matching 3-dimensional impression comparisons and 800 known non-matching 2-dimensional impression comparisons. Testing performed by the author on bullets known to have been fired from consecutively manufactured barrels and tool marks made by consecutively manufactured knives has also support the use of this criterion.

CMS is not a substitute for or in conflict with the traditional pattern matching approach. Pattern matching has a quantifiable aspect whether it is conscious or subconscious. CMS is simply a conscious tabulation of that quantifiable aspect. The traditional pattern matching approach defines an identification in language that is relative and non-specific, thus susceptible to communication and articulation difficulties. Using CMS, the examiner can easily articulate the basis for an identification in language that is consistent and easily understood by colleagues and the end-user.

In summary, there is a wealth of published literature dealing with identification criteria in the firearms and tool mark discipline. The literature that examines the quantitative aspect of pattern matching, i.e., consecutive matching striations, strongly supports the use of the conservative criterion for identification as proposed by Biasotti and Murdock. Understanding the available information should allow the firearms and tool mark examiner a solid foundation upon which he or she can develop a well-articulated criterion of identification.

Firearms and Tool Mark Identification, Criteria for Identification, Consecutive Matching Striations (CMS)

B119 The Soap Box Bullet Recovery System — Or the Soap Solution

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The goal of this presentationt is to call to attention a novel bullet recovery system enabling microscopical comparisons to be performed.

To test the proposition that a questioned or evidence bullet was fired from a particular gun barrel, test bullets fired from that barrel are necessary. Such test or exemplar bullets need to be decelerated gradually in order to be most useful for forensic microscopical comparison with evidence bullets. Achieving the required degree of uniform deceleration is not a trivial matter. Historically, a range of types of bullet recovery devices has been used. One of the earliest of these to be used widely in forensic science laboratories was the cotton waste box. The basic design consisted of an elongated rectangular box with a hole or port at one end through which the test shot was fired. The box was filled with cotton mill waste as the decelerating medium. Alternatively, cotton batting could be used. The mill waste, consisting of tangled lengths of threads or yarns, had the advantage that the spinning bullet would often cause the short lengths of yarn to become wound around it forming a cocoon-like structure and rapidly increasing its size and cross-sectional area. This caused the bullet to slow down and come to rest in a shorter distance than it would have otherwise. An additional advantage was that the "cocoon" forming early and encasing the bullet protected the bearing surface containing the micro-striae from further abrasion damage. Despite this potential for protection, important microscopic details could be polished off the bearing surface. This was especially true in the case of non-jacketed lead bullets.

Beginning about four decades ago, the cotton waste boxes began to be replaced by purpose-built vertical water tanks. These could occupy the better portion of two office-size rooms, one above the other, on two floors in a building. It was easier to incorporate these vertical water tanks into a newly designed structure while it was being built rather than to retrofit an existing building. These tanks normally had a basket-like device at the bottom for collecting the test bullet. After each shot it was necessary to raise the basket to allow the bullet to be recovered. The devices for accomplishing this were often quite elaborate. The next generation of bullet recovery devices consisted of various horizontal water tank designs, which are widely used today. They can be accommodated on a single floor of a building, if the floor loading is adequate for supporting the weight of the few thousand kilograms of water contained in the tank. In use the bullet is fired into the tank at a slightly downward angle. The bullet is more easily recovered than was the case with the vertical water tank. Because the horizontal tank is relatively shallow, a device as simple as a wand or rod with a piece of tacky modeling clay or plasticine on the end can be used to effect recovery of the bullet. The wand-like device is manually inserted into the water until the plasticine contacts and adheres to the bullet, at which point it can be withdrawn. To keep the water clear and free of microbial growth the designs incorporate a circulation and filtration system, and a disinfectant such as hypochlorite may be added to the water. Due to their size and complexity these tanks can represent a significant investment. Such an expense can be difficult to justify for a small laboratory. An additional drawback of water tanks is that high-speed interaction of hollow-point bullets with the water causes them to open as they are designed to do when striking a body. Much of the bearing surface can be obscured by jacket and core material that has folded back. This can make the use of such bullets as exemplars difficult.

Recently, two additional approaches have been used. One consists of a metal cabinet where heavy gauge polyurethane curtain-like sheets are hung vertically normal to the line of fire. Depending on its energy a bullet will perforate a succession of sheets losing its energy incrementally until it lacks sufficient energy to even penetrate the next sheet. Typically, it will deform this sheet elastically, rebound, and fall into a collection tray. The tough elastic polyurethane sheets are several millimeters thick and resistant to deformation. After the passage of the bullet, the hole can be observed to have closed much like what is seen with a bullet hole in a vehicle tire tread. Clearly, each passage through a sheet wipes the bullet quite vigorously. For lead bullets significant material is removed from the surface, as visible bullet wipe surrounds the hole on the entry side, again similar to what is seen with tire treads. Despite this removal of material by this trapping technique, success in matching bullets has been achieved with those stopped in this fashion. However this is not an ideal technique for producing exemplar bullets.

The second newer technique utilizes a chamber filled with specially designed small elastomer balls. Each of these elastomer balls displaced along the bullet trajectory by contact with the bullet absorbs some of its energy. The mass of each ball is chosen to be similar to the mass of typical bullets for efficient momentum transfer. This results in lower impacts for each interaction and less damage to the balls. The bullet is stopped efficiently after multiple low impact interactions. Some of the elastomer balls do suffer damage after a number of shots and do need to be replaced. The cost is about $250.00 for the elastomer ball replacement kit. The typical chamber has a capacity of ~2 gallons.

Although developed independently, conceptually the method described in the present paper is very similar to the elastomer ball method. Here small hotel-size soap bars are used in place of the elastomer balls. The soap bars have several advantages. Soap in bulk form has been used for many years as a medium in ballistics research. Some researchers have used it in lieu of ballistic gelatin. Hotel supply houses sell large quantities of small bars at economical prices. For example, the authors purchased 2,00 one-half ounce bars for 85 dollars, including shipping. The friction between the soap and bullets is very low. As smaller fragments of soap form with extended use of the recovery trap, they can be collected, put into water, and reformed into small bars. Thus soap, in addition to being a low cost medium to begin with, can be recycled. The authors have designed and built a Lexan® bullet recovery box to be used with the soap bar medium. The soap is supported by a coarse grid, which allows the bullet to fall through, when the soap bar assemblage is agitated following a shot. Small fragments of damaged soap can fall through the grid as well. By opening a shallow drawer these and the test bullet can be recovered.

Criminalistics, Firearms, Bullet Recovery

B120 The Significance of Elemental Analysis of Lead Projectiles

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Attendees of this presentation will learn the significance of the results of comparison of the elemental composition of projectile leads, the discrimination capabilities of ICP-AES for comparison of lead compositions, the strengths and limitations of comparative bullet lead examination, and suggestions for wording the results of examinations.

The concentrations of several select elements have been used as points of comparison of the lead component of projectiles for over 30 years. When bullet lead specimens are found to have indistinguishable compositions, it lends strong support to the idea that they were produced from the same melt of lead at a manufacturing site. However, the mixing of lead sources that occurs in the manufacture and packaging of assembled cartridges make assessing the significance of a finding of bullets with indistinguishable compositions difficult. Multiple distinguishable compositions of bullets often occur in a single box of cartridges, and bullets with indistinguishable compositions are found in many boxes produced in the same or closely related production runs. Statistical approaches to assess significance based on variations in manufactured products over time have proven unsuccessful because of the complexity of the processes leading to the ultimate distribution of lead compositions.

The results of a study that was conducted using the FBI Laboratory's collective lead composition data to assess the frequency of occurrence of given compositional patterns will be presented. From a data collection of the results of analysis of 26,000 projectile leads submitted as evidence, a subset of 1,837 specimens having no known manufacturing relationship was randomly selected. This statistically robust data set was used to assess the frequency of randomly occurring associations between projectile leads from the general evidentiary population. Of more than 1.6 million pairwise comparisons among these leads, only 669 pairs were found to have indistinguishable compositions. These results will be evaluated based on the number of elements present at measurable levels and suggestions will be made concerning appropriate wording of significance statements for several typical evidence scenarios.

Bullet Lead, Elemental Analysis, Statistics

B121 An Examination of Aromatic Content in Various Medium Range Ignitable Liquids

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Upon completion of this presentation, the attendee will be able to recognize the variations existing among medium-range ignitable liquids, understand the potential effects of sample preparation on these types of products, and illustrate the necessity of examining the aromatic content when classifying these types of ignitable liquids.

In this study the compositions of a variety of medium-range (C_8–C_{13}) ignitable liquids were examined with regard to their relative proportions of aromatic and aliphatic content, as represented through the use of extracted ion profiles (EIPs) and the affect that aromatic content has on their classification. Classification of a product as an isoparaffinic product, naphthenic/paraffinic product or as a normal alkane product requires that, in addition to other specific criteria, there be virtually no aromatic compounds present. Conversely, classification of a liquid as an aromatic product requires that there be virtually no aliphatic components; the liquid is entirely comprised of aromatic compounds. These types of products are also distinctive in pattern, leading to a relatively unambiguous classification. The presence and relative amount of aromatic components becomes critical in differentiating the classes of distillates and dearomatized distillates. The criteria for identification of a distillate, as stated in ASTM 1618 includes "AROMATICS: Always present in medium and heavy distillates; less abundant than alkane;" whereas, the criteria for identification as a dearomatized distillate states "AROMATICS: Not present in significant amounts." Adding to the significance of the amount of aromatics in medium range products is the existence of commercially manufactured blends of aromatic products with medium range distillate-type products. It was hypothesized that there would be three distinct ranges of aromatic contribution and therefore, three distinct ways of classifying these types of products. These categories could be described as: medium petroleum distillates, dearomatized medium petroleum distillates, and medium-range petroleum products with an added aromatic component.

Numerous medium range ignitable liquids were analyzed via gas chromatography-mass spectrometry. A semi-quantitative examination of the data from these liquids was conducted, utilizing extracted ion profiling (EIP), focusing on the relative proportion of aromatic compounds to aliphatic compounds. In addition, the effect of adsorption-based sample preparation methods on the aromatic:aliphatic ratio was also examined. The results of the data analysis show that the tested medium range products exhibit a broad range of compositions with respect to the proportion of aromatic compounds relative to the major aliphatic compounds present. The relative proportion of aromatic compounds was shown to be a very significant factor in classifying these types of liquids. It was concluded that there is not a clear demarcation or natural break separating these three classes of products. Rather, the aromatic concentration amongst various products represents a continuum, not three distinct ranges. An approach for classifying these products is suggested based upon a semi-quantitative examination of aromatic content with respect to aliphatic content.

This study demonstrates the importance of examining the relative proportion of aromatic compounds to aliphatic compounds in the classification of medium range ignitable liquids. It also suggests guidelines for differentiating medium range distillate products from dearomatized products, and from blended products. Future work will focus on the effects of adsorption based extraction methods had on the recovery of aromatics with respect to aliphatics, and how competitive adsorption may alter the expected results.

Fire Debris Analysis, Petroleum Products, Aromatic Content

B122 Carbon Disulfide vs. Dichloromethane for Use of Desorbing Ignitable Liquid Residues From Activated Charcoal Strips

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After attending this presentation, the participant will understand the advantages and disadvantages of using dichloromethane instead of carbon disulfide for desorption of activated charcoal strips in fire debris analysis.

Passive diffusion headspace extraction is a widely used method for extracting ignitable liquid residues from fire debris utilizing activated charcoal strips. This procedure requires a solvent to remove the ignitable liquid residues from the activated charcoal in order to conduct the necessary instrumental analysis. A suitable solvent is one in which the organic compounds commonly identified in ignitable liquids would be readily soluble. The solvent would also have sufficient ability to bind to the adsorption sites of the charcoal, thereby desorbing the ignitable liquid residues from the charcoal.

In forensic fire debris analysis, carbon disulfide is generally used for desorbing the activated charcoal strips due to the strong adsorption of the solvent to the charcoal. However, the health and safety risks associated with carbon disulfide make it undesirable for daily use. The effect of carbon disulfide on the reproductive systems of both males and females is a significant concern. The explosive nature of carbon disulfide and consequently the long-term storage of the solvent are also considerable issues. Therefore, other solvents should be explored to determine if one exists which would provide the same level of desorption without the safety hazards.

A carbon disulfide substitute would be a comparable non-polar solvent with solubility characteristics similar to that of carbon disulfide. The substitute would also effectively bind to the charcoal desorbing ignitable liquid residues from the strips. A significant aspect of forensic fire debris analysis is pattern recognition and comparison of all components in the product and also the various classes of compounds which make up the ignitable liquid. These classes include: alkanes, aromatics, isoparaffins, cycloparaffins, and naphthalenes. The substitute solvent would perform without selective preference for specific functional groups or molecular weight. The substitute would also be relatively safe to handle and be exposed to on a daily basis. Finally, the substitute would be priced so as to be financially feasible to purchase in large quantities.

Dichloromethane is a non-polar solvent widely used for desorbing organic compounds from charcoal strips or tubes in a variety of fields, including environmental analysis laboratories identifying petroleum products. A number of Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) methods have been identified which utilize dichloromethane as opposed to carbon disulfide. However, there appears to have been little or no work presented or published regarding the use of dichloromethane in the field of forensic fire debris analysis. Dichloromethane is comparably priced. Finally, dichloromethane does not carry the same level of health risk given the exposure limits of the solvent, however it is a suspected carcinogen. Dichloromethane is also an easier solvent to store, since it does not present an explosion hazard. Although safe laboratory practice minimizes exposure to solvents during the extraction procedure, clearly the safest appropriate solvent is preferred.

Dichloromethane should be considered as a possible substitute for carbon disulfide in passive diffusion headspace analysis of fire debris samples. Valuable information can be obtained from a comparison of the total ion chromatograms and extracted ion chromatograms of ignitable liquid samples eluted with dichloromethane and carbon disulfide. Calculating percent recovery of the various classes of chemical compounds would assist in an understanding of preferential desorption, if any exists, of both solvents. By examining both sets of data and taking into consideration the health and safety risks involved with both solvents, a laboratory would be able to make a decision as to the applicability of dichloromethane to forensic fire debris analysis.

Approximately ten commercially available products and two laboratory created standards were extracted using activated charcoal strips and normal passive diffusion headspace extraction procedures. Some of the strips were eluted with carbon disulfide and a portion eluted with dichloromethane. The results were then compared. With some limitations, dichloromethane appears to give comparable results to those of carbon disulfide.

Fire Debris Analysis, Adsorption, Dichloromethane

B123 An Initial Report of the Arson Stable Isotope Analysis Project

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The goal of this presentation is to inform the forensic community about the potential usefulness of naturally-existing stable isotopic tracers that occur in arson-related accelerants recovered from crime scenes and on putative arsonists' clothing or in accelerant containers, allowing an evidentiary connection between potential arsonists and crime scenes.

Compound-specific isotope analysis (CSIA) was developed to trace the provenance of individual hydrocarbons in natural petroleum samples. Arson-related accelerants are largely composed of mid-range hydrocarbons, including alkylbenzenes, napthalenes, *n*-alkanes, *etc*. It is suggested that CSIA can be performed on accelerant samples from suspected arson-crime scene sites and from the personal belongings of putative arsonists and/or accelerant containers permitting a causal connection to be made between the suspect and the crime scene.

Stable isotope analyses has been performed under three conditions of evaporation-combustion: (i) Control accelerant: 0% evaporation 87 octane, (ii) Moderately-(50%)-evaporated gasoline in fire debris: petroleum-ether washing (ASTM E 1386) of 20 ml of 50%-residual gasoline extracted from burned carpet and padding, and (iii) Severely-(90%)-evaporated accelerant in fire debris: dynamic headspace separation (ASTM E 1413) and concentration of 10 □l-residual gasoline extracted from burned carpet and padding. Initial results for the 50%-evaporation experiment show relative small (~0.5-1.3‰) and generally consistent ^{13}C-enrichment in the residual gasoline compounds, while the 90%-evaporation results generally span from ~0.3‰ depletion to ~1.3‰ enrichment. A recent report on the stable isotopic composition of petroleum hydrocarbons and included references (Pond *et al*., 2002,

Envir. Sci. Technol. 36:724-728) emphasizes the resistance to isotopic fractionation (*i.e*., 'tracer stability') of carbon isotopes relative to hydrogen isotopes under natural conditions. Well-controlled evaporation-fractionation experiments on individual organic compounds encourage further research into the behavior of complex accelerant mixtures under varying degrees of evaporation and burn conditions.

Stable Isotopes, Arson, Profiling

B124 An Update on Activities at the National Center for Forensic Science

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The goal of this presentation is to inform the community of the programs and products of NCFS (National Center for Forensic Science) in the areas of research, education, training, and technology transfer in the area of physical evidence, biological evidence, and digital evidence.

The NCFS is a program of the National Institute of Justice hosted by the University of Central Florida. Technical areas are physical evidence, biological evidence, and digital evidence. NCFS has a strong research program in DNA, RNA, and Y-chromosomes as well as an online master's degree in forensic biology directed by Dr. Jack Ballantyne. Research, training, and technology transfer in physical evidence includes an online database of ignitable liquids managed by the Technical Working Group for Fire and Explosives (TWGFEX), Ignitable Liquid Reference Collection Committee.

Dr. Jehuda Yinon directs NCFS' research in explosives residue analysis. The Identification of Ignitable Liquids is a class that NCFS delivers around the country. In the fall of 2001, the first participants in the newly developed Graduate Certificate in Computer Forensics at UCF were welcomed. An online version of this certificate is being developed as well. The same computer forensic processes training will be offered to state and local law enforcement. Additionally, digital evidence research is being conducted. NCFS has formed an Institute for Forensic Digital Evidence (IFDE).

Technology and the needs of the community will drive the goals of the IFDE. The motto of NCFS is "Bridging the Gap from the Crime Scene to the Courtroom." Where there are needs in forensic digital evidence, the IFDE will be there to help "bridge the gap" for the community.

National Center for Forensic Science, Research, Training

B125 The Demarcation Problem and the Cheapening of Forensic Science: How Philosophical, Practical, and Legal Definitions of Science Shape Our Discipline

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The goal of this presentation is to provide information about the demarcation problem in the philosophy of science (distinguishing science from pseudoscience) and how it relates to forensic science. Forensic science offers a new wrinkle to the demarcation problem in the requirement of science to be defined in legal, not scientific, settings. Legal rulings, such as *Kumho*, threaten to reduce forensic science to a technical specialty and this must be avoided for the benefit of the discipline.

In the philosophy of science, the demarcation problem is the decision between what constitutes science, i.e., astronomy, and distinguishes it from pseudoscience, astrology. This has a direct bearing on forensic science, inasmuch as certain disciplines are still considered scientifically "borderline" by some and it is important to sort out the science from the junk. Forensic science adds a novel wrinkle to the demarcation problem because, not only must it adhere to the definitions of science as understood by philosophers and practicing scientists (à la Kuhn), its science is applied in the legal arena where the home field provides a distinct advantage. Under *Daubert*, Courts act as gatekeepers, allowing "good" science to pass while barring the door to "bad" pseudoscience. This legal interpretation of what constitutes acceptable science, as seen in such rulings as *Frye, Daubert, Kumho*, and others, may or may not have any grounding in what scientists consider "good science" to be.

The four conditions of *Daubert* are well known: general acceptability by the relevant scientific community, knowledge of the actual or potential rate of error for the practice, subjection of the practice to peer review, and actual or potential testability of the method's results. This final condition is an overt homage to Karl Popper's falsification model, which is referenced heavily in the *Daubert* court's decision. The *Daubert* decision is only one case law interpretation of Federal Rule 702 and not all philosophers of science agree that the Popperian approach is what defines science most accurately and, in fact, few adhere to this model today.

Popper's model precludes any science that is not overtly oriented toward controlled laboratory experimentation, such as geology, astronomy, archaeology, and, to some extent, forensic science. This is because forensic science is partly a historical science, albeit dealing with very short time frames.(1) As has been noted(2) reference to known rates of error and testability presumes a model of science focused on controlled laboratory experimentation. Forensic scientists rarely have the luxury of controlled experimentation: Crimes cannot practically or ethically be reproduced under strictly proscribed conditions. Certain isolated events, such as discharging a firearm, identifying a controlled substance, or spattering blood, can be approximately repeated to allow for experimentation and these results are part of daily casework or publications in peer-reviewed journals. These results are not used, however, solely to further the growth of science but to reconstruct past events to determine causes, sources, and effects in crimes. This information, and other, is presented in court to assist the trier of fact. Of the possible competing hypotheses offered by the involved parties, one will be selected as more plausible by judge or jury, based in part on scientific conclusions and interpretations, leading to a legal decision.

This duality of identity, empirical and historical, has probably led to the perception that forensic science is a lesser science or even "merely" a technique with no guiding philosophy. Historical disciplines have been derided as unscientific.(3) Legal rulings such as *Kumho* encourage this perception by reducing scientific disciplines with potentially sufficient supporting research to technical specialties that are unscientific and simply applications of "real" scientific principles.(4) Forensic science as a discipline is cheapened by the promulgation and reinforcement of this perception; resources of all kinds, from grants to budgets to public confidence, are reduced by the devaluing of the science in forensic science.

But if *Daubert* isn't a proper definition of science and *Kumho* cheapens forensic science, what is to be done? The legal community and forensic science laboratories should seek more education on the nature of science and the underlying philosophy of forensic science. Forensic scientists should eschew the implications of current legal rulings and pursue research that will integrate the forensic science literature into a cohesive scientific foundation that will exceed the *Kumho* and even the *Daubert* framework. The information exists, the requirements are known, and the only obstacle that remains is our perception of forensic science as a lesser discipline.

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Demarcation Problem, Philosophy of Science, Admissibility

B126 Student Outcomes as Standards for Accreditation of Undergraduate Forensic Science Programs

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After attending this presentation the participant will understand: 1) the history of outcome-based specialized accreditation; and 2) the student outcomes identified as standards for accreditation of undergraduate forensic science programs in USA.

Undergraduate forensic science programs in institutions of higher education are experiencing unprecedented growth in numbers of programs offered and, as a result, student enrollment numbers are increasing. Currently, however, undergraduate forensic science programs are not subject to professional specialized accreditation. This study seeks to identify desirable student outcome measures for undergraduate forensic science programs that should be incorporated into such an accreditation process.

To determine desirable student outcomes, three types of data were collected and analyzed. Existing undergraduate forensic science programs were examined with regard to degree requirements, curriculum content, and student outcomes. Accreditation procedures and guidelines for other science-based disciplines were examined to provide guidance on outcome-based accreditation processes for undergraduate forensic science education programs in the USA. Expert opinion was solicited from forensic science educators, crime laboratory directors, recent program graduates, and other forensic scientists via a structured Internet-based survey. Based on the analyses of these data, preliminary student outcomes suitable for use in the accreditation of undergraduate forensic science programs were determined.

The results of this study can be used to identify student outcomes and to suggest accreditation guidelines for undergraduate forensic science programs based on those outcomes.

NOTE: The final analyses are currently being done as of July 2002, for anticipated completion in August/September 2002.

Outcomes, Accreditation, Undergraduate Programs

B127 2002 Census of Publicly Funded Forensic Crime Laboratories

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The goal of this presentation is to inform the forensic science community of the status of the 2002 Census of Publicly Funded Forensic Laboratories that is being administered throughout the United States.

This paper will describe the work to date in support of the 2002 Census of Publicly Funded Forensic Laboratories in the U.S. In December 2001 the Bureau of Justice Statistics (BJS) issued a notice in the Federal Register soliciting proposals to conduct a census of publicly funded crime laboratories. BJS announced it would be funding a survey to obtain "baseline information about the workload and operations of the approximately 400 forensic crime laboratories in the United States." The solicitation went on to state that it wished to identify "specific activities and resources" within laboratories that support their forensic analyses, including "personnel, budget, workload," and agencies for which scientific work is performed and results reported. In addition to supplying baseline statistical information on operations and workload of laboratories, BJS foresaw the survey assisting various governmental entities in assessing where added resources are needed and any technology disparities across jurisdictions. The University of Illinois at Chicago (UIC), in concert with the University's Survey Research Laboratory and the American Society of Crime Laboratory Directors, offered a proposal to engage in such research and was awarded a one-year grant in May 2002 to perform the census.

Forensic science laboratories are a mainstay in today's criminal justice system. In the past thirty-five years crime laboratories have evolved from an uncoordinated collection of fewer than 100 federal, state, and local laboratories scattered in various jurisdictions around the country, to today's array of more than 400 sophisticated scientific operations serving the nation's police and courts. Reliance on scientific evidence has grown dramatically, stimulated by rapid growth in laboratory technology applied to the examination of controlled substances, trace and pattern evidence, and biological fluids. It is in this latter area that revolutionary strides have taken place in DNA typing that have advanced the identification of human remains, promoted the solution of violent crimes, and contributed to the conviction of the guilty and exoneration of the innocent. DNA, fingerprint, and firearms computerized data bases today assist police investigators in developing suspects and in clearing otherwise unsolvable cases.

There have been several surveys of crime laboratories over the past 35 years, beginning with the John Jay survey in 1967 and culminating with the most recent BJS surveys of DNA Crime Laboratories for the years 1998 and 2001. The American Society of Crime Laboratory Directors (ASCLD) has also been a major player in plotting crime laboratory resources, with their most recent survey in 1998 that included descriptive/operational characteristics of laboratories and workload data, covering cases received, completed, backlogged, productivity of examiners, and court appearances. The workload section includes extensive discipline-specific reporting. The ASCLD surveys, however, are limited to its member laboratories.

The UIC research team has drafted a survey instrument and has had it reviewed by ASCLD advisors and cleared by the Office of Management and Budget. The major sections of the survey include organizational information, budget, staffing, workload, laboratory processes and procedures, equipment/supplies, private casework outsourcing, and quality control procedures. Names, addresses, and contact persons in laboratories have been verified and the survey pre-tested in four sites. Surveys are being mailed to all identified publicly funded crime laboratories in the U.S. with plans for extensive follow up (automated tracking system, telephone calls, emails, etc.) in order to achieve a 100% survey item response rate. UIC will provide BJS with a documented, formatted and archivable data set. Project team members will be available to discuss the current status of the survey and to answer any questions.

Census of Publicly Funded Forensic Crime Laboratories, UIC, ASCLD

B128 What Can Forensic Science Learn From the Tragedy in Walkerton, Ontario, Canada?

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The goals of this presentation are to recognize the critical importance of appropriate training and education for forensic scientists, recognize the value of laboratory accreditation and quality assurance programs, recognize the dangers of "grandfathering in" of individuals in certification programs, and to understand the difference between method certification, individual certification, and accreditation.

In May 2000, in Walkerton, Ontario, Canada, 7 people died and more than 2,300 others became ill after drinking water from the town supply that was heavily contaminated with Escherichia coli O157:H7. The community was devastated and the losses to local businesses were enormous.

This public health catastrophe raised serious questions about the safety of drinking water across the Province of Ontario. As a result, the Government of Ontario called a Commission of Inquiry to determine what had caused the deadly contamination and to ascertain responsibility for this event, with a view to ensuring that such a tragedy never happens again.

The Inquiry was divided into two parts. Part 1 examined the circumstances that caused the outbreak. Part 2 focused on ensuring the safety of drinking water in Ontario. This presentation is based on the Report from Part 1 and on testimony provided during the Inquiry.

The Inquiry determined that there were a number of factors that led to the events of May 2000. This paper focuses on issues pertaining to training, certification, laboratory accreditation, and quality assurance. The primary goal is to answer the question: What can forensic science learn from the events in Walkerton?

Inadequate training issues were at the heart of the Walkerton tragedy. From the water system operators (who had twice been "grandfathered" as certified waterworks operators), to the Public Utilities commissioners (to whom the water system operators reported), to the Ontario Ministry of the Environment (which has regulatory oversight of municipal water systems in Ontario), and to the scientists of the private sector laboratory responsible for the actual testing of Walkerton's drinking water, there were repeated training failures.

E. coli O157:H7 and Campylobacter jejuni entered the Walkerton water system through a shallow source well during a period of heavy rainfall. The source well was very vulnerable to surface runoff and the primary source of the bacterial contamination was identified as manure from a farm near the well. The waterworks operators lacked the training and expertise to identify the vulnerability of the well to surface contamination. Consequently, they lacked an understanding of the necessity for continuous chlorine residual and turbidity monitoring. Monitoring chlorine residuals allows for assessment of the capacity for disinfection in treated water as it moves through the distribution system and provides a way to determine whether contamination is overwhelming the disinfectant capacity of the chlorine that has been added to the water. The Inquiry Report stated that the General Manager of the Public Utilities Commission (PUC) was skilled in the mechanical operation of the water system but lacked knowledge and appreciation of the health risks associated with failure to properly operate the system.

The waterworks operators, the PUC commissioners, the Ministry of Environment inspectors and the scientists testing the drinking water all suffered from a lack of knowledge regarding the dangers of fecal coliform contamination of drinking water in general and the deadliness of E. coli O157:H7 contamination in particular. This lack of knowledge left 7 dead and 2,300 seriously ill.

The Walkerton PUC commissioners were responsible for establishing and controlling the policies under which the PUC operated. The commissioners were concerned primarily with the financial side of PUC operations and had very little knowledge about water safety or the operation of the water system. This lack of knowledge is demonstrated by their failure to understand the significance of a 1998 report from the Ministry of the Environment that indicated serious problems with the operation of the Walkerton water system, including the repeated presence of E. coli in treated drinking water samples. As a result, the commissioners did nothing.

Evidence given at the Inquiry showed that Ministry of the Environment personnel in the office responsible for Walkerton were unaware of matters essential to carrying out their responsibilities in overseeing municipal waterworks. The District Supervisor and three inspectors who testified were all unaware of the potential lethality of E. coli. In addition, some of the Ministry of the Environment staff were unaware of or unclear about some provisions of the Ontario Drinking Water Objectives (the government guidelines they were responsible for enforcing).

During the 1990s there was a substantial reduction in the Ministry's staff and budget. This resulted in a severely reduced training budget and focused toward administrative and management training and away from technical training. Staff shortages created a climate of frequent job rotations with little or no supporting technical training.

In 1996 water testing of drinking water, a function previously carried out by government laboratories, was privatized. There was no regulation of the private laboratories: no criteria governing the quality of testing, no requirements for qualifications or experience of laboratory personnel, no requirement to have scientists on staff, and no provisions for licensing, inspection, or auditing of such laboratories.

Although the laboratory testing Walkerton's water in May 2000 was performing microbiological analyses, none of the scientific staff had academic backgrounds in or experience with microbiological assays. The lab's experience was in chemical analyses. Unfortunately, for the people of Walkerton, none of the laboratory staff knew the significance of the results obtained from the microbiological analyses. While the laboratory was certified and accredited to perform standard chemical analyses for drinking water, they were neither certified nor accredited to perform microbiological analyses.

What are the lessons for forensic science from the Walkerton tragedy? This case clearly demonstrates the critical importance of education and training programs, laboratory accreditation and quality assurance programs, and the dangers of "grandfathering" in individual certification programs. The work we do as forensic scientists affects the lives and/or freedom of many people. It is crucial that our profession takes all of the necessary steps to ensure the quality of the science and the scientists and recognizes the very direct connection to the lives of the people we serve.

Training, Accreditation, Quality Assurance

B129 Reducing the Prevalence of Pseudoscientific Interpretations in Complex Physical Evidence Casework

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The goal of this presentation is to increase awareness concerning the essential role that reconstructions based on physical evidence play in a complete forensic science service.

Information of critical relevance in both civil and criminal investigations is often encoded in the physical evidence record that results from activities taking place at the crime or event scene. Human initiated events, through the medium of chemical and physical laws, alter the environment or the scene of the event. It is these interactions of energy and matter, resulting from the human activities taking place during events of concern to an investigation that produce the physical evidence record. This encoded record is never perfect, but it can often provide a wealth of information. However, it is essential that the physical evidence is recognized, analyzed, and properly interpreted for this potential to be realized. These activities, recognition, analysis, and interpretation, require extensive expertise based on experience built around a solid scientific core. Unfortunately, the need for reconstruction is given insufficient attention by many forensic science laboratory systems. This leaves an empty niche which may create two kinds of problems. There may be no integration of the scientific data to yield a reconstruction that develops the information encoded in the physical evidence to give it meaning; or worse, a well-intentioned non-scientist expert, who underestimates the complexity of reconstructions, may fill the niche. The latter phenomenon has been occurring with increasing frequency. This can lead to misinterpretations and miscarriages of justice. Reconstruction should be viewed as the culmination of the scientific work in a complex case. Interpretation should not be left to chance or to a non-scientist expert.

Laboratory accreditation, scientist certification, and the development of standard methods have all been among the major advances taking place in forensic science in recent years. However, these advances have not come without a cost. One unintended negative consequence of laboratory accreditation and the increasing reliance of standard methods has been the neglect of the need for integration of laboratory results leading to scientific event reconstruction. The quality assurance effort has been focused predominantly on individual test results. The focus needs to be broadened to include the product of the overall forensic science service.

Attention to reconstructions by scientists is not a panacea. It does not guarantee freedom from pseudoscientific interpretations and inaccurate expert testimony. An opinion held by a scientist is not necessarily a scientific opinion. Scientists are human beings and develop opinions on many issues in everyday life. Most of these are formed without the luxury and rigor of a scientific analysis. Some opinions of this type may form during a review of the physical evidence and may relate to important issues in a case. They have no place in expert testimony. It is the obligation of the scientific expert witness to recognize those opinions that are not supported scientifically and differentiate them from those that are so supported. Such a differentiation of opinions might appear to be relatively straightforward, and it is clear that scientific expert testimony should only be offered on the latter. However, in practice the two are often conflated. This must be guarded against vigorously. Forensic science service systems need to address this in considering the issue of overall quality assurance.

The physical evidence record has limitations. Sometimes no reconstruction will be possible. At other times, a valid and detailed reconstruction will not yield information that addresses critical issues in the case at hand. These limitations are best recognized by an experienced forensic scientist. There is a need for forensic scientists and laboratory administrators to direct an increased amount of attention to the overall interpretation of the totality of the physical evidence and the reconstruction of the event based on this physical evidence. This should be the capstone work of the forensic laboratory service. No one should be better qualified to render this important service than those who examined the physical evidence and generated the laboratory data. It should not fall to someone else by default.

Casework, Laboratory Accreditation, Pseudoscientific Interpretation

B130 Optimized Extraction of Nuclear DNA From Hair Shafts

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The goals of this presentation are to describe a variation of an organic extraction used on samples obtained from the World Trade Center victims and reference samples from these victims to obtain nuclear DNA from hair shafts.

Extracting nuclear DNA from hair has mainly been performed if the root of the hair is present. Nuclear DNA typing on hair shaft material has not been very successful since it is known that the amount of nuclear DNA in hair shafts is low and that the keratinized cells present in hair as well as the hair pigments are inhibitors to the PCR reaction. mtDNA testing of hair shafts has been proven to be a more successful and very effective method but most laboratories are not equipped for mtDNA testing as it is time-consuming and of less discriminatory value. Attempts to extract nuclear DNA from hair shafts have recently been reported in the literature. However, results of these experiments indicate that hair shafts are poor sources of nuclear DNA and are generally not suitable for STR testing.

In response to the World Trade Center DNA identification project it was necessary to optimize a method for extracting DNA from hair shafts. Hair samples removed mainly from hairbrushes or combs had been submitted as personal reference samples. Toothbrushes and other personal effects were the preferred source of comparison of DNA but in several instances it was necessary to test the hair. Additionally, clumps of hair without adhering tissue had been recovered at the World Trade Center disaster site. In order to find a biological trace of as many victims as possible, these samples could not be left untested.

The hairs were cleaned when placed into 5% Tergazyme, sonicated for 15 minutes, rinsed in deionized water several times, and allowed to air dry. After the cleaning, the hair or hairs were examined and 5-10 hair shafts per extraction were cut into 2 mm lengths. The hair shafts were incubated in organic extraction buffer overnight at 56°C in thermal shakers at 14,000 RPM. If the hair had not dissolved, the mixture was transferred to a glass mortar and pestle and the sample was ground until it disappeared. The extraction method for the World Trade Center samples employed a phenol/chloroform/Microcon 100 combination procedure. DNA was quantified, amplified using Promega PowerPlex™16, and run on ABI 3100's.

This modified procedure for extraction of nuclear DNA from hair shafts has shown that the "last resort" of biological samples suitable for DNA extraction (hairs) may be used. Hair shafts are a viable source of nuclear DNA for human identification.

DNA Extraction, Nuclear DNA From Hair Shafts, Mass Disasters

B131 Application of Synchrotron Radiation X-Ray Fluorescence to the Analysis of Forensic Trace Evidence

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This presentation will define the application of synchrotron radiation X-Ray fluorescence (SR-XRF) to the analysis of forensic trace evidence.

When trace physical evidence, such as glass fragments or rust of iron, is encountered at an actual crime scene, it should be compared with the same kind of material collected around a suspect in order to prove the relationship between the suspect and the crime and/or victim. Elemental analysis of physical evidence has been performed by ICP-AES, ICP-MS, SEM/EDX, or XRF at forensic laboratories. However, ICP-AES, and ICP-MS require destruction of samples and time-consuming pre-treatment, as well as large amount of samples. Scanning electron microscope equipped with energy dispersive X-Ray analyzer and XRF method does not show enough sensitivity for analysis of trace elements. Synchrotron radiation X-Ray fluorescence spectrometry has potential to the nondestructive analysis of trace elements with the extremely high efficiency. In this study, the importance of trace elements analysis using SR-XRF was evaluated in the forensic discrimination of trace physical evidence by the comparison of trace elements.

In this experiment, arsenous acid (As_2O_3), headlight glass, and rust of iron were selected. Thirteen kinds of commercially available As_2O_3 were collected. Of the samples, 7 were manufactured in Japan, 4 in China, and 1 each in Germany and Switzerland. Glass fragments were taken from the headlights of 17 different cars. The rust samples were prepared by immersing NIST (National Institute of Science and Technology) standard reference materials in the purified water for 1-2 days. The rusty chips were transferred to the filter paper. After drying, the filter paper was cut into 5mm x 5mm and applied to analysis by SR-XRF.

All the measurements using SR-XRF were carried out at BL08W beam line of Spring-8. A small sample was placed on the sample holder with the adhesive tape or the polypropylene sheet. This holder was set on the automatic X-Y stage and irradiated by monochromatic X-Ray, 116 keV, which could excite K-shells of all the elements. The X-Ray beam size was adjusted to 1.0mm x 0.8mm for the As_2O_3 and the headlight glass, and0.5mm x 0.4mm for the rust. X-Ray fluorescence spectra were obtained by an energy-dispersive XRF analysis system composed of a pure-Ge solid-state detector.

Analytical results obtained for each material were as follows.

1) Arsenous acid samples exhibited the characteristic patterns of trace elements in countries where the samples were manufactured countries and could be classified into the 3 categories. Various kinds of elements, such as Sn, Sb, and Bi, were found in Chinese samples; whereas, only Sb was characteristically found in Japanese samples; and, no trace elements could be detected from the samples from Germany and Switzerland. K-line of As normalized the peak intensity of each trace element and this parameter was compared with the concentration determined by ICP-AES. Sufficient correlation values were observed between these two methods.

2) Trace impurities, such as Zn, As, Sr, Zr, Sb, Ba, and Hf could be analyzed using a single fragment of sub-mg level. Most pairs of samples with identical refractive index (RI) value could be distinguished from each other by the comparison of SR-XRF spectra. Of 136 pairs among 17 samples, 135 could be discriminated by the combination of RI measurement and SR-XRF analysis, while 19 pairs could not be discriminated by the RI only.

3) In addition to dominant K-line of Fe, which appeared in the spectrum of all the rust samples, the peak of trace elements with certified values, such as Mo and W, was observed in some of the rust samples. This result suggested that SR-XRF spectra of the rust sample reflected to the components of the original materials. But the conventional analytical instruments, such as microprobe X-Ray fluorescence and ICP-AES spectrometers, could not measure these trace elements in the rust samples.

In conclusion SR-XRF has great potential for the nondestructive analysis of ultra trace physical evidence with extremely high sensitivity.

SR-XRF, Trace Evidence, Trace Element

B132 Use of a Database of Elemental and Refractive Index Values From Glass Samples to Determine the Significance of "Matching" Profiles in a Comparison Between Glasses

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The goal of this presentation is to present the evaluation of elemental and refractive index data from the analysis of ~700 different glass samples with the aim of aiding trace examiners in the interpretation of glass comparison data.

Elemental analysis of glass fragments by Inductively Couple Plasma Mass Spectrometry (ICP-MS) has been shown to provide an excellent means for distinguishing between different glass samples. ICP-MS provides quantitative data for the determination of metals that are present in trace level concentrations in the glass matrix. These measurements can be used to differentiate between very similar glass samples, resulting in a powerful test for distinguishing between glass fragments in a comparison.

The purpose of this presentation is to describe a number of different datasets resulting from the analysis of glass populations in order to determine the utility of the ICP-MS technique as a method for distinguishing between glass fragments. A statistical test to conduct and facilitate the pair-wise comparisons on the multivariate data is also presented. The interpretation of the results from this analysis leads to the conclusion that it would be an extremely rare occurrence for two glass fragments to contain indistinguishable elemental profiles if they did not originate from the same source of glass.

Data from 161 containers, 45 headlamps, and 458 float glasses (among them at least 143 vehicle windows) are presented and summarized. Data from the analysis of ~190 glass samples collected from a single glass manufacturing facility over a period of 4 years at different intervals, including ~100 samples collected in a 24-hour period are presented and data from the analysis of 125 glass samples representing several manufacturing plants in the U.S. are also presented.

A standardized method for the elemental analysis of glass by digestion and solution analysis has been subjected to a round-robin test by four different laboratories and the results of this round-robin are also presented. The precision and bias of the method are reported.

ICP-MS is shown to be an excellent method for distinguishing between different glass samples. Using the proposed method, the database supports the hypothesis that it is expected that different glass samples result in different elemental profiles and a comparison between fragments from the same source results in indistinguishable profiles.

One major disadvantage to the ICP-MS method is that the sample preparation step is time consuming and laborious. Laser ablation is an alternative sample introduction method that can address this disadvantage effectively.

Glass Analysis, ICP-MS, Data Interpretation

B133 Evaluation of Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS) as a Tool for the Elemental Analysis and Discrimination of Glass Evidence

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The goals of this presentation are to present to the forensic community the discrimination power of Laser Ablation as a direct sample introduction technique in the elemental analysis of glass samples by ICP-MS.

Glass is a common type of evidence encountered in crimes such as burglary, car accidents, vandalism, and kidnapping. Elemental analysis by ICP-MS has provided a high degree of discrimination between glass fragments. However, typical sampling introduction methods require time consuming and complicated sample preparation steps to bring the sample into solution and subsequent analysis.

LA-ICP-MS is a modification of ICP-MS in which a laser is used for initial sample volatilization and direct introduction of solids into the plasma. Recent developments in this technique have demonstrated its potential for rapid and simplified microanalysis of the major, minor, and trace elements in solid materials.

The aim of this presentation is to evaluate the discriminating value of the laser ablation sample introduction technique in comparison with well-studied solution ICP-MS methods.

Two laser ablation systems both with a wavelength of 266nm but with different nominal energy density output energies were used during this study. In order to optimize the sample introduction into the plasma, laser parameters such as spot size, carrier gas, ablation frequency, laser power, acquisition, and ablation mode were optimized for glasses of forensic interest.

The elemental composition was quantitatively determined using internal standardization with the isotope Si^{29} and using a one-point calibration with the reference material NIST SRM 612. The reference glasses SRM 1831 and SRM 1411 were used as control standards to evaluate the accuracy and precision within the analysis.

Different types of glasses that are commonly found in crime scenes were evaluated. One set of forty-five headlamps samples was characterized by elemental analysis using 20 elements and 14 elemental ratios. A second set of 46 automotive glasses was also characterized using 12 elemental ratios composed of 20 elements. The 45 samples consisted in 34 lens and 11 reflectors and the auto windows set contained both windshield and side window glasses.

The relative discrimination power of refractive index, LA-ICP-MS, and their combinations, using pairwise comparisons and statistical tests are also presented. From the pairwise comparisons, the relative discrimination power of each elemental ratio with ICP-MS was determined. The number of indistinguishable pairs arising from RI and LA-ICP-MS provides a means of evaluating the relative strength of each technique, as well as its comparison with previously reported results for external calibration and isotope dilution techniques.

In LA-ICP-MS, the elimination of the digestion and solution step not only reduces the cost of high quality reagents (trace quality) and standards but also eliminates the risk of use hazard materials, such as HF, in the digestion procedure. Another important advantage that LA presented is that it is a relatively non-destructive technique and small fragments (as small as 100 m) may be easily analyzed. Laser ablation also significantly reduces the time of sample preparation by as much as 75%. Finally, the laser ablation technique has shown to provide very low detection limits for absolute mass measurements of metals of interest to forensic scientists permitting the quantitative analysis of femtograms of the metal analytes analyzed from craters as small as 50 microns in diameter and 70 microns deep.

The simpler, faster and less intrusive sample introduction method of LA-ICP-MS provides similar discrimination power to the conventional nebulization techniques for aqueous samples and is a viable and alternative to the solution methods of elemental analysis.

Laser Ablation, Elemental Analysis, Glass

B134 Self-Cleaning Window Glass: A New Subclass of Glass Trace Evidence

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The goal of this presentation is to acquaint the forensic science community with a new subclass of glass trace evidence and to present the results of various chemical and physical methods of characterizing tiny pieces.

Criminals frequently gain entry by breaking glass windows. Although most of the broken pieces will fall away from the glass breaker, there will also be a fine spray of tiny fragments directed back towards the criminal. Also, it is likely that a high percentage of these tiny pieces will have originated from the surface of the pane that was towards the breaker. These fragments may be recovered from a suspect's clothing and may help provide an association between the suspect and the crime scene.

Self-cleaning window glass under the brand name of Activ™ Glass from Pilkington Glass was first introduced in 2001. In 2002, Pittsburgh Plate Glass introduced its own version of self-cleaning glass, SunClean® Glass. Both products are only intended for exterior windows, with the side having self-cleaning properties facing the outside. The self-cleaning treated side is always opposite the float glass side. Titanium dioxide at or near the outside surface interacts with ultraviolet rays from the sun to produce a catalytic effect that gradually breaks down organic dirt and grime to carbon dioxide and water. Because the treated surface is hydrophilic, rain (or water from a hose) sheets down the pane washing away any residues and leaving a surface free of water spots upon drying.

This presentation will illustrate various chemical and physical methods of characterizing self-cleaning glass. Methods that distinguish self-cleaning glass from ordinary float window glass and those that-distinguish between the Pilkington and Pittsburgh Plate Glass products will also be discussed. Characterization methods used in this project include polarized light microscopy, microscopy with an interference objective, refractive index determinations, scanning electron microscopy/energy-dispersive spectroscopy, Raman microscopy, and laser ablation inductively-coupled mass spectrometry.

At the conclusion of the presentation free samples of these glasses will be available on the basis of one per laboratory.

Trace Evidence, Glass Analysis, Self-Cleaning Window Glass

B135 Quantitative Assessment of the Accuracy of Fiber Comparisons

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Attendees of this presentation will learn about a framework developed for assessing the accuracy of experience-based analytical methods, which can be applied to a variety of trace evidence types, and the application of this model to fiber comparisons.

One interpretation of recent Supreme Court rulings that address the admissibility of expert opinion testimony, such as *Daubert* and *Kumho*, is that analytical method error rates must be known and quantifiable. This has traditionally been difficult for experiential examinations, such as microscopic comparison of fibers. Additionally, it has been difficult to quantify the amount, if any, of improvement in discrimination obtained by the addition of another analytical method to an existing protocol. In this study, a blind-testing protocol using gray automotive carpet fibers was defined and evaluated as a model for assessing the accuracy of experienced-based analytical methods. Such a protocol may provide a numerical estimation of the frequency of correct identification of fiber sources, as well as aid in the comparison of current and proposed analytical methods in fiber comparison protocols. The forensic science community may also implement the framework developed in this study to assess analytical methods in individual laboratories for a variety of trace evidence types.

The sample set selected for this blind test is a set of 30 gray nylon automotive carpet fiber samples from several sources, the total of which is less than the number of samples (i.e., some sources may appear more than once in the test set). Macroscopically-similar gray nylon fibers were selected as the test set in order to assure a level of difficulty that would adequately test the discrimination capability of fiber examinations as performed by experienced fiber examiners. The fibers were collected from late model (1990-1999) automobiles with interior carpets that were nominally gray in color. Whenever possible, fiber samples were taken from two diagonally opposite distant locations (front and back) within the vehicle in order to obtain a measure of the variability of the carpet within the vehicle. This sampling approach should identify the presence of multiple carpet sources within the vehicle, if present. Fiber samples were coded so that the identities of the vehicles from which they originated were unknown to the examiners.

Because of the experiential nature of fiber comparisons, this project required much time investment from qualified fiber examiners. Using the FB protocol for casework, comparisons of all pairwise combinations (435 pairs) of these fiber samples were performed independently by two experienced fiber examiners. Notes and measurements for all properties compared were recorded in order to permit the determination of the sensitivity and specificity of each analytical measurement. For the purposes of this study, all optical microscopical measurements were considered as one analytical measurement. The results provide a numerical measure of the number of incorrect associations (more appropriately expressed as a lack of distinguishable features among fibers from two sources) and incorrect exclusions for each analytical method used. The robustness of the statistics is controlled by selection of the number of samples and sources. Using this model, the effects of variables such as analytical method and specific fiber characteristics can be tested. The evidential value of the addition of non-routine tests, such as elemental analysis, to the analytical protocol for source discrimination was also assessed with this model.

This paper will detail the salient features of the test design and present its application to fiber comparisons. An evaluation of the results of this blind test, using fiber comparisons, and an assessment of the relative discrimination capability of each analytical method, including elemental composition, will be presented.

Fibers, Criminalistics, Trace Evidence

B136 Determining the Sheddability of Various Fiber Types

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The goal of this presentation is to present to the forensic community a reliable method for determining the shedding potential of garments.

Fibers are frequently recovered as evidence in criminal cases. The number of fibers obtained can vary from a single fiber to a large clump. The application of the shedding potential of a garment is very significant, for example, in cases where the source of the fiber(s) is known.

A standard method for determining the sheddability index of various fiber types was developed. The low-adhesive backing of a 3" x 3" 3M post-it note was utilized to simulate a 'natural' shedding of the fabric. Shedding indices were determined for sole content non-dyed, dyed, and printed fabrics. Dyed fabrics and prints were used to investigate whether the application of colorant affected shedding. Fabric structures for the tested fabrics included knits and woven and non-woven fabrics.

A raw mean shedding index was assigned for 31 tested fabrics. Shedding indices for 31 fabrics were assigned by counting the number of target fibers found on the adhesive backing of the post-it note with a compound microscope at 45X magnification. Each fabric was "post-it" noted in four different places. A raw mean shedding index was calculated from these four trials. Natural breaks occurred in the data when comparing the raw median shedding indices among all 31 fabrics. These breaks yielded 6 categories in which fabrics were placed. Those categories included high shedders, high-medium shedders, medium shedders, medium-low shedders, and low shedders. This categorization of fabrics was employed when fabrics were chosen for the fiber-transfer study.

A fiber-transfer study with the tested fabrics from each of the 6 categories as donors and white/black felt as recipients was performed and compared to the previously determined shedding index. Simulated contacts, a handshake (no contact), and a hug (friendly contact), were used as transfer conditions. Research participants were required to wear a white lab coat with a swatch of fabric (either donor fabric or white/black felt) safety pinned to the front chest area. The participants then either shook each other's hand or hugged one another. To investigate whether the number of transferred fibers decreased after a repeated number of contacts, each transfer was repeated 3 times with each of the tested fabrics using a different piece of recipient felt.

The method developed here for determining the sheddability of a fabric is efficient, reproducible, and reliable. A standard 3"x 3" 3M post-it note is sufficient for providing accurate results. The low-adhesive backing provides a comparable alternative to the taping method without pulling fibers from the fabric, which is often the case with the more aggressive adhesives, used on tape.

Fibers, Shedding, Fiber-Transfer Studies

B137 Forensic Taphonomy of Textile Fibers

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Upon completion of this presentation, the participant will have an understanding of how both natural and man-made textile fibers are degraded by the environment.

Textile fibers encountered in the course of forensic investigations may have been subjected to a variety of environmental conditions. They may have been buried with a corpse, exposed to sunlight and precipitation or immersed in streams, tidal estuaries, or the ocean. Environmental conditions may have little or no effect on a textile fiber; on the other hand, the fiber may lose color through bleaching or its morphology may be altered through polymer degradation. In extreme cases, the fiber may be completely destroyed. This presentation will survey the current forensic and archaeological literature on the environmental degradation of natural and man-made fibers. Finally, taphonomic alteration of natural fibers from excavations of Harewood Cemetery (near Charlestown, WV) will be presented.

Taphonomy, Fibers, Degradation

B138 Deep UV Microspectroscopy of Textile Fibers

Paul C. Martin, MS, PhD, CRAIC Technologies, 2400 North Lincoln Avenue, Altadena, CA*

This presentation is a tutorial of the unique identifiers found in the deep UV spectra of textile fibers associated with trace evidence.

The ultraviolet region of the spectrum has some of the most distinguishing characteristics for textile fibers. This includes absorbance from the additives, brighteners, colorants, and the fiber itself. The purpose of this paper is to show the results of a novel analysis of a series of commonly occurring textile fibers. The deep UV spectra of samples as small as 4 microns are analyzed by measuring the transmission of several undyed fibers. The results are compared and discussed.

Microspectroscopy, UV, Fiber

B139 Polarization Microspectroscopy of Fiber Evidence

Jumi Lee, PhD, CRAIC Technologies, 2400 North Lincoln Avenue, Altadena, CA*

This presentation will discuss the application of polarization spectroscopy to fiber evidence analysis.

Polarization microscopy has been applied for many years for the analysis of fiber trace evidence. However, only limited research has been done with polarization spectroscopy, especially on the micro scale. In this paper, the results of a study of polarization microspectroscopy of textile fibers and the utility of the technique in forensic analysis are presented. The results are compared and discussed.

Polarization, Microspectroscopy, Fiber

B140 Forensic Identification of Dyes Extracted From Textile Fibers by Liquid Chromatography-Mass Spectrometry (LC-MS)

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The goal of this presentation is to present the progress on the development of a method to identify dyes extracted from textile fibers, which will contribute to forensic fiber characterization and comparison.

Textile fiber examination is frequently carried out in forensic laboratories to provide physical evidence in crime investigations. An important part of forensic fiber examination involves the characterization of textile dyestuffs. Currently, there are several methods used for dye analysis, including ultraviolet, visible, and fluorescence microspectrophotometry, infrared spectrometry, and high performance liquid chromatography (HPLC). However, since many hundreds of dyes are used in the textile dying industry, these techniques are not specific enough for their identification, because different dyes may have the same color may have absorption at the same wavelength, or may have very close retention times. Therefore, these methods cannot provide unambiguous forensic identification or comparison. Furthermore, these techniques do not provide chemical structural information, which, in some cases, is crucial to determine the single source of a dye. Being a highly sensitive and selective method, liquid chromatography-mass spectrometry (LC-MS) has the potential to characterize and compare extracted fiber dyes according to their molecular structure. In this study, a LC-MS based method was developed to identify dyes extracted from textile fibers and create a reference database to serve the forensic and law enforcement communities.

An Agilent 1100 MSD quadrupole mass spectrometer equipped with an electrospray ionization (ESI) source and an Agilent 1100 HPLC are used for this study. The instrument can be switched conveniently between a positive ion mode and a negative ion mode, according to a dye's tendency to form negative or positive ions. The dye is extracted into an organic solvent phase from a fiber in a closed system. Heating is necessary in many cases. 5 µL of the extracted sample solution is injected into the LC-MS system. Separation is carried out with a ZORBAX Eclipse XDB-C18 (2.1 x 150 mm) HPLC column. The flow rate of the mobile phase is 0.15 ml/min. Solvent gradient is used to achieve better separation. Parameters for the mass spectrometer are optimized to get the best sensitivity. Drying gas for the ESI is 12.0 L/min. Spray chamber temperature is 350ºC.

Mass spectra were obtained for standard dyes, including disperse dyes, direct dyes, acid dyes, and basic dyes of various typical colors. The detection limit is in the range of several ppb to 100 ppb, depending on the dye's chemical structure. For a 5 µL sample injection this corresponds to an absolute detection limit of 5-500 pg. Type of organic solvent, extraction time, and other factors for the extraction process will be optimized to extract the dyes most efficiently and reduce the amount of fiber necessary for identification.

The most frequent ions in the mass spectra of the analyzed dye standards are $(M-H)^-$, $(M-xNa)^{x-}$ (x=1 - 4), $(M+H)^+$, and $(M+Na)^+$, where M represents its molecular form. In the Agilent MSD 1100 it is possible to increase ion fragmentation by increasing a certain voltage in the ion source called "fragmentor voltage." Therefore, information about a dye's chemical structure may be obtained according to its mass spectral fragmentation pattern. This method provides high reliability for dye identification, based on the fragment and molecular ions. A certain number of textile fibers were extracted and then identified by the LC-MS method. Mass spectra of standard dyes and dyes extracted from fibers will be presented and discussed. An Internet reference database of LC-MS mass spectra of dyes will be created for the benefit of the forensic community.

Dyes, Fibers, LC-MS

Engineering Sciences

C1 Persistence of Oil Spilled From the T/V *Exxon Valdez* on Beaches of Prince William Sound, Alaska, USA, After 12 Years

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This presentation will compare (1) results from a government study of the amount of oil on beaches in 2001 from the 1989 *Exxon Valdez* oil spill, (2) results from a covert audit of the study attempted by scientists supported by Exxon Corporation, and (3) results from a government audit prompted by allegations based on the Exxon supported audit.

The rapid disappearance of oil from the surface of beaches three years after the *Exxon Valdez* oil spill implied that remaining oil would quickly disperse. This presumed rapid dispersal has been cited in criticism of recent reports claiming long-term toxic impacts of the spill to fauna that forage or reproduce intertidally. This presumption was evaluated by conducting an extensive field study of *Exxon Valdez* oil remaining in Prince William Sound (PWS) in summer, 2001, based on a representative probability-based sampling design. At random, 91 beach segments were selected from 3 mutually-exclusive categories of oiled beaches surveyed during 1989-1993, and a total of 6,775 quadrats were excavated, each 0.25 m^2 and up to 0.5 m deep placed according to a stratified random sampling design among the selected beach segments, at tidal elevations that ranged from +1.8 m to +4.8 m. An additional 2,000 pits were excavated to delineate the size of oil patches discovered by random sampling. All pits were backfilled immediately after excavation and evaluation.

Exxon Valdez oil was found on 53 of the selected beaches, as surface oil in 226 quadrats and as subsurface oil in 347quadrats. We estimate the equivalent of 3.94 $\pm$ 1.14 ha ($\pm$ SE) and 7.99 $\pm$ 2.36 ha of beach remained oiled by surface and subsurface oil. The combined oiled area (correcting for overlap) was 11.4 $\pm$ 2.25 ha, over twice the oiled area measured in 1993, indicating the area of oiling has probably changed little since then. Most of the surface oil was present as weathered asphalt pavements, soft surface oil residues or surface sheens. Subsurface oil was present as a fluid light oil residue in 62% of subsurface oiled quadrats, followed by fluid medium oiled residue (21%), oil film (11%) and fluid heavy-oil residues (6%). Subsurface oil was most prevalent in the mid- and lower-intertidal, in contrast with surface oil. The total volume of oil remaining in 2001 is estimated as about 65,000 L, or about 8% of the volume estimated remaining in 1992, indicating annual dispersion on the order of 22%. The remaining subsurface oil contains suites of polycyclic aromatic hydrocarbons (PAH) that are readily available biologically, and is most prevalent in beaches that were most heavily oiled initially. These beaches are most abundant in bays where evidence for long-term toxic effects of oil has been indicated.

Exxon-supported scientists attempted to audit this study covertly by evaluating beaches after they were assumed to have been sampled by the government study. The audit was conducted with only approximate knowledge of the locations of the sampled beaches, and no knowledge of when they were sampled. The audit was conducted during the final five weeks of the 17-week sampling period, and relied on enumeration of the number of sampling pits evident. Based on the Exxon scientist's inability to find evidence of excavated pits, it was concluded that the government study was not executed according to the study plan, but was instead highly biased. This conclusion disregards the possibilities that (1) the beaches sampled by the government may not have been accurately located for the audit, (2) the audit occurred weeks or months after the pits had been backfilled on most beaches, (3) the audit likely occurred before government sampling on some beaches, and (4) pits are naturally excavated by sea otters and other biota inhabiting the region.

These allegations prompted a government investigation of the conduct of the study, which found the Exxon allegations entirely without merit. The government audit relied on the extensive documentation produced by the study along with corroborative documents such as the log's of the support vessels, and statements from field personnel contracted by the government. Thorough cross-validation of these documents revealed no evidence that the study was no performed as claimed by the participating government scientists.

Exxon Valdez, Defamation, Scientific Fraud

C2 Environmental Forensic Microscopy

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The goals of this presentation are to describe to the environmental forensic community the use of light and electron microscopy for the identification of small particles that have been released into the environment. Attendees will gain an understanding of particle collection and analysis techniques where microscopy is used to determine the source of hazardous dust in different environmental settings.

Environmental forensic microscopy is the application of microscopy to the collection, analysis, and identification of small particles and the interpretation of any results as they pertain to environmental investigations and governmental regulations. Collection techniques vary according to the situation presented and range from simple scoop and bag techniques to sophisticated filtering and particle isolation techniques. Airborne particles are usually collected by filtration or impaction, although passive sampling tins are also used. To collect samples of particles from surfaces, scraping, brushing, adhesive tape sampling, wipe sampling, and vacuuming have been employed. When collecting liquid samples for the analysis of suspended particles, consideration must be given to the material used in manufacture of both the sampling container and the filter upon which the particles will ultimately be examined so that no adverse reactions occur between the material and the liquid being sampled. The specific particle collection technique for a particular project is chosen to maximize the probative value of the particles collected and to ensure that a second party preserves portions of any sample collected for analysis. Analysis procedures involve the use of a variety of microscopical tools, including polarized light microscopy with microchemical testing, scanning electron microscopy with X-Ray analysis, transmission electron microscopy with diffraction and X-Ray analysis, infrared microscopy, ultraviolet microscopy, and scanning white light interference microscopy. Identification techniques require the knowledge of trained microscopists utilizing the microscopes to characterize small particles and compare their physical and chemical characteristics to suspect sources.

The forensic environmental microscopist is often called upon to interpret the results of his findings according to applicable environmental or other regulatory law. In many projects, the environmental forensic microscopist must work closely with environmental engineers and practitioners of environmental law to solve complex questions. The following case studies illustrate the range of analytical procedures and variety of information determined during environmental forensic microscopy studies. These projects have been selected from case files compiled over a 12-year period – 1990 to present. Case 1 concerned a surface dust from a residence that was thought to be contaminated with lead-based paint. Paint particles were not detected by scanning electron microscopy, but lead-containing fly ash was found in considerable quantities. Subsequent investigation and sampling of possible sources resulted in matching the fly ash with an outdoor stockpile at an industrial site. Eventually charges were brought against the owner of the site for improper control of

environmental emissions. Case 2 involved surface dust samples from residences around a Superfund site that had formerly produced a lead-arsenate pesticide. Scanning electron microscopy with X-Ray analysis showed that particles consistent with the pesticide were present in the residential dusts near the former manufacturing plant. The microscopical analyses were used to discriminate between the lead arsenate and other forms of lead present in the dusts such as lead-based paint and to determine the how far the particles had migrated away from the manufacturing plant. Case 3 showed how environmental forensic microscopy is used to investigate indoor environmental questions. A woman complained of allergy-like symptoms in her office in Virginia. The symptoms included irritated eyes, runny nose, and respiratory problems. Examination of dust by polarized light microscopy after collection by micro-vacuuming the woman's work area showed cat hairs in the woman's office. After initially denying it, a co-worker finally admitted to bringing her cat into the workplace when she worked after hours (after the cleaning crew had been through) and letting it run throughout the office complex. Case 4 involved the constituent analyses of bulk asbestos-containing building materials and the matching of results to manufacturers' formulae in environmental cost-recovery litigation being conducted by the Attorney General's Office of the State of Illinois. A number of building products in the state-owned buildings were found to be consistent with products sold by specific manufacturers based on the analyses performed using polarized light microscopy, scanning electron microscopy and transmission electron microscopy. Case 5 involved a sample of water with suspended particulate. The sample was collected from a drainage area outside an industrial complex. The particles were shown to be high in rare earth elements by the x-ray analysis in the scanning electron microscope. The investigation was directed toward a manufacturer of optical glass products in the complex. Case 6 concerned the analysis of a piece of white material that was clogging a drain in a newly renovated building. Light and scanning electron microscopy were used to analyze the material and compare with possible source materials that were being used by various contractors on site. The material was consistent with one of the products being dumped inappropriately into the building drain system. Case 7 is an ongoing investigation using environmental forensic microscopy to investigate dust produced by the collapse of the World Trade Center buildings on September 11, 2001. The characterizations of the dust by polarized light microscopy, scanning electron microscopy and transmission electron microscopy will be useful in determining the extent of the buildings contaminated by the tragedy as well as useful in the studies of health effects and cleaning procedures necessary for building recovery.

Microanalysis, Environment, Scanning Electron Microscope

C3 Initial Evaluation of Negative Temperature Ramping in Gas Chromatography

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This presentation will discuss the development and evaluation of a low thermal mass (LTM) gas chromatograph potentially capable of laboratory quality analyses in the field including rapid positive and negative temperature programming.

Law enforcement, defense, and private industry personnel involved in on-site hazardous material testing or monitoring are faced with a critical challenge: the analysis of samples when decisions as to public safety or regulatory compliance need to be made quickly and accurately. Laboratory-based analysis using gas chromatography coupled with mass spectrometry (GC-MS) has long been the workhorse of confirmatory testing for the majority of these situations.

Traditionally, temperature programming in gas chromatography has involved heating the analytical column within a convection oven. This approach limits heating rates due to the combined thermal masses of the column and oven. The low thermal mass (LTM) GC described here encases the column within a highly thermal efficient toriod wrap that can be temperature programmed at high speed while maintaining low power consumption. With a total mass of less than one ounce, this combined oven and column can be heated as well as cooled at rates considerably higher than traditional GC configurations while maintaining reproducibility.

Field as well as laboratory GC-MS systems are limited due to size, power consumption, and a narrow range of temperature programming rates. A resistively heated low thermal mass GC system has been developed that can overcome most of these limitations, offering laboratory-level performance, or better, in a small, lightweight package. Using a sixteen-component custom chemical warfare GC-MS performance test mixture and a sixteen-component PAH standard, a prototype LTM GC was evaluated for speed and quality of analysis through application of pressure and temperature tuning.

This work reports the application of both positive and negative-going rapid temperature ramps resulting in more efficient separations compared to more traditional isothermal and positive-going temperature programs with regards to resolution and analysis time. The data presented illustrates resolution improvements for targeted critical pairs upon application of a temperature program including a rapid negative going temperature ramp; this includes a modest decrease in analysis time over a previously optimized separation.

This work also shows that the advantages provided by rapid temperature programming, including negative temperature ramping, are available to those who do not wish to depart from a conventional 15 meter by 0.25 mm ID GC column or the injection techniques commonly used in their applications. The LTM GC, when combined with MS detection, has the potential to offer significant analysis and economic benefits to forensic laboratories while maintaining a high level of performance and method flexibility.

Field GC-MS Analysis, Fast GC, Portable GC

C4 Glass Measurements and Standards for Forensic Analysis

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The goals of this presentation are to describe forensic procedures and measurements related to the characterization of glass specimens for linkage to evidence or probable cause for glass failure or breakage.

This paper describes physical, optical, and chemical properties of glass; as well as analytical procedures and measurements related to the identification and/or comparison of glass specimens to be linked to evidence or to the probable cause for failure or breakage.

The measurement of physical, optical, and chemical properties of glass pieces or fragments are often used to identify the type of glass, such as ophthalmic glass, window glass, container glass, technical glass for electrical/electronic applications, bulbs, or automotive glass installed as windshields, windows or headlights. Measurements of glass properties can be used to track and identify the original producer or manufacturer, the date period of manufacture, and the intended application. For example, property measurements and/or evaluation of glass product characteristics, in addition to visual markings, can establish a link in the chain from producer, fabricator, distributor, geographical area, to the end-use or application. In auto hit-and-run cases, visual examinations and measurements of headlight fragments left at the scene of a crime, can establish a link to the manufacturer, year, and model of a vehicle. Furthermore, visual and residual stress measurements, as well as breakage patterns of glass

fragments or fracture in articles, can confirm a poor annealing state, the presence of imperfections such as cords, striae, inclusions, and surface and other defects which may have caused failure. Also, residual stress analysis may point to the cause for the breakage of bottles, jars, windows, shelves and other glass products.

The most common and highly diagnostic measurements used to characterize glass, besides visual examinations, microscope evaluations and stress analysis, are measurements of the refractive index with its associated dispersion, density, and chemical analysis.

The refractive index and dispersion are highly sensitive measurements in the comparison of glass specimens, in order to determine if samples are identical or come from the same population or manufacturer. Refractive index measurements are used routinely and systematically in glass production to insure that the melting process and forming operations are kept invariable, and that the product homogeneity throughout the production development remains within strict tolerance levels. For major commercial producers, the refractive index for a specific glass composition is targeted to be a constant number, usually within 10 to 20 parts per million, and significantly more restrictive for optical glass. For window glass, the index is around 1.52 while for very dense optical glass the index reaches 2.0.

The refractive index of a transparent material, such as glass, obeys Snell's Law that is essentially the ratio of the velocity of light for a fixed wavelength in air to that in the glass medium. The refractive index varies with the wavelength of the incident light beam. For instance, in the ultraviolet end of the visible spectrum, the index is higher than in the red end. Glass manufacturers, especially for optical applications, specify the index at different wavelengths in the visual range spectrum. However, the most common specification of the index is for that determined with light emitted from a sodium lamp (yellow, D doublet). Associated with the index of refraction is the dispersion coefficient number, which is the rate of change of the index with wavelength.

The refractive index can be determined by using refractometers of various kinds or by comparing the glass immersed in fluids with specific fixed indices. Fluids with different indices can be mixed to obtain a fluid having different specific indices.

The density of a glass is another sensitive and highly diagnostic parameter in forensic studies. The density of glass is also kept as a constant number in the production process for any specific glass composition. The density of glass is specified in grams per cubic centimeter. It varies from 2.40 g/cm^3 for window or container soda lime glass, 2.2 g/cm^3 for borosilicate glass, to 4.0 g/cm^3 for lead or crystal glass. Common techniques to determine the density of glass are sink-float and buoyancy techniques. For sink-float, glass samples are immersed in a liquid having variable densities near the room temperature region (25°C). For buoyancy determinations, the Archimedes Principle is utilized.

There are several measurement methodologies related to the determination of chemical composition. Methods cover basic "wet chemistry" procedures and other sophisticated techniques, which utilize atomic and radiation physics principles, and nuclear interactions that require complex and expensive apparatus. Fortunately, a number of reference glasses having components comparable with those of the glass under test have been established. These reference materials and associated methods standard procedures are available for equipment calibrations. Similarly, for the measurement of residual stress, there are techniques that range from complex laser techniques, polarimeter examinations, and comparison to standard discs using a polariscope.

This paper will discuss the properties and characteristics of glass of interest to the forensic community. The discussion will encompass measurement practices, methods, standards, and precision and accuracy considerations to be taken into account for the measurement methodologies employed. This paper will provide insights on the needs for standards to be utilized in glass measurements and characterization.

Glass, Classification, Forensic Science

C5 The Use of Aerial Photography to Determine Contamination Events at Agricultural Chemical Facilities

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The goals of this presentation are to discuss examples from environmental cases involving four different agricultural chemical facilities at which historical aerial photography was used to determine the timing of environmental damage and to allocate remedial costs among litigants.

Method: Comparative stereoscopic analysis of a series of historical aerial photographs to identify former activities or features potentially responsible for contamination on site. Overlay contaminant information to a time series of digital aerial images to show correlations between contaminant distribution and/or waste removal areas with historical releases and disposal activities.

Former agricultural chemical facilities abound in the southeastern U.S. and range in size and scope. Some facilities formulated pesticides onsite, while others were only involved with the storage, resale, mixing, and dispensing of fertilizers and pesticides. Common soil and ground water contamination associated with these facilities include agricultural chemicals such as Toxaphene, BHC, DDT, Dieldrin, and Aldrin. In the following case histories, three of the facilities were involved in insurance coverage litigation, and the fourth site was a PRP case filed under CERCLA.

The first facility began formulating pesticides onsite in the 1930s. Aerial photography from the 1930s to the 1990s was acquired and analyzed stereoscopically to show the development of the facility's infrastructure and the location and timing of the storage, release, and disposal of materials. The analysis revealed the presence of various tanks, drums and other containers with associated releases; open storage of uncontained raw materials and products; a wash water discharge ditch and unlined pit; a disposal trench; and releases in loading areas.

The second related facility was used for disposal of off-spec pesticides. The primary legal issue at this site was the timing of the environmental damage (i.e., when did the groundwater contamination occur). The historical aerial photographic analysis showed that solid material (off-spec BHC) was dumped on the surface of the site from the mid-1950s to the mid-1960s. Then sometime in the late 1960s to early 1970s the waste material, along with other containerized wastes, were consolidated and buried in trenches. It was believed that burying the wastes brought it into contact with the groundwater and initiated the groundwater contamination. During remediation of the site these buried wastes were excavated leaving large depressions onsite. By overlaying a time series of digital aerial images, it was possible to show the jury the precise correlation between the trench scars present in the 1972 photography with the depressions indicating where the wastes had been excavated in the late 1980s. This resulted in the jury determination that environmental damage occurred close to the 1972 time period, well out of the insurance policy coverage period.

The third facility was also a disposal site for off-spec pesticides and other wastes. At this site the historical aerial photographic analysis documented waste disposal and the associated environmental damage during an approximate 25-year time period. Wastes were buried in pits and trenches and dumped on the surface. Severe vegetation damage resulting from surface run-off and leachate springs was evident. Consequently the remediation costs were allocated across the entire time period of activity.

The fourth facility consisted of several contiguous parcels of land owned by a railroad company. The parcels were leased to different entities from the 1940s to the 1980s. The property was utilized at different times for the formulation, distribution and storage of agricultural chemicals; for parking equipment and tank trailers used to transport and/or spread agricultural chemicals; and for the storage of petroleum products. Aerial

photography spanning the time period from the 1940s to the 1990s was analyzed stereoscopically and combined with site data from other sources. The locations of soil and ground water samples indicating high levels of pesticides (BHC, DDT, Toxaphene, and Dieldrin) were registered to digital aerial images representing different dates of photographic coverage.

As expected, some of the contamination correlated with the portion of the property associated with a former agricultural chemical formulation plant. However, the plant was only in operation for a short period of time and not all the contamination could be attributed to these former operations. Another portion of the property was utilized as a farm market for approximately 20 years. Primary operations at the farm market consisted of bulk storage of fertilizers that were distributed to local farmers. The farm market conceded that small quantities of pre-packaged pesticides were stored and sold at the facility; however, they contended that these operations did not contribute to those contaminants that drove the corrective action across the majority of the site.

The historical photographic analysis revealed that the farm market used portions of the railroad property, which were not leased to them, to park tank trucks and tank trailers - equipment used to transport agricultural chemicals to local farms. In addition, the analysis revealed that the farm market leased equipment such as spreaders to local farmers, and that these spreaders were also parked on railroad property not leased by the farm market. The farmers could purchase chemicals from other sources and use the farm market's spreaders to dispense pesticides on their fields. Contaminants were found in high concentrations in areas where these spreaders were washed and parked. This source of contamination was only discovered through identification of the agricultural equipment and a washing area onsite using stereoscopic analysis of the historical photography.

The preceding examples demonstrate the value of using historical aerial photography in conjunction with other site environmental data to document the timing of various contamination events.

Historical Aerial Photography, Stereoscopic Analysis, Agricultural Chemical Facilities

C6 Petroleomics: Environmental Forensic Applications of High Resolution FT-ICR Mass Spectrometry

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The goal of this presentation is to introduce FT-ICR mass spectrometry and its applications in the environmental forensic arena.

The number of distinct chemical components of petroleum is already approaching tens of thousands, and is thus becoming roughly comparable to the number of genes (genome) or proteins (proteome) in a given biological species. Therefore, the inherent complexity of crude oil and its derived products has until now made environmental analysis difficult or in some cases, impossible. Once introduced to the environment, subsequent biotic and abiotic modifications of the petroleum product further complicate an already complex mixture. Traditional analytical techniques such as Liquid Chromatography (LC), Gas Chromatography (GC) and Gas Chromatography-Mass Spectrometry (GC-MS) have inadequate chromatographic resolution for the baseline separation of all species present in most petroleum distillates above diesel fuel. As a result, combined techniques (such as GC-MS and LC-MS) are ineffective due to co-eluting species that complicate the mass spectrum and hinder component identification. Furthermore, mass spectrometers commonly employed for GC-MS and LC-MS are low resolution / low mass accuracy quadrupole mass filters or quadrupole ion trap type mass analyzers that are unable to adequately resolve complex mixtures for individual component identification. As a result, the utilization of traditional analytical techniques provides a limited amount of compositional information and is often dominated by a large unresolved "hump," commonly referred to as an unresolved complex mixture (UCM). Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS) benefits from ultra-high mass resolving power (greater than one million), high mass accuracy (less than 1 ppm) and rapid analysis which make it an attractive alternative for the analysis of petroleum products that range from crude oil to gasoline. For example, the authors recently resolved almost 20,000 different elemental compositions in a single positive-ion electrospray FT-ICR mass spectrum of a heavy crude oil.

The presenter will report three environmental forensic applications of FT-ICR mass spectrometric analyses in the initial site characterization of a U.S Air Force jet fuel (JP-8) spill site, the initial results from forensic typing of crude oils, and recent instrument advances that aide in the analysis. High-resolution mass spectra of electron-ionized jet fuel samples are obtained from as little as a 1 microliter septum injection into an all-glass heated inlet system. Molecular formulas (elemental compositions) are assigned from accurate mass measurement alone. From a compositional analysis of an unweathered standard, components are identified and monitored as a function of weathering. Identifying the leachable and volatile components present in such a complex mixture is useful in fate and risk assessment and environmental impact studies. JP-8 contaminated soil samples were obtained from Eglin Air Force Base, Soxhlet extracted, and analyzed for compositional similarities to weathered standards. Crude oil standards were provided by ExxonMobil and Petrobras and analyzed by electrospray ionization (ESI) FT-ICR mass spectrometry. Each crude consisted of thousands of peaks and hundreds of compound classes. Ten crudes were analyzed in an effort to differentiate the crudes from one another based on their compositions provided from the FT-ICR MS analysis. Instrumental advances discussed include selective ion accumulation, a new octapole ion accumulator, and the addition of a field desorption / ionization ion source.

Mass Spectrometry, High Resolution, FT-ICR MS

C7 Comparison of Microprobe Two-Step Laser Desorption/Laser Ionization Mass Spectrometry and Gas Chromatography/ Mass Spectrometry

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The goals of this paper are to present the forensic community comparisons between microprobe laser desorption/laser ionization mass spectrometry and gas chromatography/mass spectrometry in analyses of environmental samples.

Microprobe two-step laser desorption/laser ionization mass spectrometry (μL ^{2}MS) is a relatively new and powerful analytical technique used for the detection of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and other molecules having low ionization potentials. μL ^{2}MS is highly sensitive, requires only small quantities of sample, and is capable of spatial mapping with a resolution of 10-40 gm. Additionally, μL ^{2}MS provides *in situ* analysis, which minimizes sample handling and the potential for contamination or chemical alteration. μL ^{2}MS has been used to analyze contaminated soils and sediments[1,2], interplanetary dust particles[3], meteorites[4] , and artificial ices that simulate the interstellar medium[5].

A mass spectrometric analysis using μL ^{2}MS requires a two-step vaporization-ionization process, which is carried out using two independent laser sources. In the first step, a pulsed infrared (IR) laser is

focused on the sample, causing volatilization over an area as small as 10 ?m thereby releasing a plume of intact neutral molecules. In this step, low laser power density is used to ensure desorption of neutral, unfragmented molecules. In the second step, a single-frequency pulsed ultraviolet (UV) laser beam intersects the desorbed plume causing (1 + 1) resonance-enhanced multiphoton ionization (REMPI) of those molecules that absorb the UV radiation and have a sufficiently low ionization potential. As well as excellent selectivity, REMPI also provides a means of "soft ionization" in which very little molecular fragmentation occurs. The resulting ions are analyzed over the complete mass range in a reflectron time-of-flight mass spectrometer.

Much of the data obtained using μL ^{2}MS may be compared to the more traditional mass analysis technique of gas chromatography/mass spectrometry (GC/MS), which is often used for analysis of environmental samples. μL ^{2}MS and 6 GC/MS have different strengths as analytical techniques, and they provide complementary information[6]. *In situ* analysis with μL ^{2}MS eliminates much of the time-consuming and potentially contaminating sample preparation that is necessary for GC/MS. In addition, μL ^{2}MS accommodates much smaller sample sizes and has a much lower detection limit than GC/MS. Specifically; a μL ^{2}MS analysis can be completed on milligram quantities of sample in only a few minutes and can detect subattomole concentrations of analytes over the complete mass range. μL ^{2}MS can only poorly differentiate isomers by changing the ionization wavelength, whereas isomers are readily separated and detected by GC/MS. Moreover, the determination of absolute values of concentrations by μL ^{2}MS are quite problematic because of difficulties associated with different desorption rates and different ionization cross sections for various species. Nevertheless, the relative concentrations of an alkylation series for a given species are generally well determined by μL ^{2}MS, whereas in electron impact ionization, different members of the alkylation series often show differing extents of fragmentation. Some examples will be presented of the similarities and differences of these two techniques for investigating environmental samples.

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Laser Desorption, Laser Ionization Mass Spectrometry, Gas Chromatography

C8 Quality Assurance in Qualitative Analyses

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The goals of this presentation are to describe quality assurance methods for the qualitative procedures used in the forensic analysis of environmental samples by GC-FID.

Analytical data are used to make a variety of forensic decisions, e.g., whether a chemical or product is present, the concentration of the contaminants, how the contaminants have interacted with the environment, the identity of the contaminant, etc. Much of this work is performed by gas chromatography with flame ionization detection (GC-FID). Errors in the interpretation of the data can have costly effects – either fiscal, environmental, or both. It is the role of the laboratory quality assurance program to provide safeguards, minimize errors, and provide a means of detecting errors when they occur.

Characterizations of petroleum products by GC-FID, (sometimes called "fingerprinting"), are specifically mentioned in EPA SW-846 Method 8015, and Washington State Department of Ecology NWTPH-HCID. Method 8015 Section 1.3 limits the discussion to: "This method is restricted for use by, or under the supervision of, analysts experienced in the use of gas chromatographs and skilled in the interpretation of gas chromatograms. In addition, if this method is used for the analysis of petroleum hydrocarbons, it is limited to analysts experience in the interpretation of hydrocarbon data. Each analyst must demonstrate the ability to generate acceptable results with this method." The language in NWTPH-HCID is almost identical.

There are no established quality assurance methods for the characterization of petroleum products by GC-FID. Similarly, no performance evaluations or testing is either performed or required by any agency promulgating this method. However, many laboratories perform this analysis and freely offer their interpretations, whether requested or not. An interlaboratory comparison of five labs analyzing soil samples for total petroleum hydrocarbons (TPH) by GC-FID generated interpretations of the contaminants by four of the five laboratories, each of which incorrectly described the contaminant, a weathered diesel fuel.

The GC-FID traces of fresh petroleum products, particularly automotive gasoline and diesel fuel, are easily recognized, even by a neophyte. Moderate evaporation, biodegradation, and dissolution processes generally alter the chromatograms in predictable ways. Consequently, simple products may be characterized reproducibly by different laboratories. However, unfamiliar products, such as aviation gasoline, jet fuels, solvents, and mixtures of products, rapidly increase the uncertainty in product characterizations. Similarly, the combination of several weathering processes will complicate the interpretation of GC-FID data.

The ability to recognize a petroleum product from the GC-FID trace is due to the relationship that exists between the chromatogram and the physical and chemical properties of the material. Gas chromatography separates components based upon their molecular weight, boiling point, and their interaction with the solid phase of the GC column.

Petroleum products, particularly fuels, are designed to boil within a certain range. Thus, automotive gasoline, which has a fuel specification to boil between approximately 50°C and 190°C, will have a GC-FID trace which shows the presence of peaks eluting from approximately hexane to triadecane.

Diesel fuel is a petroleum distillate, i.e., it is distilled from crude oil with relatively little modification; automotive gasoline is a 'manufactured' material generated by the combination of several refinery product streams. The production of these fuels generates distinctive chemical mixes that may be recognized in the chromatograms of the fresh materials. The chromatograms differ in the separation and relative heights of the component hydrocarbon peaks.

Quality assurance in the characterization of petroleum products by GC-FID is not merely a whim of the analyst, but can be dictated by certain reproducible, measurable observations. The boiling range of the material as determined from the chromatogram limits the number of possible product identifications that can be ascribed. The spacing of the peaks is dictated by the chemical composition of the product. The relative peak heights of the components are indicative of the chemical formulation. Consequently, the GC-FID trace immediately yields three points on which the identification or characterization any petroleum product must comply: boiling range; peak spacing; and relative peak height.

Weathering of petroleum products distinctly affects the GC-FID trace. Evaporation removes the earlier eluting peaks, while biodegradation and dissolution tend to selectively remove certain chemicals. While

these mechanisms can be recognized and distinguished in the GC-FID trace, they confound the principles of identification that were previously described. An evaporated product does not have the same boiling range as a fresh product; a biodegraded fuel will have different peak heights and peak spacing based upon the removal of certain classes of chemicals.

The principles of characterization of a weathered petroleum product are the same as those for a fresh product. The boiling range is diminished, but the high-boiling point will still match that of the original product. The peak heights of some components will change during biodegradation and dissolution, but other peaks are recalcitrant and will not change significantly during those processes. Thus, while the specific points on which an initial characterization had been made might have changed there are other related points on which identifications can be based.

Quality assurance requires setting limitations on the variability of the analysis – this principle is enforced in quantitative procedures but is never applied to qualitative analyses of environmental samples. Petroleum contamination can be characterized by GC-FID analyses using 'points-of-compliance' such as boiling range, peak spacing, and relative peak height. Those points of compliance may be quantified and applied objectively between samples and between labs to determine the accuracy of product characterizations.

Quality Assurance, Qualitative Analysis, Fingerprinting

C9 Age-Dating Leaded Gasoline Releases

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The goals of this presentation are to learn how to use the ALAS model in order to age-date leaded gasoline releases to the underground environment and how to evaluate the results for an environmental forensic litigation case.

Introduction

Richard W. Hurst introduced the ALAS (anthropogenic lead archaeostratigraphy) model at the 1996 National meeting of the American Society of Mass Spectrometry in Portland, Oregon. This model uses the changes in lead isotope ratios over time (in years) to predict the age of a gasoline from the organolead antiknock additives such as tetraethyl lead (TEL). The ALAS model used calibration samples from the literature as well as from gasoline collections. However, the major assumption is that these calibration points represented lead in gasolines nation-wide and were consistent over a one-year time period. This seems to be a "stretch" for either common sense or scientific data.

In a recent paper by Hurst[1], the ALAS model calibration has been verified by an independent method. Using the lead mining records and literature estimates of lead recycling, Dr. Hurst calculated the lead isotope ratios over time from these data. The correlation between the ALAS model obtained from samples and the ALAS model from lead used in the U.S. is excellent. (The correlation coefficient [R] for the time frame of 1950 to 1990 is 0.967.) This strongly supports the ALAS model's usefulness in age-dating leaded gasolines anywhere in the U.S. It also extends the ALAS model to the 1920s when TEL was introduced into gasoline.

How to Use the ALAS Model

Soils contaminated with a petroleum product(s) or a free phase petroleum product(s) from a soil boring or monitoring well is taken as a sample. A soil sample should contain a significant quantity of the petroleum product.

Step 1) Gas Chromatography with a Flame Ionization Detector (GC/FID)
The initial test is to determine what the petroleum product or products are. The easiest analytical method is to use GC/FID to "fingerprint" the petroleum sample. A solvent extraction is needed to prepare the soil sample for analysis. The free liquid product must be diluted with a solvent prior to analysis. If the product is at least in part gasoline, then the analysis is continued to Step 2.

Step 2) Gas Chromatography with an Electron Capture Detector (GC/ECD)
The solutions used in the GC/FID experiment can be used in the GC/ECD analysis if the solvent is relatively inactive for the electron capture detector. Step 2 is used to determine the presence or absence of the various organolead gasoline additives such a TEL. If the organolead additives are present, then the analysis is continued to Step 3.

Step 3) Determination of the Amount of Organolead in the Sample
There are two methods for determining the amount of organolead in the sample. The extract can be digested with nitric acid and total lead determined by Inductively Coupled Plasma (ICP) or Atomic Absorption Spectroscopy (AAS). The specific organolead compound or compounds can be determined using GC/ECD, if the standards are available, by quantitative GC methodology.

Step 4) Lead Isotope Ratio Determination
The sample is sent to a laboratory with a multicollector mass spectrometer for the measurement of the abundance of lead isotopes 204, 206, 207, and 208. These measurements are very accurate and precise. The data is calculated using a "delta" notation based on equation 1.

$$*^{206}\text{Pb ALAS} = 1000 \times \frac{[\text{Pb}^{206}/\text{Pb}^{207}\ \text{sample} - \text{Pb}^{206}/\text{Pb}^{207}\ \text{standard}]}{\text{Pb}^{206}/\text{Pb}^{207}\ \text{sample}}$$

The delta value from the mass spectrometric analysis of the lead isotope is used with the ALAS model to obtain the date of the organolead additive in the gasoline found in the soil or as a free liquid in the environment (Figure 1).

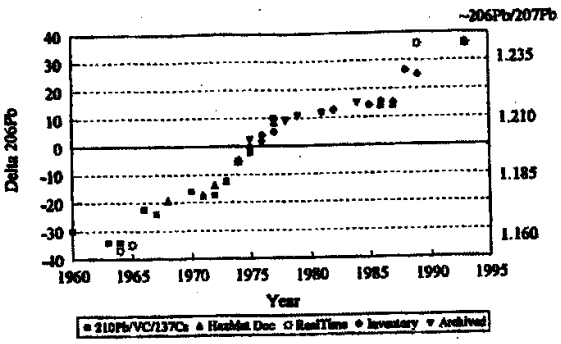

FIGURE 1: (FT)ALAS model calibration curve. (COP Richard W. Hurst, 1997; Hurst, 2000.)

What Does the Result Mean?

The interpretation of the ALAS model result is not trivial due to a number of factors.

1) Most corner gas stations that sold leaded gasolines did not sell premium leaded gasoline after 1981, sold leaded gasoline in 1985 that contained a lower concentration of lead than the immediate preceding years, and did not sell leaded gasoline after January 1986.[2]
2) The slope of the ALAS model of $*\text{Pb}^{206}$ versus time in years is such that age-dating is accurate to ± 1 to 2 years. Before 1965 and after 1985, the age-dating has a large error term due to the horizontal nature of the calibration curve.
3) The type of gasoline release at the site is also important. If there is a single catastrophic release, then the age-dating value is very good.

But most underground storage tank leaks are not catastrophic. These leaks are not consistent or constant. They depend on where the hole in the tank is located and how rapidly the hole corrodes to a larger opening. Piping leaks could be similar to tank leaks.

In these circumstances, the ALAS model result is a weighted average of the lead from years of a slow, leaded gasoline release. Thus, the ALAS model's error term is not the range of time for the release. This time range needs to consider the site history such as tank abandonment, documented releases, and the timing of leaded gasoline sales at the station to aid in rendering a time frame for the leaded gasoline release.

All of these interpretations are based on the knowledge that gasoline production, transportation, storage, distribution, and use is a short period of time compared to the year in the ALAS model.

Errors

Even with this careful, stepwise procedure one can obtain an erroneous result. Caution is especially important in a soil sample where native lead in the soil can be more abundant in the extract for the lead isotope measurement than the lead from the gasoline. In this case, an ethyl alcohol extract of the organolead from the soil will be better than the usual dilute nitric acid digestion.

Other Uses

Used motor oil contains wear metals and one of the most prominent wear metals is lead. Used motor oil from gasoline engines will contain a low percentage of gasoline and that gasoline may have been leaded. The same stepwise procedure is used for the used motor oil for age-dating purposes. Now the ALAS model result depends on the average age of the engine bearings as the source of lead wear metal. One needs to assume that the lead used for these engine bearings has the same history as the lead used to produce the organolead gasoline additives.

Cases

The presentation will use case studies to illustrate the ALAS model in environmental forensic applications.

Conclusion

The environmental forensic use of the ALAS model for age-dating leaded gas releases to the environment is scientifically defensible. The analytical chemistry needs to be done in a stepwise manner and caution is necessary to avoid background natural lead in soil from compromising the result.

1. Hurst, Richard W., "Lead Isotopes as Age-sensitive Genetic Markers in Hydrocarbons. 3. Leaded Gasoline, 1923-1990 (ALAS Model)," Environmental Geosciences, Vol. 9, No. 2, pp.43-50, 2002.

2. 40CFR, Parts 61 to 80, Subpart B-Controls and Prohibitions, 80.20, p. 1201, Rivised as of July 1, 1994.

Gasoline, Lead, Age-Dating

C10 Benzofluorene/Methylpyrene Ratios as a Source Identification Tool

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The goal of this paper is to present data in support of the use of benzofluorenes and methylpyrenes as a means of tracing environmental contamination to its source.

Polycyclic aromatic hydrocarbons (PAHs) often drive costly site investigation and remediation work. Former manufactured gas plant (MGP) sites frequently are contaminated by PAHs from one or more sources depending on their operational histories, and in many cases the nature of environmental work at MGP sites can depend on identifying the sources of the PAHs. However, identifying the sources of PAH contamination at MGP sites is complicated by the numerous possible PAH origins. Common anthropogenic sources of PAHs include coal tar and coal tar products, refined petroleum products, MGP wastes, exhaust from heating systems, vehicular emissions, and others. PAHs also are created naturally by forest fires and, in some cases, synthetically by bacteria and algae. As PAHs weather and commingle with PAHs of other origins, as is typically the case in industrial soils and urban sediments, identifying their sources proves increasingly difficult.

Current approaches for identifying sources of PAHs in soil, groundwater, sediments, and surface water at former MGP sites have largely relied on the molecular fingerprint or the relative abundance of individual PAHs or groups of PAHs[1]. However, this approach suffers from two major problems: first, there are many sources of PAHs and their PAH patterns can be very similar, and second, environmental weathering (dissolution, evaporation, and chemical and biological transformations) can alter the PAH patterns and confound their interpretation. Recent studies have shown that certain ratios of PAHs and alkylated PAHs are relatively insensitive to environmental weathering processes and can be used to distinguish separate sources with similar PAH patterns even in weathered samples. For example, the ratio of benzo(b+c)fluorine to total monomethylpyrenes was found to vary little in coal tar contaminated ediments that had weathered to various degrees (unpublished). The benzofluorenes/methylpyrenes ratio (BF/MP) depends on PAH formation conditions and is measurably different among different PAH sources. For example, the BF/MP ratio of a coal tar sample was found to be approximately 3.9 while that of a former MGP tar was about 1.5.

This presentation reports some of the results of research by META Environmental, Inc. to identify effective environmental forensic methods for application at former MGP sites[1]. The application of extended PAH profiles (EPA 8270 modified) and the use of various PAH ratios, especially BF/MP ratios for the determination of PAH sources in non-aqueous phase liquids (NAPLs), soil, and sediment will be discussed.

1. "Chemical Source Attribution at Former MGP Sites," EPRI Technical Report 1000728, December 2000.

PAHs, Environment, Litigation

C11 Age-Dating Diesel Fuel: Facts and Fallacies

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The goal of this presentation is to inform participants of some of the pitfalls of Age-Dating petroleum products.

Petroleum distillates, such as diesel fuel, heating oil, and fuel oil #2, have been in widespread use for nearly 100 years, with minimal changes to their manufacturing process and chemical composition during that time. They are also common environmental contaminants. The degradation of these products in the environment has been widely studied and is generally well understood to be comprised of three major pathways: biodegradation, evaporation, and dissolution. Biodegradation and evaporation are easily recognized in the traces of fresh and weathered products analyzed by gas chromatography with flame-ionization detection (GC-FID). Consequently, it is tempting to assume that the date of release or "age" of a petroleum distillate may be determined simply by comparing the chromatograms of the samples with known standards.

GC-FID is a chemical analysis process that separates the components in a mixture based on physical properties, primarily boiling point, polarity, and molecular weight, and detects them using their tendency to create ions in a flame. Thus, mixtures with similar chemical composition will have similar GC-FID traces. Hydrocarbons are commonly grouped in chemical classes of aliphatics (alkanes and isoalkanes), naphthenes (cylcoalkanes), aromatics (BTEX), polycyclic aromatic hydrocarbons (PAHs), and olefins (alkenes). The hydrocarbons seen in the GC-FID traces of diesel fuels generally form a pattern of tall, regularly spaced peaks interspersed with

shorter, irregularly spaced peaks, all surmounting an unresolved "hump." The tall, regularly spaced peaks are n-alkanes and the shorter, irregular peaks are generally isoalkanes, some of which belong to a particular chemical class called "isoprenoids" (branched alkanes based on the structure of isoprene.) The majority of the material in a middle distillate fuel will elute between n-C_{10} and n-C_{25} on the GC-FID chromatogram.

The process of evaporation is so common that it is sometimes over-simplified, particularly when applied to mixtures, such as diesel fuel. The GC-FID chromatogram of a diesel fuel that has evaporated at ambient temperature and pressure is quite distinctive, showing a loss of most of the hydrocarbons lighter than n-C_{12}. However, useful reference standards of evaporated diesel fuel are more difficult to generate because a diesel fuel distributed over a large surface area, such as a surface spill on sandy soil, will evaporate very differently from the same fuel confined in a column of product such as might be found in a monitoring well. A rate of evaporation of bulk material determined at standard temperature and pressure cannot be reliably applied, either directly or indirectly, to the evaporation rate of identical material distributed in the environment.

Biodegradation of diesel fuel by microbial populations has been described by many researchers. It generally follows a pattern based on the chemical structure: e.g., n-alkanes will be lost more rapidly than isoalkanes, which will in turn be lost more rapidly than PAHs. However, the actual rate of biodegradation of any of these chemical classes varies with the type(s) of microbial population(s) present, the temperature, moisture, pH, oxygen, and nutrient content of the environment, the geometry of the spill, etc. Thus, while the amount of biodegradation may be described (e.g., highly biodegraded, slightly biodegraded) for a petroleum product by looking at the relative levels of n-alkanes versus isoalkanes in fresh and weathered materials, it is not possible to determine the age of the material, as the rate of loss of these components over time has certainly not been constant. In addition, some hydrocarbons are known to occur naturally and some are created during the biodegradation process, further confounding the determination of age based on the apparent losses of the peaks in the GC-FID chromatogram.

Despite the many factors confounding the empirical determination of degradation rates for diesel fuel in the environment, it is still possible to measure and estimate the TPH concentrations and the individual component concentrations for environmental samples. It is possible to determine relative amounts of degradation from these data. The measured amounts of degradation may be related to the samples' situation in the environment, and from that information a relative age may be assigned. For example, two samples that appear to have undergone identical types and amounts of degradation but which were collected at different distances from the source may be inferred to have different ages; and similarly, two samples that were collected at the same distance but which show different amounts of degradation may be different from each other in age, assuming all other factors to remain constant.

The accuracy of these relative determinations is a function of the number and distribution of the samples collected and analyzed. It is also important to note that these determinations can only be relative: sample 'A' is older than sample 'B'. Unless a set of samples can be related to a particular date, either by knowledge of a specific release or site activity, it is not possible to age date the contaminant.

The environmental processes that degrade middle distillates, such as diesel fuel, can be recognized from GC-FID analyses, and rates of degradation can be experimentally determined. However, there are no empirical formulas to describe the rate of degradation of diesel fuel in the environment. The confounding interactions of evaporation, biodegradation, and biotransformation make it impossible to 'age-date' petroleum distillates. It is possible to estimate or measure the amounts of material lost from the original material in the environment, and relative amounts of degradation may be calculated for field samples, which may be used to infer relative aging of the material. However, such estimates are subject to great uncertainty unless the sampling and analysis meets specific data quality objectives.

Petroleum Products, GC-FID, Diesel Fuel

C12 A Potential Metallographic Technique for the Investigation of Pipe Bombings

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The goal of this presentation is to discuss a potential method for identifying the explosive fill used in a pipe bomb by examining collected fragments using standard metallographic techniques.

Three common pipe materials, ASTM A53 low carbon steel, AISI 304L stainless steel, and 6061 aluminum, were shock loaded using five high explosives and three propellants. The explosives used were ANFO, nitroglycerine-based Dynamite, flake TNT, C6 detasheet, and composition C4, the propellants studied were 4F black powder, Red Dot smokeless powder and, in the case of A53 steel, Turbo Fuel A (Jet A). The post-blast microstructure, microhardness and, in the case of the steel tests, macro-hardness were examined for each test. Additionally, X-Ray diffraction (XRD) was preformed on the 304L fragments to determine the amount of a martensite induced by a shock, and high-pressure liquid chromatography (HPLC) was run on residue collected from 6061 fragments to detect the presence of the test explosive in the post-blast residue.

The explosives ranged in detonation velocity from a few m/s, for the black and smokeless powders to over 8 km/s for C4. This induced a pressure in the steels ranging from essentially ambient pressure to over 45 GPa, and a range of essentially ambient to 35 GPa in the aluminum. Significant amounts of shock heating were also seen in each material at the high end of the detonation velocity and pressure range in these tests, with a maximum temperature rise of over 200^{O}C in the aluminum and low carbon steel and a maximum temperature increase in the stainless steel of around 120^{O}C. The discrepancy in temperature rise in 304L as opposed to A53 and 6061 can be attributed to the low value of the empirical constant (s) and high value of the bulk sound speed (C_0) for 304L, which dictate the shape of the Hugoniot, and the response of the material to shock loading. The 304L Hugoniot exhibits less concavity than the A53 and 6061 Hugoniots, meaning less work is lost in heating the material.

There was a strong correlation between the microstructure of fragments and the detonation velocity and pressure of the explosive used. This trend being that there was more material flow and grain damage, in some cases even recrystallization, as the detonation velocity of the explosive and the pressure generated in the material increased.

Material hardness showed a sharp increase, followed by a plateau as the shock pressure and explosive detonation velocity increased. This trend was observed in all the materials, although material softening due to shock heating recovery and recrystallization was seen in aluminum in the pressure and velocity range studied.

X-Ray diffraction patterns were used to calculate the amount of shock-induced martensite present in the post-blast microstructure of 304L fragments. This property showed the same trend as did the hardness data, namely a sharp increase in microstructure with shock, followed by a plateau as pressure increased. A decrease in martensite formation due to shock heating was not observed over the pressure range studied.

These studies were done in the hope that a metallographic method could be developed for the investigation of pipe-bombings. While many of the results in this work are qualitative in nature, the trends seen are definite and promising. With further study, these methods could be quantified and applied to the field of forensics as a powerful investigative technique.

Pipe Bombs, Metallography, Forensics

C13 Arson or Accidental Flashback?—Sorting Fact From Fiction

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The goal of this presentation is to provide some insight into the objective evaluation of expert witness opinion and testimony that may initially appear realistic, but which may in fact be flawed and inappropriate.

There is an increasing reliance on experts in the assessment, reporting, and resolution of insurance loss episodes, and of claims and counterclaims arising from such loss episodes. Regardless of how the resolution of such a matter is attained by various parties, be it settlement, mediation, arbitration, or trial in a court of law, dependence on expert opinion will frequently be a key factor in determining the outcome.

The fact that different experts may express differing opinions on the same matter will present a dilemma to those who would rely on expert opinion to guide the resolution of a matter under dispute to a true and just decision. Added to this delicate balance is the fact that some experts may – either by accident or by design – present an opinion which is intended to serve the interest of their client before serving the interest of truth and justice. When such an opinion is packaged in the shroud of scientific and engineering jargon, it may appear to be quite convincing even though it is not completely accurate.

A truly objective forensic expert will periodically be faced with the challenge of identifying, explaining and hence, unmasking the flaws of an opposing opinion, an opinion that is in reality partisan to the case of one party over another.

This presentation will review the salient details of an actual case history that was resolved at trial. The matter before the court dealt with a fire loss that resulted in an insurer denying a claim on the basis that the insured had committed arson. The insured claimed that the fire was caused accidentally, and denied that arson was committed and sued the insurer for breach of contract.

Furthermore, as is often the case in such matters, the insured had been previously charged with the criminal offence of arson, but was acquitted at trial because he was given the benefit of reasonable doubt. At the criminal trial, no expert or expert opinion was introduced to the court on behalf of the accused.

In preparation for the subsequent civil trial, which followed the acquittal of the insured on criminal charges of arson, counsel for the insured now retained the services of an expert. The expert put forward the notion of accidental flashback as an explanation for the cause of the subject fire, thereby negating the allegation of arson by the insured.

In a civil trial, while the plaintiff must prove their case, the final decision will be made on the balance of probabilities, as compared with a criminal trial, where there is a presumption of innocence, and hence the accused must be given the benefit of doubt. If the plaintiff's expert in a civil trial that will materially alter the balance of probabilities can introduce a scientific opinion, this may be sufficient for the plaintiff's case to effectively succeed at trial. This is a delicate process that could work if it effectively strengthens the plaintiff's case by simply weakening the defendant's case. Note that in so doing, no overwhelming factual evidence need be introduced by the plaintiff's expert. That is, the plaintiff's case was not strengthened by the introduction of important evidence, but rather by simply diluting the strength of the defendant's case, instead.

As will be demonstrated in this presentation, the careful and objective forensic engineering assessment of every detail associated with the plaintiff expert opinion and hypothesis concerning flashback resulted in identifying a subtle but important flaw. Once exposed, and removed from the hypothesis, the flaw rendered the hypothesis of flashback as being not merely improbable, but clearly impossible.

Finally, it was absolutely necessary that the identified flaw be checked and crosschecked to assure its validity. This presentation will explain how, through the use of parallel forensic experts, the flaw was checked, tested and confirmed absolutely. When the flawed hypothesis was exposed in a clear, concise, and objective manner at trial, the plaintiff's case was totally destroyed and his claim was dismissed.

Arson, Expert, Flashback

C14 An Overview of the ATF Fire Research Laboratory

Scott E. Dillon, MS, Stephen Hill, MS, and David Sheppard, PhD, Bureau of Alcohol, Tobacco and Firearms, Fire Research Laboratory, 1401 Research Boulevard, Rockville, MD, 20850*

The goal of this presentation is to educate the forensic community about the fire testing and research capabilities that the ATF (Bureau of Alcohol, Tobacco and Firearms) FRL (Fire Research Laboratory) can provide to fire investigations.

The FRL is the first scientific research laboratory in the U.S. dedicated to supporting the unique needs of the fire investigation community. Research is crucial to understand the scientific principles associated with fire ignition, growth, and spread. This information is critical for accurate fire scene reconstruction and to develop reliable scientifically valid theories for effective criminal prosecutions. At the present time, there are no fire research facilities in the U.S., or elsewhere, dedicated to the specific needs of the fire investigation community. The FRL will provide the necessary facilities, equipment, and staff to work on important fire investigation issues such as fire scene reconstruction and modeling, flashover studies, validation of fire pattern analysis indicators, impact of accelerants on fire growth and spread, ignition studies, and electrical fire cause analysis. This presentation will focus on the capabilities of the FRL, the lab's state-of-the-art facilities and equipment, and the benefits that the FRL can provide to fire investigators and the forensic fire research community.

Fire Testing, ATF Research Lab, Fire Investigation

C15 The Use of Fire Modeling in Fire Investigations: Overview and Case Studies

Scott E. Dillon, MS, Stephen M. Hill, MS, and David Sheppard, PhD, Bureau of Alcohol, Tobacco and Firearms, Fire Research Laboratory, 1401 Research Boulevard, Rockville, MD, 20850*

The goals of this presentation are to educate the forensic community about the potential use of computer fire modeling in fire investigations.

The presentation will focus on FDS (Fire Dynamics Simulator), a computer-based computational fluid dynamics fire model. By providing inputs regarding the building, available fuels, and fire scenario, the model makes dynamic predictions of the fire physics throughout the fire duration, including temperature, visibility, heat flux, gas concentrations, smoke spread, and fire spread. Three-dimensional graphical visualizations (animations) can be created from the modeling results that are representative of the fire scene. Fire modeling can be used to simulate a fire event in an attempt to compare predicted burn patterns and reported fire behavior to those observed at the scene. These simulations can help fire investigators better understand the modes by which a fire could grow and spread throughout the space and the effects that the smoke and heat can have on the building and its occupants. Variables such as open doors and windows, fuel load, and fire growth may be changed easily and used to analyze multiple fire scenarios or to perform a sensitivity analysis on a particular scenario. Fire modeling can also be used to support or discredit

eyewitness statements and assist in developing a more accurate timeline of events. Where possible, fire scenarios may be physically reconstructed and burned in a laboratory environment to gain actual fire test data. By comparing test data to the model predictions, the model can be calibrated and used for further simulations when additional fire tests are not economically feasible. The presentation will provide examples for the uses described above and illustrate the benefit of utilizing FDS in a fire investigation.

Fire Modeling, Fire Investigations, Fire Dynamics Simulator

C16 A Flaming Farm Gasoline Tank Turned Into a Rocket

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The goals of this presentation are to describe a strange disastrous and lethal event, which may well happen again, as is apparent after determining the cause. Beware the circumstances and note the conditions!

The subject gasoline storage tank was the standard type erected on a steel stand above ground, the type used on farms in Canada and the U.S. It had two compartments each with a top filler cap and each with a pressure relief valve. These standard tanks have a gravity flow coming from each compartment, each with an external valve/hose and a standard hand nozzle/closing valve similar to gasoline service stations.

Both tanks had been filled on the previous day. It was hot spring weather. Vented gasoline vapors from the rear compartment filler cap ignited producing a 6-10 ft. flaming torch over the filler cap. The cause of ignition was never determined although it is strongly suspected that the power company's service Triplex was the cause as it passed directly above the tank and there was certain metallurgical evidence on the Triplex cable which supported such a suspicion.

Rural neighbors and the local village fire department gathered at a "safe" distance. The rear compartment of the tank exploded blowing the end out of the compartment driving the tank 400 feet across the farmyard at which point it threw flaming fuel on a spectator neighbor family. Tragically this family was virtually wiped out, three children and the mother - truly a Greek tragedy!

One sentence of the statement made by a witness spectator confirmed the cause of the explosion and the rocket launching. The author will explain all with photographs and diagrams. Perhaps the classic Hollywood gas tank explosion is not entirely imagination and drama - is there a real danger of a similar occurrence?

The conditions and situation required for such an accident will be explained and those conditions are obvious once the cause is determined.

Gasoline Storage, Explosions, Gasoline Precautions

C17 Analysis of an Alleged Premature Air Bag Deployment—Achieving Firm Conclusions With Limited Vehicle Data

William Rosenbluth, MSEE, Automotive Systems Analysis, Inc., 12015 Canter Lane, Reston, VA*

The goals of this presentation are to explain the detection and calculation methodology of a single point crash sensor, and then explain a methodology to prove an improper response of such a single point air bag crash sensor by using mechanical component analysis. This mechanical component analysis confirmed, with a reasonable degree of engineering certainty that the single point sensor responded to a below-deployment-threshold impact velocity change.

Theory of the Analysis: Analysis of crash events in contemporary vehicles considers both magnitude and principal direction of force (PDOF) as shown in Figure 1. When those crash contemporary air bag deployment controllers evaluate events, that evaluation is usually accomplished by single point crash sensing *transducers*, which provide a ratiometric electrical voltage output representing the physical acceleration magnitude of a crash event. For frontal air bag deployment systems (or subsystems), the crash detecting sensors are aligned to detect force inputs in the -X axis direction, as shown in Figure 1. Thus, any off-axis crash force input must be geometrically corrected in order to properly characterize the crash sensor response. Figure 1 shows one such correction.

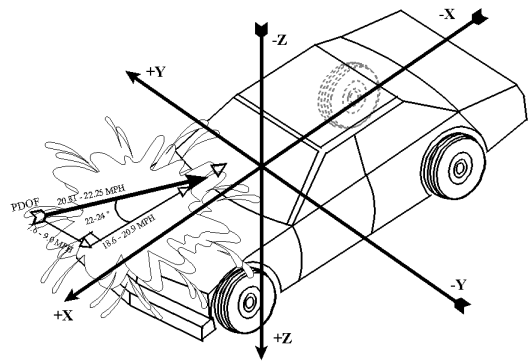

Figure 1

The transducer used in contemporary single point crash sensors is a solid-state accelerometer. An accelerometer is a transducer, which translates an input mechanical quantity (acceleration) into an output electrical quantity (volts). More precisely, the transducer responds to a change in velocity produced by a vector component of the force exerted on vehicle (acceleration, $a =)V_{-x}/t$), and produces a differential electrical signal (voltage difference from a quiescent voltage value) proportional to that acceleration (vector component).

The sensitivity of accelerometers is usually expressed in terms of units of standard electrical output (volts) per units of a standard acceleration (gravity, "Gs"). In operation, the accelerometer output (volts/G) is converted into a digital numeric value by an Analog/Digital (A/D) converter, usually incorporated internally within a microcontroller within the single point crash sensing assembly (SRS ECU). In order to evaluate the crash magnitude, and, thus, make a deploy/no-deploy decision, a time series of those converted digital values, saved in digital memory, are filtered, integrated and evaluated by the control program for the microcontroller to calculate a Delta V and oscillation profile of that crash event. Those calculated Delta V and oscillation profiles (short term variations in acceleration values) are then compared to desired deployment thresholds or data tables, so that a valid deploy/no-deploy decision can be made. Figure 2 shows an amplified schematic of that process.

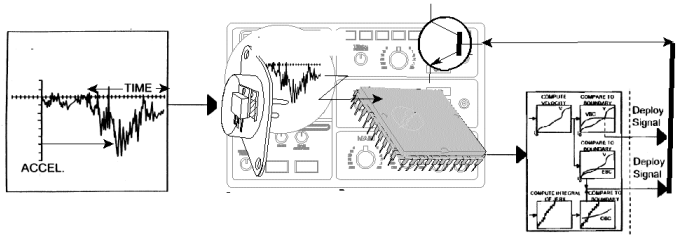

Figure 2

In the subject case, the air bags in a 1994 Volvo 940 were deployed by a single point sensing controller as described above, and caused injury

to the driver. However, the vehicle physical damage did not appear to be consistent with the established deployment criteria. The manufacturer's expert opined that, because the air bags were deployed, the crash magnitude had to be above the proper threshold, thus, assuming that the single point sensor was "infallible," and that there was certainly no defect in the system. Because of this variance in observed versus assumed data, I was asked to investigate this matter.

Notwithstanding assumptions of infallibility, there are conditions that can cause a single point sensing controller to misfire its associated air bags. Examples of these include:

A. The faulty use of A/D range shifting wherein, for certain program branches, an acceleration voltage translation done at a 10 bit resolution is actually evaluated at an 8 bit resolution, and the result of a faulty translation is that the acceleration digital value evaluated by the microcontroller algorithm is actually 2x or 4x the correct value.

B. The accelerometer transducer can have various sensitivity modes (volts/G) dependent on installation circuitry and on potential electrical artifacts (short circuits - open circuits) on the printed circuit board in the SRS ECU. Such sensitivity variations can range from null (zero output) to 2x the expected sensitivity.

With such potential conditions, one cannot simply assume that the crash sensor is always infallible in its judgement of crash magnitude.

In the subject accident, the Subject Vehicle (SV), a 1994 Volvo 940, was entering a parking lot when it contacted the rear end of another vehicle (1990 Toyota Wagon). The air bags in the 1994 Volvo deployed and the driver was injured. After the accident the Toyota was driven away, and the Volvo was towed. The driver of the Volvo estimated that she was going 8-10 mph maximum.

A photographic observation of the SV revealed no significant-discernable impact damage. The driver of the 1990 Toyota stated that there was no structural damage to her vehicle, and this was confirmed by Toyota mechanics. Neither of the vehicles was available for inspection.

The only evidentiary materials consisted of a Volvo investigation report, done at the time of the accident, which confirmed the following artifacts:

A. Both left front (LF) and right front (RF) air bags deployed, and the seat belt pretensioners deployed (all fired by a single firing criteria). There were SRS fault codes (DTCs) indicative of an air bag deployment.

B. The knee bolster cover panel was kicked off as a result of the accident.

C. The impact was frontal, distributed across the front bumper only.

D. There was scuffing of the front bumper, and it was separated from its right side guide.

E. The two front collision isolators stroked 24 mm each (both LF and RF).

F. No structural damage to the Volvo was noted.

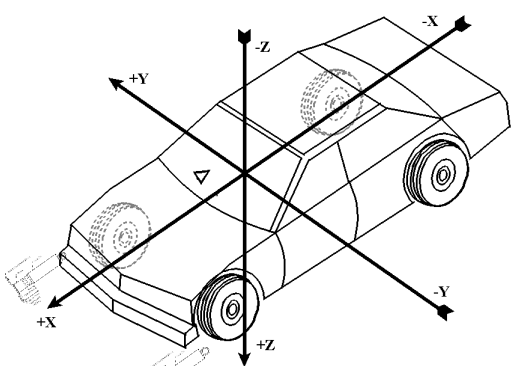

Figure 3

Given this minimum fact set, and the unavailability of the subject crash sensor for purposes of reading its EEPROM crash record, the author proceeded to initiate an analysis of the available data regarding forces in the subject collision. The only collision-force-related artifact was the collision isolator data. Collision isolators serve to insulate the vehicle from minor damage by allowing (restorable) bumper stroking, up to a hard damage limit. They are usually positioned in the front and rear bumpers as shown in Figure 3.

Stroking definitions and collision isolator detail are shown in Figure 4.

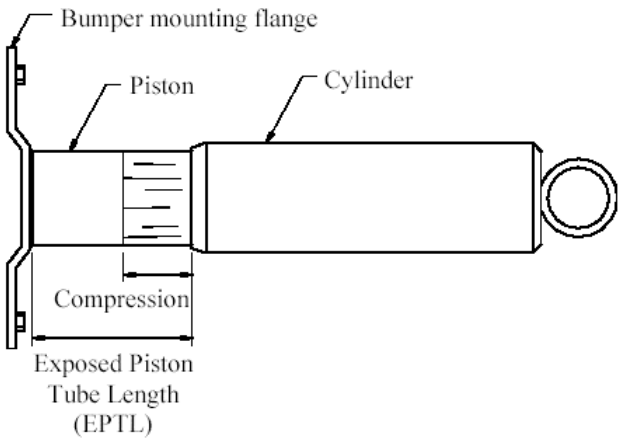

Figure 4

In this case, in order to evaluate the subject Volvo isolator data, the author contracted for a collision isolator analysis with David King, MacInnis Engineering, Lake Forrest, CA. He proceeded to use an instrumented moving barrier with exemplar Volvo isolators in order to characterize their response with respect to the data point noted in the Volvo report (24 mm stroke).

The replacement isolators were dynamically tested following the protocol set out in an SAE 1999-01-0096, "Comparison Testing of Bumper Isolators." In that protocol, a single isolator is mounted to the front of a moving barrier that was rolled into an instrumented fixed barrier at varying speeds. For each test, the isolator compression, moving barrier speed and the time-varying nature of the collision force were measured. The test data were then scaled to correct for the mass difference between the moving barrier (722 kg) and the 1994 Volvo 940 published mass (1454 kg plus 66 kg 50th percentile female). Thirty-five tests were done with the right front isolator and eighteen tests were done with the left front isolator.

The results of the exemplar collision isolator analysis show that the speed change associated with 24 mm of compression is approximately 4 mph. That is, if a 1994 Volvo 940 was rolled into a fixed barrier such that the average front bumper isolator compression was 24 mm (both isolators), the vehicle would have sustained a 4 mph speed change into the barrier. A graphical summary of that analysis data is shown in Figure 5.

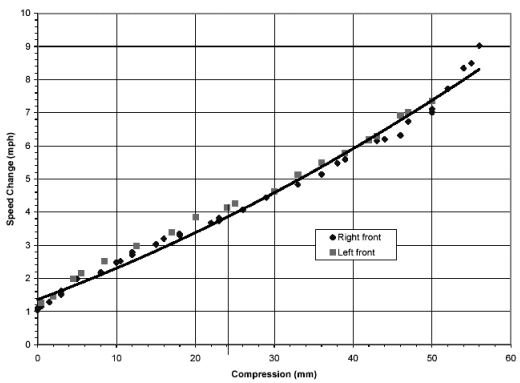

Figure 8. 1994 Volvo 940 front isolator test results. The vertical line crosses the X-axis at 24 mm compression. This represents a speed change of 4 mph.

Figure 5

That velocity change characterization is also known as a barrier equivalent velocity (BEV). However, in a collision between two reasonably similar vehicles (which do not behave like barriers, and are considerably "softer" than barriers), the BEV tends to approximate ½ the closing velocity between the two vehicles. This helps to explain the witness reports that the Volvo was traveling at approximately 8-10 mph when it hit the Toyota, and, thus, demonstrated probable witness veracity.

The 1994 Volvo fixed barrier speed change thresholds (BEV) were specified to be:

A. Less than 8 mph ==> must-not-fire
B. Greater then 12 mph ==> must-fire

Thus, using a scientific method to evaluate the only data available to us (and that being defendants' own investigation data), it was confirmed with near certainty that the Volvo air bag controller appeared to have fired its air bags at a BEV well below its specified must-not-fire threshold. The case settled to the satisfaction of the parties.

Air Bag Crash Analysis, Air Bag Premature Deploy, Collision Isolator Analysis

C18 Crash Testing to Validate Accident Reconstruction

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The goals of this presentation are to discuss analysis and reconstruction of a two-vehicle accident and to present crash test measurements that validated independent reconstruction methods.

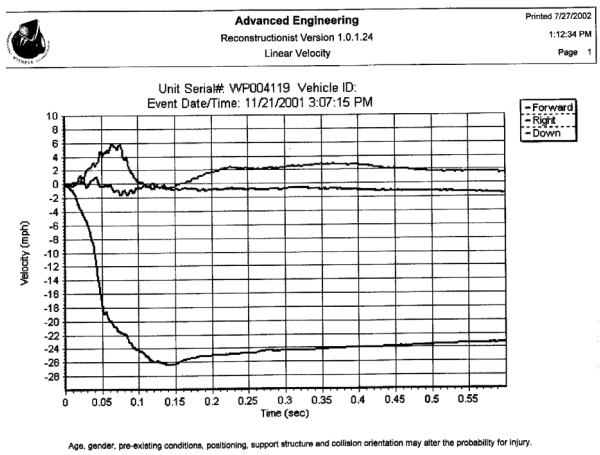
The accident in question occurred during an especially foggy morning on a mountainous four-lane highway. A late model pick-up truck was carrying two passengers northbound on this highway. A large, unarticulated flatbed transport truck was traveling on a road intersecting the highway. According to police and witness statements, the thick fog limited visibility to 150 to 200 feet. Seeing no oncoming vehicles, the flatbed truck driver pulled onto the highway in an attempt to turn left onto the southbound lanes. As the flatbed was pulling out, the pick-up truck approached the intersection. The pick-up skidded for approximately 60 feet and struck the driver's side of the flatbed. As a result of the collision, the two passengers in the pick-up endured fatal injuries.

In order to reconstruct the accident, inspections of the vehicles and surveys of the accident site were performed. The analysis involved application of two independent methods. The first method employed the conservation of linear momentum. Due to the accurate scene data and minimal rotation involved, the linear momentum model was deemed to be applicable. This analysis revealed that the pick-up truck was traveling approximately 54 miles per hour at impact. Given the pre-impact skids, the pick-up truck was traveling at 64 miles per hour prior to braking. The collision caused the pick-up to be driven backwards approximately four feet from the impact point. As such, the approximate change in speed, or ΔV, from momentum was 54 miles per hour.

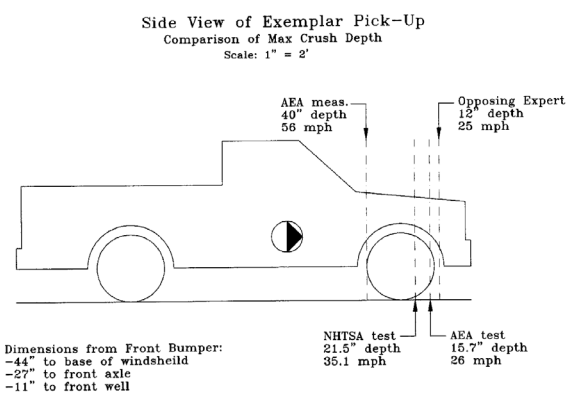
The second method involved use of crush measurements and appropriate stiffness parameters for the vehicles. Application of this data into EDCRASH revealed that the pick-up truck's ΔV was of the order of 56 miles per hour. The crush measurements were based on the vehicle inspections, which indicated that the crush extended to the firewall of the pick-up. Furthermore, the impact shortened the pick-up truck's wheelbase by nearly a foot. The stiffness parameters for the pick-up were culled from NHTSA crash tests of the same model vehicle. These NHTSA crash tests were performed at 35.1 miles per hour. The NHTSA crush deformation measurements were 60-65% of the values measured on the pick-up involved in this collision. The NHTSA crash test speed and crush depths were consistently less than the calculated speeds and measured crush for the pick-up. As such, the NHTSA crash data seemed to qualitatively validate the analysis.

This accident had also been reconstructed by other experts acting on behalf of the opposing side. These experts stated that the collision produced ΔV=s of 18 to 20 miles per hour for the pick-up. They placed a limit on the collision by stating that the pick-up was traveling at no more than 25 miles per hour at impact. This limit resulted in a speed of 45 miles per hour for the pick-up prior to skidding. The opposing experts performed an analysis using crush deformation. These experts stated that the maximum crush on the pick-up extended only 12 inches from the front bumper, and thus the maximum ΔV was 25 miles per hour. This 12-inch depth corresponds to deformations extending only to the front of the front wheel wells. It should be noted that the opposing expert entered the crush deformation code to indicate that the maximum penetration extended to the firewall and front windshield.

In order to determine the validity of the reconstructions, a crash test was performed using the same make pick-up. This pick-up was dragged into the same flatbed truck that was involved in the accident. The actual collision was distinguished by the impact of the pick-up's front end into the rear tandem wheels and a steel storage box of the flatbed. An exemplar steel storage box had since been built and installed at the same location on the flatbed truck. In order to analyze the crash, black box instrumentation was installed to record ΔVs and linear and angular accelerations. The black box was installed on the floor of the cab at the vehicle's centroid. This test was performed by dragging the exemplar pick-up at a speed of 25 miles per hour. The results of the crash were recordings of a 26 mile per hour ΔV and a forward deceleration of approximately 40 g's. A graph of the measured ΔVs recorded by the black box are displayed below.



Following the crash test, the exemplar pick-up was measured to determine its crush profile. These measurements revealed that the maximum extent of penetration was 15.7 inches, or just beyond the front of the front wheel well. The crash test produced no shortening of the wheelbase. Below is a diagram of the pick-up.



* Presenting Author

From a review of the photographs taken during the vehicle's inspection, it is obvious that the impact-induced crush extended beyond the front axle and to the firewall. Conversely, photographs of the crash tested pick-up reveal that crush did not extend to the front axle.

The measured decelerations are critical in determining the speed of the pick-up at impact. Cadaver experiments have shown a direct correlation of occupant injuries to increasing decelerations. This correlation was revealed by a linear relation between pressure and acceleration data in the same cadaver tests. Reports have shown that injuries to the heart occur at 150 g's, while the threshold of serious head or brain injury occurs at 179 g's. The damage to the interior of the pick-up revealed that the passengers died of either head or chest trauma. The 40 g deceleration, which corresponds to a 26 mile per hour ΔV, does not appear to be sufficient to cause serious injury or death. Applying a 56 mile per hour ΔV, the corresponding deceleration is 187 g's, which is above the thresholds for serious head and chest injuries.

All of the evidence indicates that the pick-up was traveling approximately 54 miles per hour at impact. As such, the pick-up's speed prior to skidding was excessive for the foggy conditions. Given the limit of visibility, a time-motion analysis revealed that the pick-up could have completely avoided a collision if it had been traveling between 43 and 51 miles per hour prior to braking. None of the physical evidence is consistent with the opinion that the pick-up struck the flatbed at 25 miles per hour. The crash test and accompanying instrumentation validate the employed reconstruction methods and contradict the opinions of the opposing experts.

Crash Test, Crush Deformation, Delta V (ΔV)

C19 Techniques of Analysis of a Log Truck/Pick-Up Collision

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The goal of this presentation is to describe the unique steering characteristics of log trucks and a practical means of demonstrating braking performance of vehicles in tow.

On July 8, 1999, on U.S. Highway 101, near Humptulips, WA, a northbound pick-up truck towing a recreational trailer emerging from about a three degree right curve collided with the loaded trailer of a "long" log truck which had entered the highway from the east and was turning south. A passenger in the pick-up brought suit naming, among others, the state, alleging improper signage and failure to cut roadside vegetation so as to maintain visibility.

More than a year after the accident, position of the log trailer wheels and the pick-up truck at impact were determined by a combination of the record of tire marks and other scene artifacts and the impact-caused deformation of the pick-up. Next, the path of the log truck and its trailer were developed to determine the distance the log truck traveled after it started forward from its stop before entering the highway. The paths of the wheels of the truck/tractor's front (steered) wheels and its tandem dual drive wheels were relatively straightforward. However, the log bunks on the truck/tractor were forward of the "bogey" of the driving axles and the "stinger," or coupling, of the trailer "reach" was well aft of the driving axles.

On a long-log trailer, the trailer is actually towed by the logs and all acceleration and deceleration forces are transmitted by friction between the logs and the front and rear bunks assisted by whatever binders are used. Both bunks pivot on their supports and the "reach," a long tubular steel section, is free to slide within a sleeve in the trailer frame. Thus, when the tractor starts a left turn, the logs connect the bunks at a constant distance, but the reach coupling would be to the left of the log centerline so that the reach would slide forward within the trailer sleeve and turn the trailer to the right with respect to the log centerline. This action has the effect of significantly reducing the off tracking of the trailer and enables the log truck to negotiate the mountain roads of the northwest forests.

Monitoring acceleration rates of similarly loaded log trucks at the site gave a reasonable approximation of the acceleration of the log truck entering the highway. Then an iterative process varying the time rate of steering and plotting the paths of the truck/tractor and trailer was performed until the path of the tractor stayed within the limits of the roadway and the trailer passed over its position at impact. The time intervals were then calculated from the log truck's start at the stop line to its position at impact and various intermediate positions.

Photographs taken at the time of the accident compared with measurements at the scene during the investigation gave a basis for determining the probable sight lines at the time of the accident.

Examination of the recreational trailer being towed by the pick-up truck revealed that the electrical system of the brakes functioned properly but the brake drums were worn. The brakes were also out of adjustment, and three of the four drums were contaminated with grease.

Another expert was reported to have towed the R.V. trailer with a similar pick-up and had determined that, when the brakes were applied, a deceleration of 0.4 g's was measured using a G-analyst.

Analysis of the accident indicated that, at impact, the speed of the log truck was 15 to 17 mph and the speed of the pick-up was 27 to 33 mph after leaving 246 feet of skid marks from the pick-up. Using the measured braking capability of the pick-up and trailer combination, an initial speed of 61 to 64 mph was calculated. The speed limit was 60 mph, but a speed advisory plate for the intersection indicated 40 mph.

There was dispute about the sight distance available at the accident scene because of roadside vegetation. However, using the accident photos, the nearest position at which the approaching pick-up driver could have seen the log truck in the intersection was determined. An actual run of a similar vehicle being decelerated at 0.4 g's demonstrated that from a speed of 60 mph, the pick-up truck could have been stopped in time to avoid the accident. Using the opposing expert's measurements avoided the argument about drag factors.

It was further shown that the pick-up driver could have avoided the collision by simply steering to the right in his lane, rather than jamming on the brakes and skidding the pick-up to straddle the line and impact the log trailer. It was also found that the positioning of the warning signs conformed to the state standards.

Recognition of the major contribution to the cause of the accident by the pickup driver facilitated a settlement of the case.

Log Trailer, Pick-Up, Braking

C20 Analyzing a Fuel Circuit to Prevent Post-Accident Fuel Fed Fires

Holly A. Adams, BSME, and William Rosenbluth, MSEE, Automotive Systems Analysis, 12015 Canter Lane, Reston, VA*

The goals of this presentation are to analyze an OEM fuel delivery system for functionality specifically related to fuel cut-off in the event of an accident. Then to show an alternative cut-off system utilizing an inertial switch that decreases the chances of an unwanted post-accident fuel run-on.

Theory of the Analysis: The case that prompted this analysis involved a 1995 small pickup truck. The subject vehicle received a frontal impact from the rear-end of an overturned 1988 sedan that had lost control and already impacted one other vehicle. After the impact, the driver of the pickup was trapped inside. A fire started, became obviously fuel fed, and the driver was burned inside of the subject vehicle.

The first question that arose was whether the fuel came from the subject vehicle or the sedan. Careful examination revealed that the fuel did not come from the sedan, as first thought, but from a damaged fuel line

in the pickup's engine compartment. The subject accident was so severe that the pickup's engine was displaced rearward and downward into the firewall. The impact with the firewall broke a hexagonal fitting on the rear of the engine where the fuel line attached. This discovery led to tests on an exemplar vehicle and the construction of a model to determine under what conditions would the subject fuel system continue to circulate fuel.

The stated operating pressure of the subject fuel system is 37-45 psi, as measured between the fuel filter and the engine. However, tests on an exemplar vehicle showed that the fuel system would continue to idle (circulate gasoline) with an operating pressure of approximately 10 psi, well below its stated operating pressure. Additionally, at first the subject fuel delivery system's main shut-off mechanism appeared to be the oil pressure switch (which is a separate hydraulic circuit from the fuel pressure circuit). However, subsequent exemplar vehicle tests showed that the oil pressure switch did not even need to be connected for the engine to run and fuel to circulate, as long as the circuit was primed. This confirmed that all of the control was through the subject vehicle's engine computer and fuel pump relay.

In the event of crash-induced fuel system damage, the fuel pump can continue to run under the following circumstances:

1. The engine continues to idle after the crash.
2. The (redundant) oil pressure switch contacts become shorted.
3. The prime connector becomes shorted to a positive battery line with the engine not running (i.e., the fuel pump relay is deactivated).
4. The PCM sends an errant signal.
5. The fuel pump relay sticks.

None of the avenues for emergency fuel shut-off in the subject vehicle involved directly removing power to the fuel pump.

A well known and defined system existed in the industry at the time the subject vehicle was designed and manufactured that would remove power from the fuel pump in the event of a crash. This system utilized an inertial cut-off switch inserted into the fuel pump's primary power supply line. These inertial switches can be calibrated to each vehicle, and, when activated (opened), they directly disconnect power supply to the fuel pump, regardless of whether or not the engine is still turning. The simple insertion of this switch dramatically reduces the amount of fuel that can be lost through a crash-induced fuel system leak. The difference in the amount of fuel lost between the two systems was documented on video through the use of a model.

Discussion: As was shown and documented in testing, the insertion of a simply device can have a major effect on unwanted post-crash fuel run-on. This device has been used by other manufacturers in their production vehicles for many years and has proven its functionality. By removing power from the source of the fuel flow, one has reduced or even eliminated the possibility of fuel run-on. The model that was built showed not only the effect of the addition of the inertial switch, but also the ease in which it could be added to the fuel system circuit.

Fuel System, Fire, Fuel Run-On

C21 OSHA Citations in Electrical Accidents

Helmut G. Brosz, BASc, PEng, Brosz and Associates, 64 Bullock Drive, Markham, Ontario, Canada*

The goal of this paper is to present a number of cases highlighting specific violations/penalties assessed by OSHA. The author will also report on a number of OSHA review commission trials pertaining to electric arc cases. The subject is of great importance to all companies involved in electrical testing, maintenance and construction.

OSHA – Occupational Safety and Health Act

The Act

To assure safe and healthful working conditions for working men and women; by authorizing enforcement of the standards developed under the Act; by assisting and encouraging the States in their efforts to assure safety and healthful working conditions; by providing for research, information, education, and training in the field of occupational safety and health; and for other purposes

Both the U.S. and Canada have Occupational and Safety Health Laws & Regulations. In the U.S., Congress created OSHA in 1970 by promulgating a federal public law # 91-596. In one province of Canada, it is called OHSA – The Occupational Health and Safety Act (OHSA), a provincial act in Ontario.

The 26 states and territories with their own OSHA-approved occupational safety and health plans are Alaska, Arizona, California, Connecticut (for state and local government employees only), Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Montana, Nevada, New Mexico, New Jersey (for state and local government employees only), New York (for state and local government employees only), North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Virgin Islands, Washington and Wyoming.

Since 1970, workplace fatalities have been reduced by half. Occupational injury and illness rates have been declining for the past six years, dropping in 1998 to the lowest record level. Nearly 50 American workers are injured every minute of the 40-hour workweek and almost 17 die each day. Federal and state OSHA programs have only about 2,500 inspectors to cover 100 million workers at six million worksites.

In 1999, there were 5.7 million occupational injuries and illnesses among U.S. workers. Approximately 6.3 of every 100 workers experienced a job-related injury or illness and 6,023 workers lost their lives on the job. There were 5,915 deaths in 2000, two percent fewer than in 1999. Fatalities related to highway incidents, electrocutions, fires and explosions and contact with objects or equipment all declined.

In fiscal year 2000, OSHA inspected 36,350 workplaces. The 26 states running their own OSHA programs conducted an additional 54,510 inspections.

Worker Injuries/Illnesses/Fatalities for 2001 – 55,848 State Inspections

Number	Percent	Reason for Inspection
14,929	27%	Complaint/accident related
32,932	59%	High hazard targeted
8,087	14%	Referrals, follow-ups etc.
Number	**Percent**	**Industry Sector**
25,365	45%	Construction
11,611	21%	Manufacturing
18,872	34%	Other Industries

In the inspections categorized above, OSHA identified the following violations:

Violations	Percent	Type	Penalties	Average
289	0.2%	Willful	$7,998,747	$27,677
55,800	40%	Serious	$52,511,156	$941
2,161	1.5%	Repeat	$5,040,240	$2,332
673	0.5%	Failure to Abate	$3,343,587	$4,968
81,752	58%	Other	$5,037,065	$62
23	0%	Unclassified	$43,888	$1,908
140,708		**Total**	**$73,974,683**	**$525**

Of interest to the electrical industry is the fact that OSHA penalties range from $0 to $70,000 depending upon how likely the violation is to result in serious harm to workers. Other-than-serious violations often carry no penalties but may result in penalties of up to $7,000. Repeat and willful violations may have penalties as high as $70,000. Penalties may be discounted if an employer has a small number of employees, has demonstrated good faith, or has few or no previous violations.

For the purpose of this presentation we will be referring to the following regulations.

		REGULATIONS
United States	29 CFR 1910	Sec. 332, 333, 335
United States	29 CFR 1926	Sec. 957, 416, 95, 21, 416, 403, 951, 302
Canadian – Ontario	RSO 1990, Ch. 0.1, Sec. 181 – 195	Sec. 213/91, 631/94, 571/99, 143/99, 145/00

OSHA's efforts to protect workers' safety and health are all built on the foundation of a strong, fair and effective enforcement program. At the same time OSHA seeks to assist the major of employers who want to do the right thing, it is aggressively pursuing "bad actors" as in Case #1.

Case #1: A laborer permanently employed by a substation construction company was working with an electrical foreman and two apprentice electricians in a U.S. Navy shipyard 34.5 kV substation. The substation was energized. New 34.5 kV switches were being installed and connected by means of 34.5 kV underground cable.

During the tie in phase of the work, mechanical work was being done on the underside of a 34.5 kV switch, which was de-energized on the jaw side and energized on the blade side (unqualified person, approach clearance). The victim was instructed by the electrical foreman, who was on an adjacent stepladder, to tighten some bolts on a steel bracket that support the new cable terminations. The laborer used his own crescent wrench to do so. He then repositioned himself at the switch and placed his left hand on the grounded common gang operating rod and his right hand on the energized weather sheds of the insulators. Prior to repositioning himself, he parked his crescent wrench 12 inches from the energized insulator in violation of the 28-inch minimum working distance. (Ref. 1926.950 Table V-1)

OSHA levied a fine of $52,000 for each of the two violations. The contractor elected to go to court to contest. The administrative law judge ruled in favor of OSHA. The contractor declared bankruptcy. The F.B.I. then filed perjury charges against some witnesses employed by the contractor based on false testimony. A witness stated that the victim never reached within the 28-inch minimum working distance when in fact, the victim's wrench was found on a ledge within the 28-inch distance.

Worker Injuries/Illness/Fatalities from 1988-2000 investigated by the author.

CASE	SECTION	FINE LEVIED	NOTES
W.O: 3353-96 Obj: Switch/Buswork Vic: T.L. (Death) Cli:OSHA/U.S. Navy	1926.957(a)(3) 1926.416(a)(4)	$112,000	Trial
W.O: 2929-94 Obj: 480 V Service Panel Vic: A.P. & W.H. (2 Injuries) Cli: E B & E 1926.21(b)(2)	1926.21(b)(2) 1926.416(a)(1) 1926.403(i)(2)(i) 1904.2(a)	$1,200 $900 $600 $150	No
W.O: 2931-94 Obj: Bucket Truck Vic: C.W. (Death) Cli: E B & E	No Citation – N.I.O.S.H. Recommendation 1926.951(f)(3) 1926.302(d)(1)	N/A	No
W.O: 1996-88B Obj: Substation Transformer Vic: V.S. (Death) Cli: F F V M & D	No Citation – M.I.O.S.H.	N/A	N/A
W.O: 2836-93 Obj: 600 V Motor Vic: T.N. (Death) Cli: Alcan	OHSA – RSO 1990, Ch. 0.1		Settled
W.O: 4117-00 Obj: High Voltage Switch Vic: H.G. (Injury) Cli: R C & R	CALOSHA T8CCR 342(a) T8CCR 3203(a) T8CCR 2943 (b)(2)(B)	 $175 $175 $3,000	Settled

OSHA, Violations, Electrical Accidents

C22 Load Shift vs. Jackknife—The Use of Photogrammetry in Accident Reconstruction

Harold E. Franck, MSEE, PE, and Darren H. Franck, BSCE, Advanced Engineering Assoc., 4713 MacCorkle Avenue, SE, Charleston, WV*

Participants will learn how vehicle wire frame models may be photogrammetrically superimposed on accident scene photographs. These photogrammetric techniques can then be used to assess whether a vehicle lost control as a result of a weight shift or because the driver jack-knifed the tractor trailer.

In the early morning hours, a tractor with box trailer overturned on a gentle curve. The tractor remained on the road surface while the box trailer carrying rolls of paper proceeded over an embankment. The driver sustained permanent injuries to his right hand. The next day, the driver's father photographed the tire marks deposited on the road surface that were produced by the tractor-trailer as it lost control. The driver claimed that the paper load in the box trailer shifted causing the loss of control and ensuing accident.

The authors were asked to investigate this incident to substantiate the claims of the tractor-trailer driver. From a preliminary review of the police report and the photographs taken by the driver's father, it was revealed that the accident was not produced by a load shift. Counsel for the driver was informed that the physical evidence did not support the load shift hypothesis. Further analysis was not performed until a few days before the ensuing trial.

As the trial date approached, counsel for the driver provided the authors with the defense expert's report and asked if the defense scenario of the accident matched the physical data. The attorney for the plaintiff had, in the intervening time period, obtained a trucking expert who supported the weight shift scenario. Upon review of the opposing expert's report, it was determined that the defense reconstruction was consistent with the physical data, within engineering accuracy, obeying the laws of physics, and descriptive of the accident scenario. When informed of the authors' findings, plaintiff's counsel was still not satisfied and asked for further analysis. Since the defense reconstruction was deemed to be correct, photogrammetric techniques were used to show the plaintiff's attorney why the defense reconstruction was correct.

In order to show the vehicle path in a more dramatic fashion, the scene was accurately reconstructed in a virtual three-dimensional environment. The virtual scene was not rendered and animated in order to save expenses. The scene, including the tractor-trailer, was drawn in wire frame so that it would become transparent when superimposed on photographs. In this manner, plan views of the procession of the accident could be compared to camera views of the tire marks deposited by the tractor-trailer. The camera views were photogrammetrically aligned to the photographs taken by the driver's father.

In order to accurately align the wire frame camera views on the photographs, an accurate survey of the road surface must be made. The survey may be accomplished with a laser transit that stores the appropriate azimuth elevation, depression, and distance readings. The data may be stored electronically and downloaded into AutoCAD and 3D Studio Max. The data is used to construct the wire frame rendition of the road, guardrails, poles, and any other pertinent information. The wire frame

rendition of the tractor-trailer is then added to the scene. The photogrammetric alignment of the camera view in wire frame then takes place. This alignment uses the horizon or zenith lines in the photograph along with the inclination angle of the oblique angle photographs and is governed on the road surface by the following equations.

$$\theta = \tan^{-1}\left(\frac{k_o}{f'}\right) \quad (1)$$

$$\alpha_a = \tan^{-1}\left(\frac{x_a}{f'\sec\theta - y_a\sin\theta}\right) \quad (2)$$

$$\beta_a = \tan^{-1}\left(\frac{y_a\cos\theta}{(f'\sec\theta - y_a\sin\theta)\sec\alpha_a}\right) \quad (3)$$

Where

θ = angle of inclination
α_a = azimuth angle
β_a = depression angle

This process must be carried out for each photograph for proper camera - scene alignment. After the process is completed, the wire frame rendition of the vehicle is superimposed on the wire frame photograph. In this manner, the vehicle's path is determined and an evaluation of the loss of control is then made.

The conclusion of this type of analysis revealed that the tractor-trailer driver most probably fell asleep or became inattentive as the vehicle veered toward the right berm. The driver over-corrected and caused the tractor to be misaligned with the trailer (jack knife configured). The action produced the accident. Given the right circumstances and data, Photogrammetry may be used in a variety of ways to support or contradict accident scenarios. The combination of Photogrammetry and wire frame renditions gives incident reconstructionists a powerful visualization method for the progression of an accident.

Photogrammetry, Wire Frame Rendition, Incident Reconstruction

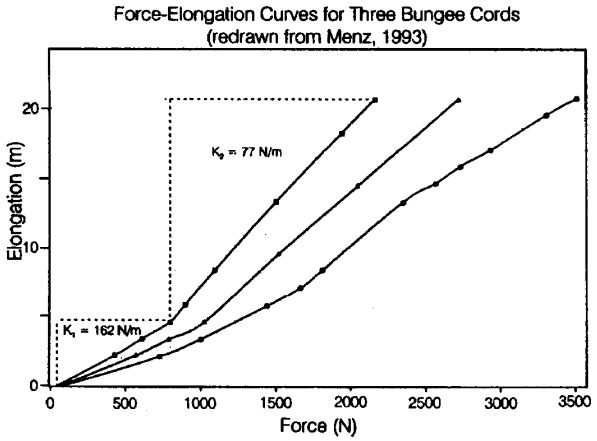
C23 Forensic Elasticity in the Air, on Land, and Sea

Thomas L. Bohan, PhD, JD, and Joseph A. Keierleber, BA, MFA, MTC Forensics, 371 Fore Street, Portland, ME*

The goals of this presentation are to provide forensic engineers and scientists with an increased appreciation of the role of elasticity in the dynamics and analysis of industrial and recreational accidents.

Introduction: The analysis of bungee jumps, scaffold drops, and "rocket rope" water-tubing mishaps involves Hooke's Law, harmonic motion, and Young's Modulus. The manner in which these elements enter into understanding untoward events involving elasticity is illustrated by two accident investigations carried out by our office: (1) that of a fatal fifty-foot drop of a painting platform supported by steel cables; (2) that of a severely incapacitating and disfiguring injury to a young woman being towed across a body of water on an inner tube that was connected to a motor boat by a bungee-cord-like tow rope.

The Physics: In describing the distortion (strain) of materials under stress, a distinction is made between "elastic" strain and "plastic" strain. The former is strain that goes away completely once the stress that caused it is removed. The latter is strain that does *not* go away completely even after the stress that caused it is removed. As long as the stress applied to a material does not exceed its — reasonably enough named — "elastic limit" for that material, the resulting strain is elastic. For most materials, the first part of the elastic range is linear. For one-dimension stress, this range is described by Hooke's Law, which in extrinsic form is usually written F = -kx, where "x" is the change in length imposed on the object and F is the "restoring force," the force that resists the imposition of the force. Usually, "k" is called the "force constant," and obviously has dimensions of force/distance, for example, lbs/foot in the U.S.-Burmese system of units and N/m in the Système Internationale. One can also express this relationship referring to the intrinsic properties of the material, using the Young's Modulus "Y"[2] characterizing the material. Hooke's Law (the "spring equation") in terms of the Young's Modulus for the material in question becomes: $F/A = Y(\Delta L/L)$, where ΔL is the change in length of an item that had an unstretched length of L, and A is the cross-sectional area of the item. Figure 1 depicts the elongation/force characteristics for three different commercial bungee cords made for jumping and is replotted from data published by Menz[2]; Figure 2 reflects our measurements on a commercial tow rope that incorporated an elastic section, to be discussed further in the final section. Note that in every case, the elastic characteristics were bi-modal, with the cord not going from an elastic region to a plastic region, but rather from an elastic region characterized by one force constant to a second elastic region characterized by a second, lower force constant. During oscillation, the motion of an object at the end



of any of these cords is more complicated than simple harmonic motion.
Figure 1

The Wire Cable Problem: This case involved one serious injury and one fatal injury as two men fell 50 feet along with the platform they had been standing on when a strong wind came up as they were painting the side of a large gas-storage tank in Lynn, Massachusetts. The scaffold had been suspended from the top of the tank by two quarter-inch braided steel cables. It was established that these cables had been improperly rigged, which lead to suit being filed against the company responsible for the rigging. That company's primary defense was to assert that the forces associated with the wind were so great that the cables would have failed regardless of how they were rigged. In particular, they relied on a report that the platform had risen a foot in the air in the wind, then had dropped vertically, and that this was the origin of the failure. In support of this theory, the defense expert put forth an original theory about how the jolt when the platform fell one foot while supported by the cables would have set up an energy wave that "blew out" one of the cables, causing the disaster. The authors approached the problem classically, examining the force that the weight of the platform and its contents would have exerted on the steel cables after they had dropped a distance of one foot under the force of gravity. The problem was very similar to that of determining the force with which an object hits the ground, where one knows the momentum change, but has to calculate the time over which the change occurred.[4] In the case of the cables, the problem reduced to the force constant K of the cables, since one knows the kinetic energy that must be converted into potential energy of the stretched cables.[5] This in turn gives us the "maximum stretch" and hence the maximum force on the cables, $K\Delta L$, providing that the elastic limit was not exceeded. In the event, the maximum force that would have occurred under the conditions hypothesized by the defendant was shown to be considerably below the yield strength of the cables. Following a jury trial in Boston, a verdict in favor of the plaintiffs was returned and damages assessed against the company that attached the cables to the tank. The calculations that apparently convinced the jury involve straightforward Hooke's Law application and will be illustrated.

The Rocket Rope Problem: Approximately 30,000 "rocket ropes" were sold for use in water sports, particularly for towing a rider on an inner

tube at high speed behind a motor boat. Out of the 30,000 such ropes that were sold, two purchased at a particular vendor in Southern New Hampshire resulted in injury to their users. According to the manufacturer, which has ceased its sales of the item, there were no other injuries anywhere with the product. Indeed, it does take special circumstances to cause the rope to behave in a dangerous way, or, rather a particular constellation of circumstances, including in particular the weight of the rider and the speed of the boat. With the "right" combination, the ride contains several distinct phases. In the first phase, the rider and tube sit low in the water while the motor boat speeds away, stretching the rope as it goes. When the stretch has reached the point where the restoring force is high enough to move rider and tube out of their "hole," the tube rises to the water's surface. At this point, the force required to keep the tube moving can (depending on the speed of the boat) suddenly become much less than the force being applied to it by the (stretched) rope. The tube and rider therefore rapidly accelerate; as they do they begin to overtake the boat. Depending on the particular combination of fixed and variable constraints, the speed of the rider and tube may get to be so high that they continue to overtake the boat even after the force from the rope has fallen to zero. This phase lasts only a very short time, the ability of a non-streamlined object to "coast" across the water being limited. Nevertheless, it is possible during that time for the rope to become slack, and if it does, it is possible for it to wrap around the rider during the brief interval before the speeding boat pulls it taut again for the next rocketing forward. Alternately, if the operator of the boat stops his boat momentarily after the phase in which the rider has overtaken the boat, there will be ample opportunity for the unsuspecting rider to become ensnared in the rope before giving the boat operator the signal to speed up again, with disastrous results.

To first order, the dynamics of the tuber being pulled by the "rocket rope" can be modeled by a mass being pulled across a sticky surface by an elastic tether, the far end of which is moving at a constant speed, where the velocity of the mass is perturbed by its oscillation at the end of the tether and where there is a threshold speed for the mass below which the mass sticks to the surface, and remains stuck until the increasing restoring force of the tether reaches a sufficient magnitude to pull it away. Alternatively viewed, this is a problem that can be treated by considering the there to be a huge difference between the static and sliding coefficients of friction between mass and surface.

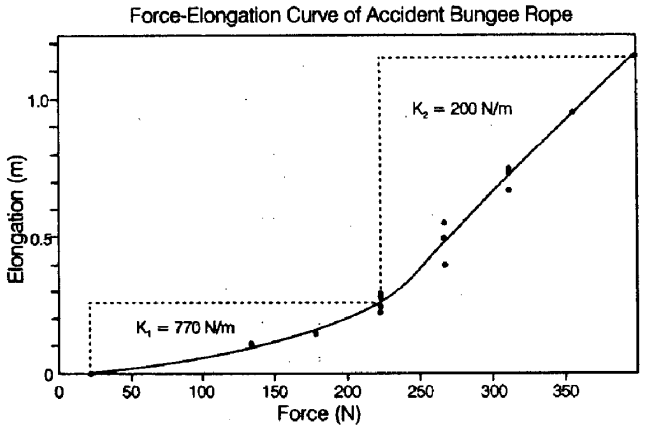


Figure 2

1 With apologies to the U.S. Marine Corps.

2 With further apologies to the engineers who tend to designate Young's Modulus by "E," a symbol physicists like to reserve for other things.

3 Menz, P.G. The physics of bungee jumping. *The Physics Teacher,* 31 Nov 1993, 483-7.

4 See, for example, Comments on why the question *"How Hard did it Hit?" is usually unanswerable without first answering the question "How Long did it Hit?" and a Couple of Experimental Suggestions for Working around Operational Fracture-Force Standards,* Thomas L. Bohan, delivered February, 1992, at the 44th Annual Meeting of AAFS, New Orleans, LA.

5 One of the authors (TLB) gratefully acknowledges a suggestion from John M. Orlowski, PE, CSP, which led to the quick solution of this problem.

Elasticity, Bungee Cords, Cables

C24 An Analysis of Test-Foot-Acclimation Issues in Walkway Safety Tribometry

Mark I. Marpet, PhD, PE, 14 Crowie Road, Chester, NJ; and Thomas M. Smith, BS, MBA, Congoleum Corporation, P.O. Box 3127, Mercerville, NJ*

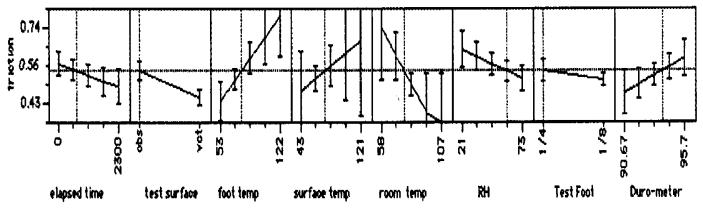
The goals of this presentation are to (1) to allow practitioners to assess potential problems from not acclimating test feet before starting testing, and (2) to provide information useful in the walkway-safety tribometry standards-development process.

Background: The evaluation of the friction inherent between a walkway and a shoe bottom (or shoe-bottom surrogate, called a test foot) is important because fall accidents represent the second largest generator of accidental-injury costs in the U.S. Because resilient-material friction does not necessarily follow the rather simple college-physics friction model (called the Amontons-Coulomb model where friction is independent of temperature, contact time, etc.), questions of the metrology of slip resistance become significant. This brief paper explores issues in the measurement of pedestrian-walkway friction, namely, the effect of having a test foot and test surface at different temperatures and, more generally, the temperature effects in friction testing.

Experiment: The testing was conducted in constant-temperature/humidity environments: a cold-room (kept at about 50°F, a room-temperature room (kept at about 70°F) and a hot-room (kept at about 105°F). Vinyl composition tile (commonly used in both walkways and as a reference surface in tribometric testing) and glass walkway tiles were utilized as test surfaces. Neolite® Test Liner, a commonly used tribometric test-foot reference material, was used as a test foot against these Surfaces. All tests were conducted under clean, dry conditions using a Slip Test Mark II Portable Inclineable Articulated Strut Tester (PIAST). The test surfaces and the tribometer were acclimated to the various room environments before testing; the test foot was brought into the testing environment at room temperature and testing was accomplished as the test foot came to the room's ambient temperature. During the testing, the friction between the test foot and test surface, the elapsed time, the test surface material, the test-foot thickness, the temperature and relative humidity of the room, and the temperatures of the test surfaces and the test foot were acquired and recorded. The latter two temperatures were acquired with a handheld remote-sensing infrared thermometer. For a subset of the tests, the durometer hardness of the test foot was acquired and recorded. Finally, the relationship between temperature and acclimation time was explored by taking the temperature of a test foot as it cooled from approximately 90°F to room temperature.

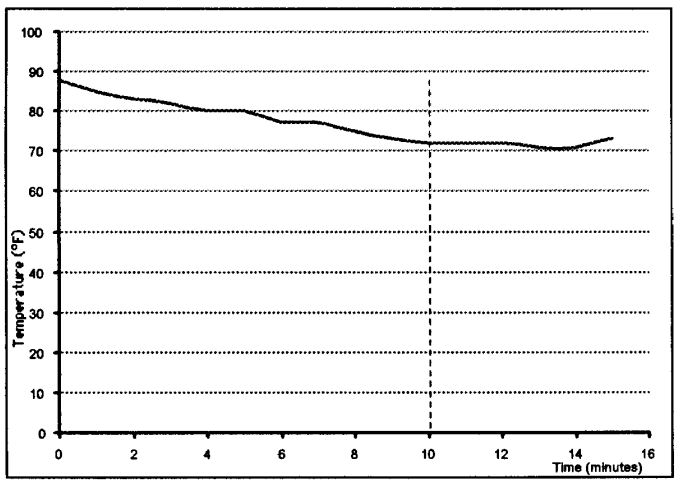
Analysis: A multivariate model was fit to the data, with friction (dimensionless) as the dependent variable and the test-surface material, test-foot thickness (inch), elapsed time (seconds), relative humidity (dimensionless), room temperature (°F), surface temperature (°F), and test-foot temperature (°F) as independent variables. The test-surface material (vinyl tile (vct) or glass (obs)) was highly significant ($p < 0.0001$). The test-foot temperature, relative humidity, and elapsed time were significant ($p = 0.0045$, 0.0156, and 0.0165, respectively). The room temperature was marginally significant ($p = 0.0626$). The test-foot thickness and surface temperature were not significant ($p \geq 0.15$ and 0.35

respectively). Durometer hardness was not utilized, as the data collection did not cover all the tests. Below are the prediction profiles, graphically displayed:



Discussion: While it is clear that there is a statistically significant effect due to test-foot temperature, that effect is slight: amounting to an increase in the friction coefficient by +0.005 per degree. Preliminary analysis of the relationship between temperature and the hardness of the test foot (not discussed in this paper) suggests that at least a part of the temperature/friction effect may be the effect of the change in test-foot hardness as a function of temperature. The elapsed-time effect, a stand in for acclimation effects, was significant.

The temperature vs. acclimation time graph is given below:



Recommendations: Because tribometric results have at least a mild sensitivity to test-foot temperature, it is suggest that practitioners of walkway-safety tribometry acclimate the test feet used in testing for at least ten minutes so that the test feet and test surfaces are at least at approximately the same temperature before commencing testing. It would be expected that this would be true no matter which tribometer the practitioner chooses to use. As is recommended in many tribometric standards, the temperature and humidity of the environment should routinely be recorded.

Future Research: The temperature sensitivity of the various commonly used tribometric test materials needs to be further explored, as well as any interactions between temperature and humidity, and between temperature, test-foot hardness, and friction.

Reference: Marletta, William, *The Effects of Humidity and Wetness on Pedestrian Slip Resistance Evaluated with Slip Testing Devices on Selected Sole and Floor Materials:* Doctoral Thesis. New York University School of Education, 1994

Forensic Sciences, Walkway-Safety Tribometry, Test-Foot Acclimation

C25 Mold Problem? How Would You Know?

James S. Smith, Jr., PhD, Oak Creek, Inc., Toxicology & Risk Assessment Consulting, 60 Oak Creek, Buxton, ME*

The goals of this presentation are to (1) characterize the mold problem, (2) evaluate the usefulness of indoor air quality tests and standards, (3) determine the plausibility of causation, and (4) develop a mold standard for the protection of human health.

Insurance companies are re-evaluating rates, coverage, and exposure to liability after a recent jury award of $32.2 million to homeowners with a mold problem (Ballard v. Fire Insurance Exchange). Even before this award, Farmers Insurance estimated mold claims cost it $85 million in 2001. Industry wide, during this same year estimates of insurance claims relating to mold problems exceeded $500 million. However, the impact of mold problems extends far beyond the insurance industry. Liability for mold-related problems affects how architects, engineers, remediation contractors, home inspectors, doctors, and environmental consultants do their jobs. It appears that dealing with mold problems will be a multi-billion dollar industry before the end of the decade.

With nowhere to turn, people are pushing for legislative action in California, Texas, Florida, and several other states. The California Legislature recently enacted SB 732-Oritz, authorizing the California Department of Health Services to establish permissible exposure limits (PELs) for molds, while requiring due-diligence disclosure of mold-related adverse health conditions by property owners, and licensing of persons involved in the investigation and abatement of mold. Under increasing public pressure to protect human health and property, state and federal agencies are beginning to wake up to the epidemic of mold-related problems that appears to be sweeping across the country.

Molds are fungi, ubiquitous organisms that make up approximately 25% of earth's living matter. They play an important role in the breakdown of organic matter like leaves, wood, and plant debris. However, not all molds flourish in indoor environments. To flourish, molds require moderate temperatures (i.e., between 40 and 100°F), a nutrient base (such as the cellulose in wood or paper), and moisture. Exposure to molds can occur through ingestion, dermal contact, or inhalation. Exposure to molds can cause immunosuppression, immunodepression, emesis and diarrhea, weight loss, nervous disorders, cardiovascular alterations, skin toxicity, decreased reproductive capacity, bone marrow damage, flu-like symptoms, sore throat, headache, dizziness, dermatitis, fatigue, and general malaise. Asthmatics tend to be particularly sensitive to mold with 10 to 32% of all asthmatics showing sensitivity. In fact, immuno-compromised people such as those with HIV/AIDS or organ transplant are especially susceptible to pathogenic molds.

Over the last 10 years, microorganisms have become the primary source of indoor air contamination, accounting for as much as 50% of all indoor air quality (IAQ) cases. For the California Department of Health Services, visible growth is sufficient to indicate a mold problem, yet nearly half of the buildings with microbial IAQ problems do not present visible signs. Consequently, thorough and competent testing is required to evaluate indoor environments for mold. Generally, air sampling alone does not provide sufficient evidence to indicate a mold problem. Because there are no official standards or guidelines for regulating molds in indoor air, determining that a mold problem exists can be problematic. Still several federal and international Agencies have adopted acceptable limits for the number of colony forming units in air.

This presentation will characterize the nature of IAQ mold problems in the home and office environment. The presentation will identify useful approaches to testing indoor environments for mold in indoor air and offer an approach for assessing the plausibility that mold caused adverse health effects in an exposed human population. Finally, this presentation will offer an approach for deriving a mold IAQ standard for the protection of human health.

Toxic Mold, Tests, Standards

C26 A Study of Several Case Histories of Successful Method Detection Limit (MDL) Studies Consistent With 40CFR136, Appendix B

James E. Norris, BS, MS, 315 Dalewood Drive, Mobile, AL*

The goals of this presentation are to address the studies of analytes and methodologies (organic compounds, GC/CD and GC/MS), non-metals (e.g., Total Cyanide Distillation with automated colorimetry) metals (by ICP/GFAA), pesticides (GC/CD, GC/MS). A comparison will be made which demonstrate the often dramatic differences in EPA published MDLs versus those defined in real-world industrial wastewater matrices.

This preparation addresses several of some 15 Method Detection Limit studies conducted by the author for industrial facilities in four different states. All were successful from both a technical and a regulatory perspective.

The strategic objective of each study was straightforward: to determine a matrixspecific, analyte-specific method detection limit in an industrial wastewater discharge and to accomplish this in a manner consistent with USEPA's methodology given at 40CFR136, Apdx B. Prior to each study, the responsible State (or Federal) permitting agency had been informed of the need and the intent to execute such a study and in no case did the responsible agency veto the necessity of conducting such a study.

This presentation will address the studies of analytes and methodologies (organic compounds, GC/CD and GC/MS), non-metals (e.g., Total Cyanide distillation with automated colorimetry) metals (by ICP/GFAA), pesticides (GC/CD, GC/MS). A comparison will be made which demonstrate the often dramatic differences in EPA published MDLs versus those defined in real-world industrial wastewater matrices.

The implication of the matrix-specific MDL is demonstrated by a significant drop in the number of NPDES permit limitation violations.

The introduction by USEPA of the concept of the Minimum Level (ML) as, effectively, a limit of quantitation (LOQ) will be shown to further ease the compliance burden on permitted industries. Unhappily, the EPA has not incorporated the ML concept into binding regulation (as is the case with the MDL) but has presented the ML as mere guidance. Some states (e.g., Texas) have adopted the ML concept and incorporated it into their state water permitting regulations.

Interestingly, all new and updated 40CFR136 methods include not only the MDL but also the ML for the analytical method. In this paper, the most frequently evaluated MDLs have been one form or other of cyanide (e.g., Total Cyanide, Cyanide-Amenableto-Chlorination, Weak Acid Dissociable Cyanide).

Impetus to conduct such MDL (and ML) studies resides in the growing tendency of both USEPA and State agencies to set discharge limits below the limits of detection. The success of the various LEAF (Legal Environmental Advocacy Fund) lawsuits and the rapidly expanding program of re-classification of streams and rivers (leading to Total Maximum Daily Loads) have resulted in water quality driven mass discharge limits which translate into immeasurably low concentrations in wastewater discharges. Unhappily, many NPDES permit writers do not seem to understand that compliance with a mass-based limit in contingent not only on flow (thus, total mass of wastewater) but upon a measurement of concentration of the offending species. This aspect of the compliance problem will also be addressed in this presentation.

Method Detection Limit, Matrix-Specific, Analyte-Specific

C27 Fitting Calibration Data

Willem Schreüder, PhD, Principia Mathematica, Inc., 405 Urban Street, Suite 305, Lakewood, CO; and Leslie Eng, PhD*, Trillium, Inc., 3623 Ady Road, Street, MD*

The goal of this presentation is to present to the forensic community the concepts involved in selecting appropriate curves to accurately describe instrument calibration data. Attendees will have an understanding of mathematical foundations of linear regression using functions more complex than a linear polynomial and how it can be applied to calibration curves of analytical instruments.

An improper or poor selection of a mathematical curve to characterize the responses of an analytical instrument to known concentrations of a material can introduce errors in the determination of concentrations of unknown field samples which, in turn, could lead to misinterpretation of the character of the material being investigated.

When generating calibration curves for analytical instruments, samples with various known concentrations of a material are introduced into the instrument, and the instrumental responses are measured. The dependency of the responses to the concentrations is and is used as the instrument calibration curve. Responses from samples with unknown concentrations of the material are then measured and compared to the calibration curve to determine the concentration of the material in the sample.

In constructing a calibration curve, a normal linear regression is typically used to fit a simple curve to the calibration data. In most cases the linear polynomial, $y = a + bx$, is used. This asserts a linear relationship between the responses of the instrument and the measured quantities. Many users examine only the correlation coefficient, *R,* associated with the linear regression to determine if a linear relationship exists. A correlation coefficient of 0.99 or greater is often taken as an indication of a linear relationship between the instrument response and the concentration in the sample.

In reality this is not always the case. Often the response is non-linear, especially when calibration curves extend over large concentration ranges. Depending on the instrument, non-linearity can exist even over only two orders, or less, of magnitude. Forcing a straight line through calibration data that are inherently non-linear introduces errors into certain portions of the curve. The higher responses associated with the higher concentrations tend to numerically bias the calculated curve at the expense of the lower responses and concentrations. Yet, large errors can often exist in calibration curves having correlation coefficients of 0.99 or greater.

To produce a "better" fit of the data, 11x weighting and similar techniques are often used. While this results in a correlation coefficient *R* closer to one and a reduced error for small values of x, the error for large values of x is increased by the use of the 11x weighting technique. Any such techniques are inherently flawed since it reduces the error for some values of x at the expense of others, typically at one or the other end of the calibration range. Moreover, the error tends to vary over the calibration range making the error term also dependent on the concentration being measured.

The fundamental problem is the assertion that $y=a + bx$. If, instead, it is acknowledged that the response is nonlinear and $y=f(x)$, better instrument calibration can be obtained and more accurate determinations of unknown concentrations can be obtained. This paper shows that by choosing appropriate basis functions, linear regression can be performed using non-linear basis functions such that the approximation error over the entire calibration range is reduced. The calibration curve may be as simple as the quadratic polynomial $y=a + bx + cx^2$, or more complex such as $y=a+ bx + ce^{Bx}$. As long as the basis functions are linearly independent and functions of only x, a linear combination of these basis functions can be fitted using linear regression techniques. By choosing appropriate basis functions, optimal regression coefficients can be uniquely determined that best represent the non-linearity inherent in the detector.

Calibration, Regression, Error

C28 Analysis of Volatile Organic Compounds in Soil - Revisited

Carol A. Erikson, MSPH, Trillium, Inc., 356 Farragut Crossing Drive, Knoxville, TN*

The goal of this presentation is to consider, once again, the accuracy of current sample collection and analysis methods for volatile organic compounds. Results for actual site samples recently collected and analyzed by EPA-approved low level and EPA-approved high-level procedures will be compared, and the implications of these comparisons will be discussed.

The fact that volatile organic compounds (VOCs) are rapidly lost from moist soil and sediment during sample handling procedures (collection, transport, preparation, and analysis) has been well established. Early suggestions that all soil and sediment samples be preserved in methanol at the time of collection were not readily accepted due to concerns about the use and transport of a hazardous solvent in and from the field as well as a perceived loss of sensitivity because higher detection limits (DLs) are typically reported from this approach.

Much research has been done in search of a procedure that minimizes target analyte losses and achieves acceptably low DLs. To-date, few would argue that methanol extraction produces the most consistently accurate results of all evaluated approaches.

With the promulgation of Method 5035 in June of 1997, EPA banished the traditional soil sample collection method and replaced it with a closed-system purge and trap method, which includes several presumably equivalent options. Low concentration soils are collected by placing an aliquot into a septum-sealed screw-cap vial that already contains a sodium bisulfate solution and a stir bar and which is subsequently analyzed without ever being opened. High concentration soils may be methanol-preserved in the field by adding a sample aliquot to a similar vial that contains methanol. As an alternative (and only when necessary), both low-level and high-level soil samples may be transferred unpreserved to the laboratory for further processing. In this case, EPA recommends that appropriate sampling devices be used and that analyses be performed within 48 hours.

Figure 1

Table 1

Appropriate sampling devices include, among others, Encores™, which are sized to allow collection of 5-gram or 25-gram soil aliquots with minimal sample disturbance. The Encores can then be sealed for transfer to the laboratory for subsequent preparation and analysis.

In a recent site investigation, three Encores were collected from each soil sample location. Within 48 hours of collection, the aliquots from two of the Encores were preserved in sodium bisulfate for low-level analysis, and the third was preserved in methanol. When high target analyte concentrations were found in the low-level analysis, the methanol extract was run as a "high-level" analysis. In effect, the methanol-preserved sample was viewed as a dilution of the low-level analysis.

For all of the soil samples collected at this particular site and analyzed by both methods, results for all analytes that were within the estab-

Figure 2

lished calibration range (i.e., that were quantitatively valid) in both the low-level and the high-level analyses were compared (see Table 1 and Figures 1 and 2). Forty-seven paired results, including both chlorinated and nonchlorinated analytes, were available for this evaluation. In every case, the concentration detected in the methanol extract was higher than the concentration found in the low-level purge analysis. Ratios of the high-level analysis results to the low-level analysis results ranged from 2.2 to 170; on average, the high-level results were higher than the low-level results by a factor of 23 - more than an order of magnitude.

Based on these data, it is obvious that current low-level volatiles collection and analysis methods still do not accurately represent environmental field conditions, even when they are conscientiously followed and the quality control results are acceptable.

The implications are crucial. Accurate analytical results from a site investigation are necessary in order to allow the design and implementation of a successful remedial action approach. Accurate analytical results are crucial in order to monitor the progress of a remedial action and to determine when a stopping point has been reached. And, accurate analytical data are absolutely essential when cost allocations for cleanup must be determined.

Volatile Organics, Soil

C29 The Role of Thermodynamics in Forensic Fire Investigation—A Review

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The goals of this presentation are to a review the role of thermodynamics in forensic fire investigation.

The phenomenon of fire is a complex process. The role of the forensic scientist is critical in investigating and understanding the ignition and propagation of fire at the scene. It involves an examination of the physical and chemical evidences left a fire scene. One of the important aspects of the fire investigation is to identify the origin of the fire and to determine its causes despite certain drawbacks such as destruction and disruption during the extinguishing of fire at the scene. In such an environment, the role of thermodynamics in fire investigation, fire ignition and propagation plays a vital role to help the investigator to examine scientifically. This paper exclusively enlightens and discusses the thermodynamic classification of ignition sources, phenomena of smoldering and flaming combustion whereby emphasizing the most significant sources and analyzes them thermodynamically, consequently highlighting the role of thermodynamics and that of the fundamental physics for a scientific conclusion in fire investigation. Even though it is a fact that the fires under investigation were not performed under the laboratory conditions, the thermodynamic equations and their solutions will certainly help to identify and give an affirmative report of the indication of the magnitude of the fire process in question scientifically.

Thermodynamics, Physical Constants, Fire Investigation

C30 Use of Water Partitioning of Petroleum Hydrocarbon Free Product to Determine Material Comparability

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The goals of this presentation are to demonstrate the use of partitioning to determine potential contribution of petroleum hydrocarbon free product to the groundwater and demonstrate the differences between samples of free product.

In many instances where a specific type of petroleum hydrocarbon fraction has been spilled, it becomes necessary to identify whether a single spill event occurred or the free product is the result of multiple or continuous spill. The overall flame ionization detector (FID) chromatographic pattern of all the free product samples appear virtually identical and is not helpful in determining if all the samples are the same. The chromatographic pattern is dominated by the peaks associated with the alkanes, and minor constituents frequently cannot be observed. By extracting the free product with water advantage is taken of the fact that the alkanes are insoluble in water, and most other components, including the aromatic compounds, are more soluble than the alkanes. Upon examining the water phase, considerable information can be obtained.

In a specific study to which the partitioning technique was applied, eleven monitoring wells on a site contained jet fuel as a free product. Of the eleven samples, nine appeared identical chromatographically. Underneath the free product layer, the groundwater contained several chlorinated solvents and MTBE, neither of which is normally associated with jet fuel. In addition, the analysis of the groundwater exhibited the presence of aromatic compounds. The partitioning technique was applied to determine if the chlorinated solvents, MTBE, and aromatic compounds were derived from the free product.

Each free product sample was mixed with an equal volume of laboratory water in a closed container, and the bottles were vigorously shaken for 24 hours at room temperature. The phases were allowed to separate. The aqueous phase was then subject to analysis by GC/MS, using EPA Method 8260. In addition, the free product samples themselves were diluted and analyzed by the same method.

Based on the results, it was possible to demonstrate that:

a. The free product consisted of several distinct formulations of jet fuel, not the result of a single spill.
b. The chlorinated solvents were unrelated to the petroleum hydrocarbons free product layer.
c. The MTBE in the groundwater was derived from the free product, even though jet fuel is not normally formulated with MTBE.
d. The aromatic hydrocarbons in the groundwater were derived from the free product layer.
e. Qualitatively, the petroleum hydrocarbon free product layer was present at certain locations for a greater length of time than at the others.

The technique is powerful in determining the presence of soluble components and various additives in the free product layer. In this fashion, identification or matching of samples of free product is feasible.

Aqueous Partitioning, Petroleum Hydrocarbons, Free Product

C31 Forensic Characterization of Co-Mingled Groundwater Plumes Using Detailed Profiling Techniques for the Purpose of Liability Separation and Remedial Design

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The goals of this presentation are to discuss a novel method and case study performing detailed groundwater plume characterization using the Waterloo Profiler for the purposes of liability separation and remedial design.

Standard methods for conducting subsurface investigations often lead to oversimplification of the environmental setting and misinterpretation of the nature and extent of groundwater impacts. Inaccurate problem definition resulting from coarse site characterization often leads

to the application of ineffective remedial measures and complicated dispute resolution. A device has been developed that has the capability to rapidly collect detailed subsurface information for the purpose of problem definition, liability separation and remedial design. This vertical profiling method was developed at the University of Waterloo incorporating a direct push probe that allows measurement of both physical and chemical properties in porous media without the need for well installation. The Waterloo Profiler is known as a continuous point sample profiler because it collects samples from a very short interval in the aquifer at any desired spacing without withdrawing the device between samples. The short sampling interval eliminates depth-integrated, flow weighted averaging of key variables, such as solute concentration inherent in conventional sampling programs. The Profiler has been modified to obtain real-time hydrostratigraphic data to allow the investigator to select sampling depths on the basis of changes in hydraulic conductivity.

Application of the Waterloo Profiler coupled with an on-site mobile laboratory utilizing solid phase microextraction and gas chromatography allowed the investigators to adjust the assessment in progress at an industrial site in New Jersey. These techniques resulted in identification of a second, off-site source area and provided detailed definition of the nature and extent of two distinctly different plumes with a confluence at a local water supply well. Despite the complicated geologic setting, the results of the assessment produced detailed 3-dimensional definition of the plume geometry and chemistry.

The subject industrial client historically used trichlorethene (TCE) as a cleaning solvent during annual reconditioning of heavy manufacturing equipment. Minor releases of TCE to the subsurface had produced a narrow groundwater plume that had migrated from the original source area. A local high capacity water supply well located approximately 1-mile downgradient had measured low levels of chlorinated solvents during routine monitoring events. Chemical signatures in the well indicated a second contaminant source. Allegations were made indicating that our client was the sole source of chlorinated solvents in the well, consequently proving nexus required detailed investigation. Downgradient investigation of our client's plume required access and testing in a sensitive wetland and subsurface investigation in complicated outwash deposits. Application of the Profiler provided detailed vertical definition of the narrow plume emanating from the industrial site and co-mingling with a second, more prominent and vertically extensive plume. Upgradient tracking of the second plume resulted in confirmation of a second, much larger contaminant source with a chemical signature similar to impacts measured in the local municipal water supply well. The results of the investigation provided the client with the necessary confidence and details to develop a scientifically based conflict resolution strategy consistent with the findings and to redirect the initial allegations.

Accurate definition and separation of the measured impacts led the responsible parties to develop consensus related to the management of groundwater contamination and implementation of a focused remedial strategy. In the absence of the investigation, the client would have unnecessarily accepted liabilities remotely related to minor impacts associated with their property and principally caused by a previously unknown source.

Groundwater Plume, Waterloo Profiler, Liability Separation

C32 Hidden Trails to Unexpected Culprits and Victims of Groundwater Contamination—Go With the Flow

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Groundwater hydraulics and flow patterns are the most important single aspect of understanding the origin, fate, and potential impacts of groundwater contaminant plumes, but must be considered in concert with chemistry and other relevant evidence.

Among the most common and challenging questions posed to environmental scientists associated with groundwater contamination problems are: "Where and when were the contaminants originally released?" and "Who has been or who potentially will be exposed to the contaminants in the future?" This paper will provide three interesting case histories on how three-dimensional and time-variant groundwater hydraulics and flow patterns have proved to be the key in providing unexpected or previously unknown answers to the questions.

Groundwater contamination problems are typically discovered long after the contamination event(s) occurred or contamination process began. The discovery is virtually always by chemistry or environmental/human health impacts. Because chemical evidence is almost always the primary initial focus, it is also often the only evidence initially used to draw conclusions regarding the source and potential fate of the contaminants. In many cases, for example, a discovery of chlorinated solvents like trichloroethene (TCE) in groundwater will lead investigators to look for the nearest industrial plant that would use such solvents and to conclude that it is the likely source. However, diligent examination of groundwater flow patterns may prove that source to be impossible or highly unlikely. Similarly, present delineation of a contamination plume may suggest that areas currently not coincident with the plume position have had any impacts from the contamination. However, reconstruction of past changes in groundwater flow patterns can sometimes show that the plume was formerly in an area now apparently clean and that people may have been exposed in those areas.

One case history involves a large municipal well field in a shallow aquifer that became contaminated by chlorinated solvents. A nearby, apparently upgradient, industrial and military complex was blamed for the contamination. However, close examination of the groundwater flow patterns together with the individual contaminant concentration histories of each well in the well field showed that the major source had to be in a different location than the accused source. A second case history shows that under past pumping conditions, flow patterns were sufficiently different to cause a supply well to school to become contaminated, even though it appeared clean and out of the plume in recent years. The third case history demonstrates that groundwater flow patterns can be used, in combination with individual well chemistry, to disprove a claim that most of the groundwater contaminants being remediated in a plume were originating from other, off-site sources.

Groundwater, Hydraulics, Contaminant Fate and Transport

C33 Using Environmental Forensics to Explain the Unexplainable

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The goal of this presentation is to help environmental forensic scientists to think "outside the box," while using scientifically sound data to explain seeming incongruous or "impossible" data.

As knowledge about the behavior of environmentally sensitive chemicals increases, data that "could not possibly be correct" can often be explained, provided, of course, that the data are, in fact, correct. The behavior of dense non-aqueous phase liquids, DNAPLs, in subsurface soils provides a classic example. Data that reported the increasing concentrations of DNAPLs with depth were initially greeted with suspicion, since they were in conflict with the anticipated concentrations that would result if the contaminants were moving through the subsurface in a dissolved state. Today, this once incongruous behavior has been explained using sound scientific reasoning and accepted as correct.

The authors of this paper will present three examples of case studies where the initial data review and evaluation might have resulted in the incorrect conclusion that something was wrong with the data. The ***first***

case study involves the release of a specific PCB-containing (formerly) commercially available Aroclor mixture at a manufacturing facility, where it was used as a heat transfer fluid. The identity of the particular Aroclor that was used was well known to the operators of the facility. However, Aroclor-specific analyses of groundwater at the site revealed the "presence" of another Aroclor, in addition to the one that was used, depending on the locations where the samples were collected. This second Aroclor had been identified in samples collected during several different sampling events.

The company had no record, nor recollection, of usage of this other Aroclor that was identified in some of the groundwater samples. What happened? Could the data be wrong? The next step was a re-analysis of additional samples collected from the same locations where the second Aroclor had been identified. These samples were analyzed by multiple laboratories and the chromatograms were also reviewed independently for confirmation of the Aroclor identity. The results were the consistent in all instances, identifying the presence of the second Aroclor.

The answer to this "mystery" involved an analysis of the complex behavior of a mixture of chemicals (the Aroclor) in the environment. Additional forensic work confirmed that the data were, in fact, not only correct but also were supportive of the facts, as they were understood.

The ***second case study*** features an evaluation of measured pesticide concentrations in soil and groundwater that violated all understanding of how chemicals move through the environment. No natural transport processes could be used to explain the relative concentrations in soil, when the locations of the most likely sources were factored into the analysis. Again, what could possibly account for these data? They must be wrong.

The ***third case study*** also involves PCBs. Extensive sampling and analysis of the soil at an old industrial site indicted that PCBs (on an Aroclor-specific basis) were weathered in the soil to a depth of approximately ten (10) feet. However, there were a few soil samples collected at approximately five (5) feet that were not weathered. Why?

This seeming inconsistency was rather simple to explain, once the locations of buildings, now demolished, were identified. The samples collected in these areas had been under buildings and/or paved areas. As such, they were not subject to weathering. Easy!

However, why were there two soil samples collected at one location from depths of 15-16 feet and 24-26 feet that showed weathering? Moreover, the sample collected at the same location from a depth 18.5 –20 feet was, as expected, not weathered! Not so easy! A very detailed review of the data (which in all three instances were correct) provided an answer, consistent with sound, defensible science.

The above examples will be presented in a way that will, hopefully, challenge the audience and involve them in the environmental forensic process of identifying and determining the possible explanations for the seemingly anomalous data.

Anomalous Data, Environmental Transport, PCBs

C34 Proving a Gasoline Release Source When Your Analytical Results Are Not Helpful

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This presentation will describe how to use forensic science investigation/evaluation approaches on environmental release work where a water supply was impacted by gasoline.

In suburban Philadelphia, a country village mall shopping center had gasoline odors emerge from its water supply. Two upgradient service stations were present, one of which had a large release due to a **break in** a fill line. Despite initial promises from one service station owner to take appropriate action, remedial work and delineation work was never fully completed in a timely manner, so the downgradient mall water supply was subsequently impacted.

Solutions were further thwarted by "finger pointing" at the other service station and an initial finding that other contaminants (not petroleum related) were also present. When a new, deeper water supply well at the mall was installed, it too became impacted. Lab test results can be found in Table 1; Figure 1 shows the station and village mall locations.

Careful examination of historical information revealed that an early service station consultant said that there was considerable risk of water supply impact. Although odors in the country village water supply well were strong, analytical testing did not consistently reveal an impact. This was attributed to the "deep" nature of fractures and the vertical height of water supply pumping of the dissolved phase contamination.

Cooperation between consultants for the second service station and the country village mall shopping center resulted in findings that the first service station was the clear predominant and primary source. Releases at the second station were found to be de minimis. Expert testimony was delivered and reports were prepared which led to resolution of the case.

The use of the Risk Based Corrective techniques (or misuse as the case may be) will be presented in some detail. Attendees will learn of the importance of having adequate technical support for report conclusions and findings.

Table 1

Groundwater Contaminants - November 1998
ug/L (ppb)

		Location	
Compound	**Station A**	**Station B**	**Mall**
Methyl, t-butyl ether	ND	35	2.7
Disopropyl	ND	ND	5.1
1, 2 Dichloroethane	65	760	4.2
1, 2 Dibromoethane	34	ND	ND
Benzene	1,500	10,000	3.3
Toluene	5,100	3,000	ND
Ethylbenzene	750	1,000	0.2
Total xylenes	4,300	3,100	ND

ND means none detected
Station A never sold leaded gasoline
Station B never added MTBE to their gasoline

Environmental Gasoline, Water Supply, Gasoline Release

C35 Full Nelson, Punches, or a Combination—Biomechanics of a Cervical Spine Injury

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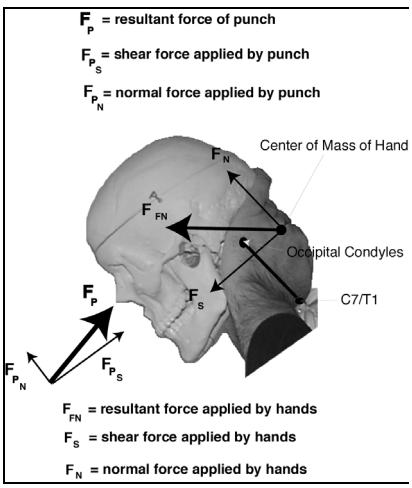
The goal of this presentation is to demonstrate a biomechanical analysis that determined what type of loading led to a fracture dislocation of C7/T1 in a manslaughter case.

A disorderly person was apprehended by the doorman of the establishment where the disorderly conduct occurred. The doorman placed the offender in a "full nelson" hold – placing his hands on the back of the suspect's head after looping his arms under the suspect's arms from behind. Police arrived on the scene, and when the suspect continued to kick and thrash, one of the officers allegedly struck the suspect in the face while he was still being held in the full nelson. The suspect was eventually taken to hospital and after several hours was taken to x-ray, revealing a dislocation of C7/T1 with C7 displaced anteriorly over T1. The suspect was paraplegic and eventually developed respiratory complications and died 6 weeks later. The police officer who allegedly threw the punches to the face was charged with manslaughter.

The x-ray in this case coincided with textbook depictions of cervical spine injuries caused by flexion. Testimony revealed that the suspect was struggling while his head was held in the forward flexed position by the full nelson, indicating that the spinal cord injury had not yet taken place even though the head was flexed near the limit of its range of motion. While the punches were unquestionably dynamic, the application of force to the back of the head and neck was quasi-static, so a static equilibrium analysis of the forces and moments at C7/T1 created by the full nelson was completed using the deceased's anthropometry and biomechanical data on ranges of motion of the neck and head link. By comparison with recent research results (Cusick and Yoganandan, 2002), it was found that approximately 20 kg of hand force to the back of the head would be sufficient to cause tissue failure at C7/T1. Large, strong males can exert this amount of force.



The shear forces (force perpendicular to the neck axis from C7/T1 to the occiput) created by the punch act in the opposite direction to the shear forces created by the full nelson, either decreasing the net posterior to anterior shear force or creating a net anterior to posterior shear, decreasing or opposing the flexion moment that causes the forward dislocation of C7 on T1. The biomechanical analysis indicates that the punches did not contribute to the forward dislocation of C7 on T1, while the full nelson alone could have caused the injury.

Cusick, JF, and N. Yoganandan. "Biomechanics of the cervical spine 4: major injuries." Clinical Biomechanics Vol. 17(1): 1-20, 2002.

Biomechanics, Cervical Spine, Flexion Injury

C36 Catastrophic Neck Injuries Can Result From Low Height Trampoline Jumps

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The goal of this presentation is to demonstrate that simple articulated rigid body models can be used to predict catastrophic neck injuries from simple backward falls while jumping gently on a trampoline.

Trampoline injuries account for about 100,000 hospital emergency department visits per year. While catastrophic cervical spine injuries are rare, head and neck injuries constitute a notable number of the more serious trampoline injuries requiring hospitalization. The prevailing view is that cervical spine injuries associated with trampoline use are the consequence of failed attempts at aerial maneuvers such as back flips and summersaults. However, in one instance of cervical spinal cord injury, it was alleged that a male subject was simply jumping vertically and stiff-legged a few inches off a trampoline mat, when his feet slipped rapidly out from under him, causing him to rotate backwards, and strike the back of his head on the mat. He sustained a C4/5 fracture subluxation accompanied by a spinal cord injury that resulted in quadriplegia and permanent neurological deficit. The main objective of the authors was to determine if a slip and backward fall, even while jumping gently on a trampoline, was a plausible mechanism for this injury. A secondary goal was to develop a general model for predicting injury risk associated with backward falls on trampolines for subjects of various heights and weights, including women and children.

Methods. The subject was modeled as two rigid bodies connected with a planar pin joint at the neck. The neck joint was modeled using a torsional spring and damper with the torsional spring assumed active only outside a dead band. The damper was assumed to have constant properties throughout the range of motion. Using appropriate initial conditions, the equations of motion were numerically integrated forward in time, using a 4th order Runge-Kutta algorithm. The Abbreviated Injury Scale (AIS) was used to describe the severity of neck injury. The predicted neck forces were compared against the tolerance limits for the human cervical spine (FMVSS 208) The criteria are referred to as N_{ij}, where the "ij" represent indices for injury in compression, tension, flexion and extension. Validation experiments were conducted using a Hybrid III crash dummy, representing a 5th percentile female. Dummy kinematics from drop experiments onto an exemplar trampoline were digitized from high-speed video. Trampoline stiffness and damping were determined by dropping a bowling ball from various heights. Friction properties between sock and mat were determined with a pull meter.

Results. There was excellent agreement (within a few percent) between angular orientation measured during experiments with the Hybrid III dummy and the angular orientation predicted by the simulation. The dummy was nearly vertical initially and then rapidly rotated backward after initial impact of the feet with the trampoline mat, resulting in impact on the back of the head as the dummy rotated past the horizontal. For the 95th percentile male involved in the incident under litigation, the kinematics were similar, with a large rapid rotation predicted as the slipping feet are accelerated vertically by the rebounding mat. As the back of the head then contacts the mat, vertical forces result in flexion moments on the cervical spine sufficient to exceed neck injury criteria.

Discussion. There is a large literature on the biodynamics of gymnastics, diving and other sport and space flight related activities that require self-rotations while in flight. There is also a rapidly growing literature on the biodynamics of falls and their relationship to injuries of the hip and spine. Finally, because of the public health importance and

fiscal impact of catastrophic injuries to the neck, the last three decades have seen important advances in our understanding of the injury thresholds and tolerance limits of the human cervical spine. Unfortunately, these approaches have seldom been applied to the use of trampolines. The fundamental issue sought to address was whether or not a slip and backward fall on a trampoline could cause serious injury. The results demonstrate a serious injury mechanism peculiar to trampolines. When slipping and falling backward while jumping even gently on a trampoline, the subject can be "whipped" backwards by a strong upward force exerted by the trampoline mat on the slipping feet. This causes the body to rotate through a large angle so that the head directly impacts the trampoline surface, producing loads on the head sufficient to result in catastrophic injury to the cervical spine for subjects ranging from a 5th percentile female to a 95th percentile male. This, to the author's knowledge, is the first analytic model for injury prediction from jumping on a trampoline. While simple, the model incorporates the major features of the trampoline response, the biodynamics of the jumper's motion, and the interaction between the jumper's feet and the mat. The model was validated using a modern Hybrid III crash dummy and a full-scale exemplar trampoline. The model did not reflect the distribution of mass and mass moments of inertia that might be possible through use of a multi-segment articulated total body model. However, the two-link model achieved excellent agreement between analytic predictions and direct experimental measurements, a finding that lends additional credence to the modeling approach. Ongoing work is extending these approaches to a consideration of comparable neck injuries in children, a consideration of multi-link articulated body models, and more complex representations of trampoline properties.

Trampoline, Injury, Biomechanics

C37 Injury Biomechanics in Rollover Motor Vehicle Accidents

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The goal of this presentation is to demonstrate that analytic predictions from accident reconstructions and simulations of occupant dynamics can be used along with injury assessment and tolerance criteria to predict injury risks and probabilities of death for complex rollover accidents.

Rollover motor vehicle accidents (MVA), while relatively rare, are frequently associated with serious injury and death and thus contribute disproportionately to national MVA injury statistics. Due to the often devastating and sometimes deadly head and neck injuries involved, rollover accidents are also frequently involved in litigation, with case issues revolving around seat belt design, roof crush properties, and seat belt use. While there is an extensive experimental and analytical literature addressing these issues, there have been relatively few attempts to use the increasingly sophisticated tools of accident reconstruction and injury biomechanics in concert to study rollover accidents and their associated injuries. One of the advantages of such an approach is that the actual incident and its known injury patterns can be used as validation of the analytical models, thereby increasing confidence in their use to address issues raised in litigation. The authors' goal was to use commercially available software for accident reconstruction and occupant dynamics, along with federally mandated standards for injury assessment and tolerance criteria to provide generalizable tools for predicting injury risks and probabilities of death for complex rollover accidents.

Methods. Rollovers are among the more challenging motor vehicle accidents to reconstruct because they involve linear motions in three dimensions (x, y, z) and rotation about three axes (roll, pitch and yaw). Accident reconstruction software (Human Vehicle Environment [HVE] suite, Engineering Dynamics Corporation [EDC], Beaverton, Oregon, 97008) was used to simulate three complex rollover events, two involving issues related to seatbelt use and one involving alleged design defects related to seatbelts and roof crush. The Graphical Articulated Total Body (GATB) Model was used to compute occupant kinematics (position, velocity, and acceleration vs. time), joint angles and torques, and contact forces between the human occupant and contact panels attached to the interior of the vehicle. Injuries were characterized using the Abbreviated Injury Scale (AIS). The Head Injury Criterion (HIC) was used to assess the risk of head injury. Predicted neck moments and forces from each rollover were compared against known tolerance limits for the human cervical spine according to Federal Motor Vehicle Safety Standard (FMVSS) 208. The resulting criteria are referred to as N_{ij}, where the "ij" represent indices for the neck injury in combinations of compression-tension and flexion-extension. The Combined Thoracic Index (CTI) was used to assess the risk of thoracic injury. The Probability of Death (POD), based on epidemiological data relating injuries to mortality, was used to predict the probability of occupant fatality.

Results. For each of the three reconstructed rollover events, there was excellent concordance between the predictions of the analytical models and the physical measurements made at the scene, the participants' recollections and testimony about the event, and the injuries that the occupants actually sustained. In one high-speed rollover, ejection of an unbelted occupant through the sunroof was both predicted by the models and occurred in the accident. Miraculously, the ejected passenger sustained only moderate injuries, including a fractured pelvis, despite being found pinned beneath the vehicle. Significantly for the case at issue, the analyses predicted that she would more likely than not have been even more seriously injured had she been fully restrained. For the belted simulation, the head injury criteria was equivalent to a 60% probability of an AIS 4 head injury, a 51% probability of an AIS 3 neck injury and a 89% probability of an AIS 3 chest injury. Taken together, the predicted probability of death was 78.5%. In a second simulation, a partially restrained (without lap belt) passenger was predicted to have a high probability of a catastrophic neck injury from contact with the roof during its first impact with the ground, prior to his being ejected during subsequent rolls. Use of the lap belt did not significantly reduce the risk of neck injury (although it would clearly have reduced the probability of ejection). In a third simulation, a fully restrained passenger was predicted to contact the roof as the rolling vehicle impacted the roadway during its second roll. The predicted N_{ij} value was 1.93, well in excess of the injury threshold, and resulting in a 64% probability of an AIS 3 injury to the cervical spine. This was consistent with the extension-compression C6/7 injury that the occupant actually sustained. Parametric studies with a two-fold increase in roof stiffness, use of seatbelt pretensioners, and interior roof padding, reduced N_{ij} to 1.46, equivalent to a 41% probability of an AIS 3 injury to the cervical spine, a 25% reduction in neck injury risk.

Discussion. These simulations demonstrate that accident reconstruction and occupant dynamics can be used to predict vehicular and occupant kinematics during complex, high-speed rollover events along with occupant injuries that actually occur. This lends credibility to analytical predictions directed at answering case questions related to seatbelt use and alleged vehicular design defects. The findings further confirm that, while seatbelts clearly reduce the probability of occupant ejection during rollovers, they do not appear to provide sufficient protection against catastrophic head and neck injuries from rollover accidents. Moreover, it appears that relatively modest increases in roof stiffness, the use of restraint pretensioners, and roof padding can dramatically reduce these injury risks. Simulations such as those presented here can also be used to study vehicular design changes that might reduce the risk of occupant injury during rollover accidents.

Rollover, Injury, Biomechanics

C38 Water/Snow Slide Tubing Neck Injury Biomechanics: Catastrophic Cervical Injuries Produced By Low-Level Head Loading When Base of Neck Is Immobilized

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The goals of this presentation are that attendees will gain skill in accurately synthesizing injury mechanisms responsible for fracture-dislocation of the cervical spine under conditions where (1) low-level head loading occurs with (2) the base of the neck immobilized.

A healthy, athletic 17-year-old female (height=5'3"; weight=117 lbs.) was sitting, buttocks-down, in a large tube, floating at a staging area of a water park, awaiting clearance to float down a chute. She and her tube were pushed into and down the chute when she was facing backwards, looking upstream. She was proceeding without difficulty, traveling backwards down the chute, when she and her tube floated into an adult male (height-5'4"; weight=135 lbs.) who was facing down the chute and walking down the chute to retrieve his tube. The girl and her tube impacted the rear aspect of the man's lower legs, knocking his legs out from under him, causing the man to fall backwards and land on top of the girl. This collision of the girl, sitting in her tube, and this adult male occurred at a place where the chute incline was relatively gentle, the water flow rate was of moderate speed, and the water was less than one foot deep. Lying on his back on top of the girl and her tube, with the girl facing down, the man and the girl then floated down together on her tube into the pool below.

Upon impact of the girl in her tube and the man, the girl could neither move nor feel her legs. In this accident, the girl suffered a C6-7 cervical spinal dislocation, with anterior flexion of C6 forward of C7, with her right C6-7 facet joint completely disrupted and her left C6-7 facet joint perched, and with subluxation offset of 50-75% of vertebral body depth. She suffered a complete spinal cord injury at the C6-7 level. She remained conscious, and no evidence was ever found that head, torso, or extremity injuries were sustained in this accident. The man suffered no injuries in this incident.

Experimentation was conducted with a surrogate seated, buttocks-down, in an exemplar water slide tube, with the surrogate's legs draped over the top of the tube and her hands gripping the right and left hand holds located on the top of the tube. The outside diameter of this tube was approximately 4', and the inside opening diameter was approximately 17-1/4". When the surrogate was seated/folded-up in a typical relaxed, comfortable configuration in the tube, the upper back and lower aspect of the surrogate's shoulders were leaning and braced against the tube. This typical rider configuration resulted in significant bracing of the tuber's base of the neck, relative to the tube. Low levels of downward, forward loading applied to the top-rear aspect of the authors' heads left little doubt that loading the head in this fashion could produce dislocation of the cervical spine.

Bauze and Ardran[1] conducted compressive loading studies on fourteen human cadaveric cervical spinal specimens that were intact extending from the basiocciput down to the second thoracic vertebra. The T1-2 base of the cervical spine was fixed to a lower plate, while the previously prepared flat surface of the basiocciput lay flush against the smooth, lubricated surface of an upper plate. When this cervical spinal specimen was subjected to compressive loading, quasi-statically, progressive "ducking" of the head, with the orientation of the head remaining essentially unchanged, caused bilateral dislocation of the facets without fracture. The maximal vertical load achieved was only 319 pounds force (lbf) and this coincided with rupture of the posterior ligament and capsule and stripping of the longitudinal ligament, prior to dislocation. These studies indicated the vulnerability of the cervical spine to head loading that induced ducking of the head when the base of the cervical spine remained relatively immobile.

This pioneering work of Bauze and Ardran identified the injury mechanism responsible for the catastrophic cervical injury sustained in the relatively low-speed impact of the girl, riding in a tube, in shallow water, and the walking man who was upended, falling backward onto the top-rear aspect of the girl's head. However, absent the significant neck base immobilization achieved riding/seated, buttocks-down, in a large water/snow slide tube, the level of contact loading sustained from a standing adult falling over rearward on top of a seated adult is typically insufficient to cause dislocation of the cervical spine.

[1] Bauze, R.J., Adran, G.M.; "Experimental production of forward dislocation in the human cervical spine." J. of Bone & Joint Surg. 60-B (2), May, 1978.

Dislocation of Cervical Spine, Locked Facets, Quadriplegia

C39 A Proposed Stress Index for Predicting Whiplash Injury

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Participants at this presentation will understand 1) the mathematical formulation of a combined stress index, 2) simple load stress values for predicting neck injury, and 3) using the proposed stress index with combined load stresses for predicting neck injury during a whiplash event.

Background: A 2-D mathematical model was developed to simulate the dynamics of vehicles and occupant dummies during collisions. The author presented a description of the model to the AAFS Engineering Sciences Section at the 1994 meeting in San Antonio. A 3-D mathematical model was developed as an extension of the 2-D mathematical model. The author's paper "Mathematical 3-D Model for Whiplash Simulation" was published in the NAFE (National Academy of Forensic Engineers) Journal December 1996. The mathematical formulations are based on a "lumped parameter" approach wherein the vehicles and the dummy occupants are represented as a series of rigid masses interconnected by springs and dampers. Nodes are selected to be at the dummy neck and low back positions and at strategic points in the vehicle body and its seat. Empirical values of various parameters in the mathematical model are the author's best estimates based in part on barrier and vehicle crash tests as reported by other researchers for crash tests that were primarily frontal and rear end crashes. Sources include, but are not limited to, AAFS Annual Meeting presentations and SAE (Society of Automotive Engineers) publications. Computer simulations of crash dynamics are solutions of initial value problems using the mathematical model programmed in a scientific language.

Computer simulations produce tabulations of values for accelerations, velocities, and positions as functions of time from the initial vehicle contact for all the mass lumps in the mathematical model expressed in linear and angular coordinates. Tabulations also give values for all forces, bending moments, and torques at the nodes between the mass lumps.

Machine design methods for predicting probable failures in machine parts typically involve: determination of stresses (force per unit area) at all critical points in the structure, selection of an appropriate failure mode, and comparing results to the strength of the material from which the part is made. When combined loads are considered, analytical methods typically employ a model known as the "Mohr's Circle." This gives calculated results for maximum shear stress, maximum principal (tension) stress, and minimum principal (compression) stress at each critical point. Material strengths are usually determined from independent destructive tests according to accepted standards.

Proposed Stress Index: It is desired to use computer simulation results to predict whether neck injury is probable during the simulated crash. Machine design methods are employed for determining the stresses

in the dummy occupant neck during a simulated vehicle crash using the calculated forces, bending moments, and torques during the simulation. If the material strength(s) and critical point location(s) for the human neck are known, then the desired task can be completed. In order to obtain approximate values for these parameters, the author analyzed data published in SAE J1460 MAR85 "Human Response Characteristics," SAE J885 JUL86 "Human Tolerance to Impact Conditions as Related to Motor Vehicle Design," and SAE J833 MAY89 "Human Physical Dimensions." Results of those analyses are given in this presentation. Several crash simulations are presented including calculations using the proposed stress index.

Whiplash, Stress Index, Load Stress

D1 The Los Angeles County Department of Coroner Special Operations Response Team: Case Examples of the Utility of Such Teams in Large Jurisdictions

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Attendees will learn through case examples the structure and utility of special operations and recovery teams for coroner/medical examiner offices in cases needing special handling or traditionally needing assistance from outside agencies, including mass fatality incidents (>5 decedents), multiple decedent assistance, special decedent recovery, buried bodies, decedent searches, and public relations events.

The Los Angeles County Department of Medical Examiner/Coroner (LACDOC) is one of the busiest offices in the U.S. In 2000, the LACDOC certified 9,156 cases: 2,668 accidental deaths, 21 fetal deaths, 1,070 homicides, 4,068 natural deaths, 728 suicides, 258 undetermined deaths, and 343 "other" (the latter category includes specimens and other remains not of forensic value).

It is estimated that approximately 75 of these cases involved multiple decedents, mass fatality incidents, special decedent recovery, and buried body recovery. Because of the difficulty in processing such scenes, the need for specialized training was recognized, and in 2001 the Special Operations and Recovery Team (SORT) was created.

Specially selected and trained coroner investigators, criminalists, forensic technicians and attendants, and other experts, including an anthropologist and an archaeologist, staff the SORT.

SORT is designed to provide field assistance to coroner investigators in cases needing special handling, or traditionally needing assistance from outside agencies. The general case categories to which SORT is designed to respond are: 1) mass fatality incidents, with five or more decedents; 2) multiple decedent assistance, at the discretion of relevant personnel; 3) special decedent recovery, including decedents found in remote areas or areas with difficult or restricted accessibility; 4) buried bodies; 5) decedent searches, including scattered skeletal remains and clandestine graves; and 6) public relations events.

The LACDOC is, to the knowledge of the authors, the only county agency in the country to initiate such a team. The reasons for this are likely many, but prominent among them is the large number of "special" cases seen in Los Angeles County. Through the use of case examples this paper presents the utility of teams such as SORT from the perspectives of the coroner investigator, criminalist, forensic pathologist, anthropologist, archaeologist, and outside law enforcement agencies.

The first case study involves the mid-air collision of two small aircraft over water. This was the first activation of the SORT, and as such was a learning experience. In this case, SORT was able to assist in the recovery of two decedents under very difficult circumstances.

Case example two involves deployment of SORT on a decedent search in a mountain environment. Prior to deployment, fragmentary skeletal remains from two individuals were recovered from a single campground on two separate occasions. The area was considered a body dump, and a search was organized for the remainder of the two partially recovered decedents. Although no human remains were found, the search provided an invaluable avenue for personnel training and interagency cooperation.

The third case example involves an urban scene where construction workers unearthed human remains. An almost complete skeleton, including most of the feet and hands but excluding the cranium or mandible, were recovered over the course of three days under challenging conditions.

A fourth example involves a fire scene. In a high-profile incident, a suspect barricaded himself in his home. The house burned to the ground. SORT recovered several burned tooth fragments, along with cranial fragments, long bone fragments, and personal possessions of the decedent. The tooth fragments were useful in positive identification of the decedent.

The case studies illustrate well the value of a team such as SORT in large jurisdictions. Personnel, both within LACDOC and in outside agencies which interact with LACDOC, agree that having a team that trains together for difficult special recoveries, the members of which work well together, makes any recovery, no matter how difficult, run more smoothly. The SORT also increases the likelihood of complete recovery of relevant remains and the rate of positive identification of unknown decedents in Los Angeles County.

Special Decedent Recovery, Coroner Special Operations, Buried Body Recovery

D2 The Living Quality Manual: An Essential For Every Forensic Laboratory

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The goal of this presentation is to describe one laboratory's approach to the development of a quality manual that incorporates all essential accreditation requirements and still has room for future growth.

The focus of today's business environment is towards one of increasing quality, certification, and accreditation. The forensic community has also felt the impact of this trend, mainly through the changing and growing requirements put forth by ASCLD-LAB as it looks to adopt recommendations from ISO (International Organization for Standardization) and various scientific and technical working groups. The problem many laboratories face today is how to incorporate requirements and recommendations from so many different sources in order to maintain necessary accreditations. Laboratories have had policies and procedures for many years, but often those manuals were written in such a way as to make adaptation to today's standards nearly impossible. How to write a quality manual that can change with the times is not an insignificant task.

Ideas for how to structure the new quality manual were researched. The quality manuals from other forensic laboratories and the quality systems implemented by non-forensic ISO certified organizations were reviewed. The system ultimately devised was structured by sectioning off all the different areas of laboratory operations into a table of contents. This consisted of the following nineteen areas:

1. Introduction
2. Personnel
3. Physical Plant
4. Document and Information Management
5. Safety

6. Customer Service
7. Subpoenas and Court
8. Purchasing
9. Laboratory Audits and Inspections
10. Chemicals, Standards, and Reagents
11. Evidence Control
12. Processing and Analyzing Controlled Substances
13. Processing and Analyzing Suspected Ignitable Liquid Submissions
14. Processing and Analyzing "Other" Evidence
15. Instruments and Equipment
16. Validation and Verification of Analytical Methods
17. Proficiency and Competency Testing
18. Corrective and Preventive Action
19. Other Professional Services.

Each section was further subdivided as necessary. The subsections were numbered at increments of five or ten to allow room for additions and changes. The development of each subsection was assigned to different personnel under the direction of the laboratory director. Each subsection contained only one policy supported by multiple methods, forms, documents, and logbooks as appropriate. A unique identifier was given to each document created. This identifier included the subsection number and a letter designation of "P" for policy, "M" for method, "F" for form, "L" for logbook, and "D" for document.

A standard layout was established under which each policy and method was created. Every policy and method had the same header of the laboratory name, section number and title. The information that appeared next was whether it was a policy or method followed by the subsection title. For example: 1535P Equipment Maintenance. Lines indicating revision, effective date, affected personnel, and approval signatures appeared next on each policy or method. The body of each policy and method included: scope, references, definitions, policy, or method as appropriate, and records. References included any other related sections of the quality manual, internally created documents, and external literature references. Definitions were created for consistency and clarity and were compiled into a glossary created for the quality manual. Records included any related forms or logbooks that were created during execution of the policy or method. Lastly, each policy had an area that was titled "compliance." Here the laboratory tracked the ASCLD-LAB, SWG, and TWG sections covered by the policy.

Analytical methods were structured a little differently to include additional sections titled "validation and verification" and "reagents and chemicals." The validation and verification section listed references for the method as well as in-house testing that was done to further validate or verify the use of the method. In-house testing documentation required for the quality manual is specified in the quality manual under a section titled "validation and verification." This format allowed a tie between the investigation and implementation phases of a method.

One of the biggest challenges a laboratory faces Under ISO is document control. This challenge is largely overcome by electronic maintenance of the quality manual. The electronic version is cross-referenced by hyperlinks to make it very user friendly. Only one hard copy of the quality manual exists in the laboratory and is maintained by the quality manager. This is the controlled copy of the quality manual. Laboratory personnel affected by a policy or method are required to sign each document signifying they were trained and cognizant of the method or policy content. As new revisions go into effect, they are presented at the monthly staff meeting and affected personnel are required to sign the new revision. All personnel have access to the quality manual electronically and sections of the quality manual may be printed. It is the users responsibility to ensure that they are not referring to outdated versions. A spreadsheet is maintained to track the implementation dates and revisions while old revisions are archived. Another spreadsheet is maintained to track on-going work to the quality manual including personnel responsibilities and target deadlines.

While starting a new quality manual from scratch can be an overwhelming task, structuring the documentation system in such a manageable format is well worth the time. By gaining input from as many people as possible the task not only becomes easier, but even more important, buy-in to the new system is achieved. Adding pieces to older documentation to meet the new accreditation requirements only results in an awkward and difficult to use quality manual. A new quality manual that is electronically based will allow for easy, unlimited future growth.

Quality Assurance, Accreditation, Quality Manual

D3 An Analysis of the Suspiciousness Factor and Role Opportunity as Related to Forensic Evidence Capture in Hospital Emergency Departments

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The goals of this poster presentation are to demonstrate the effectiveness of the clinical forensic nurse in case-finding and evidence management within the hospital emergency department. A series of patient cases will be used to illustrate the benefits of having clinical forensic nurse presence during the initial contact with a patient at healthcare's point of entry. In each of these cases, the evidence identified, documented, and preserved by the nurse later became a vital element in medical-legal or criminal proceedings.

There is a significant amount of vital forensic evidence that is unrecognized, compromised, or even irretrievably lost during resuscitation and other emergency care regimens. Failure to recognize and safeguard evidence in healthcare settings may result in medical errors, miscarriages of justice for victims or perpetrators, and may result in lengthy, complex investigations. Healthcare dollars and manpower resources consumed to support these endeavors may derail other mission activities and create immeasurable human burdens. In high-profile cases, healthcare workers, the administration of the medical treatment facility, and the federal government necessarily assume some part of the embarrassment, culpability, and tainted image that accompany public disclosure of adverse patient events and evidence mismanagement.

The emergency department is the point of entry for most patients who are victims of accidents or who become acutely ill. Patients arrive by ambulance or private transportation. In some locations, patients walk in alone, suffering from life-threatening illness or injury. Since nurses triage and obtain the data for the baseline history and physical assessment, they have the rare opportunity to capture information that may subsequently be altered or destroyed during the course of further examinations, diagnostic tests, and medical treatments. A well-honed forensic *suspiciousness factor*, coupled with human experiences and clinical judgment, provides an ideal acumen in the Emergency Department. Careful recording of anecdotal details of how an injury occurred, a thorough body survey, and precise observations about the patient's behavior may reveal important clues that may ultimately prove to be the linchpin for solving a forensic case. A forensic clinical nurse's education, skill training, and indoctrination help to facilitate the identification, preservation, and safeguarding of evidentiary materials. This acumen is "value added" to the typical emergency nurse's role. The hospital's quality management programs, as well as healthcare beneficiaries and justice systems, individually and collectively, derive benefit from the forensic competencies of nursing personnel.

Patients presented to the hospital's emergency department do not wear a tag, ***Caution Forensic Case in Process.*** However, the clinical forensic nurse believes that any patient encounter may already possess, or could develop, forensic implications. Vigilance and consistency in assessment and documentation are hallmarks of a clinical forensic nurse.

The refusal to "take stories at face value," the belief that every detail in the history and physical examination has significance, and that all patients deserve to have their human rights protected during the course of medical care are major tenets of a forensic nurse.

Forensic science indoctrination is no longer an option in healthcare facilities. The standards and scoring guidelines of the Joint Commission for Accreditation of Healthcare Organizations mandate that hospitals must equip all personnel to identify abuse and neglect, to take certain steps to protect the victims, and to refer them to appropriate resources for follow-up. This provides the foundation for a healthcare facility to justify the presence of the clinical forensic nurse, especially at entry points where many individuals may present for care. Hospital resources must be committed to forensic initiatives, even in times of overwhelming workloads, short staffing, and personnel shortfalls. The penalty for missing forensic clues and failing to initiate appropriate interventions may cost the patient his life and place a nurse's professional career in jeopardy. The costs for damage control when nurses fail beneficiaries and violate the public trust cannot be measured. Forensic education and training should be encouraged and emphasized at all levels within the hospital's chain-of-command, and position descriptions should be updated, listing specific forensic roles and responsibilities for the clinicians, supervisors, and administrators. The placement of a qualified forensic nurse in the emergency department is relevant and reasonable and demonstrates to patients the highest standards of patient care delivery.

Evidence, Forensic Nursing, Suspiciousness Factor

D4 Latent Fingerprint Detection on Dry Human Bones Using Ninhydrin, Cyanoacrylate-Fuming, and Rhodamine-6-G Methods

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The goal of this presentation is to determine the visibility of latent fingerprints on dry human bones with the intent of aiding law enforcement officials in determining culpability of homicide.

Previous studies have determined that Ninhydrin is an effective reagent in visualizing fingerprints on porous surfaces such as paper, cardboard, raw wood, and wall coverings. The Cyanoacrylate-Fuming method uses Cyanoacrylate fumes combined with humidity to develop latent fingerprints on non-porous surfaces and some porous surfaces. Both the Ninhydrin and the Cyanoacrylate-Fuming (Superglue™) techniques were used to determine which, if not both, were the most effective in visualizing latent fingerprints.

This study incorporated human femora, human pelvic bones, and deer femora from the FACES Laboratory at Louisiana State University. Cases from as early as 1983, and as recently as 2001, were used to differentiate time parameters in determining the length of time fingerprints persist on porous surfaces. Cleaned, processed bones were used as well as bones that had been housed immediately following recovery. These variables were used in order to determine the conditions necessary to reach the optimum visibility on these bones.

Ninhydrin involves a chemical reaction using a Ninhydrin crystal-based reagent to stain a porous surface when reacting with amino acids in the fingerprint. The resulting stain is called "Ruhemann's Purple" after the English chemist that first developed Ninhydrin in the early 1900s. The solution can be applied by painting, dipping, pouring, or spraying and is reapplied in the same manner twenty-four hours later. Heat and humidity are then applied to accelerate the development of prints. It is necessary to monitor the progress of the fingerprints as the process advances in order to record any visible prints that may appear and then disappear quickly.

The Cyanoacrylate-Fuming method produces more rapid results using an environmental Cyanoacrylate-fuming chamber. This allows the researcher to control the amount of humidity that is necessary for the adherence of fumes to the fingerprints. The Cyanoacrylate ester (Superglue™) packet is opened and sealed in the chamber with the bones and open containers of steaming water. This humidity facilitates development of latent prints that are present. The fumes produce a white deposit that adheres to the protein compounds in the fingerprints. The bones are then processed with Rhodamine-6-G, which is a fluorescent dye that is used to stain the fingerprints. When using these methods, it is important to perform either the Ninhydrin test or the Cyanoacrylate-Fuming method, since these methods do interfere with one another.

Initial testing showed that the deer femur developed latent fingerprints within thirty minutes using the Ninhydrin method but the prints disappeared within two hours. The Cyanoacrylate-Fuming method did not produce any results on the deer femur.

The human bones did not produce any visible fingerprints using the Cyanoacrylate-Fuming method initially. In order to determine the viability of the Ninhydrin test, lotion, which reacts with Ninhydrin, was applied to the hands of the researcher before the bones were handled again and the Ninhydrin was re-applied. The human bones produced visible prints using the Ninhydrin method after applying lotion to the hands.

Further testing showed that the human bones developed latent prints using the Cyanoacrylate-Fuming method with recent handling of these bones, but the prints only showed up after they were treated with Rhodamine-6-G. Fingerprints were not developed on the human bones with the Ninhydrin method; however, the deer femur did develop latent fingerprints using the Ninhydrin method, and the prints showed up within one hour of applying the solution. The prints did not absorb into the background after two hours as in the original test. However, the deer femur only produced results with the Ninhydrin and not the Cyanoacrylate-Fuming method.

Both the Ninhydrin and Cyanoacrylate-Fuming methods have been tested on human and deer bone in an attempt to show the presence of latent fingerprints. The Ninhydrin test proved to be most effective on the deer femora and the Cyanoacrylate-Fuming method proved to be the most effective on the human bone after treating with Rhodamine-6-G.

The delineation between the processes and their effectiveness could be due to the differences in osteon alignment in human and non-human bone or the compactness therein. Studies in osteon alignment in human and non-human bone have suggested that the non-human bones have more of a regulated alignment than do human bones. This could affect the porosity of the bone and allow fingerprints to be absorbed into bone at a more rapid pace in human bone than in non-human. The Ninhydrin method might have better results with the non-human bones, due to the compactness of the cortical bone versus the porosity of human bone. The Cyanoacrylate-Fuming method might work better on more porous surfaces such as human bone.

To be able to visualize latent fingerprints on human and non-human bone may not only impact homicide cases but may also be an effective tool in Wildlife and Fisheries departments across the country. The research shows that latent fingerprints can be visible on dry human bones as well as non-human bones. The next step in this research is to determine how long the fingerprints will remain on bone in various climates.

Fingerprints, Ninhydrin, Cyanoacrylate-Fuming

D5 Experimental .38 Caliber Pellet for Use in Environments Requiring Limited Penetration

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The goals of this presentation are to understand (1) the design and fabrication of an experimental .38 caliber pellet for use by law enforcement officers, (2) the combination of mass and velocity needed to produce enough energy for the experimental pellet to perforate skin, and (3) the depth of penetration in a pine board for the experimental pellets.

The purpose of this presentation is to offer the results of a study that evaluates an experimental subsonic .38 caliber non-diabolo styled pointed lead alloy pellet for use in environments that require limited penetration for projectiles. Aircraft passenger compartments and cockpit areas may be suitable for this type of ammunition in anti-terrorist situations. The risk of rupturing an aircraft fuselage would be less probable with the experimental .38 caliber pellet because it would have considerably less energy than a standard .38 caliber bullet. The development of a large caliber pellet would give law enforcement officers some options when selecting ammunition for environments that require limited penetration.

An experimental .38 caliber pellet was designed and a limited number were produced for the test. A positive pellet mold was made by turning a piece of aluminum stock on a lathe .350 thousandths of an inch in diameter and .620 thousandths of an inch long with a 45-degree point. The positive pellet mold was placed in a soft pliable mixture of plaster of Paris and allowed to solidify. Once the plaster solidified the positive mold was removed to produce a negative mold of the pellet's form. When the plaster mold was completely dry, molten lead was poured in the negative impression to produce a .38 caliber lead pellet. The 45-degree nose point of the pellet was machined on the lathe and the base was drilled to produce the pellet. The base of the pellet was drilled to a .250 thousandths of an inch diameter and .300 thousandths of an inch deep to produce the cavity in the pellet. The length of the experimental pellet was .620 thousandths of an inch long and the outside diameter was .360 thousandths of an inch. The wall thickness at the base of the pellet is approximately .060 thousandths of an inch. The exterior surface of the pellet's tip was filed while in the lathe to produce a smooth finish.

A .357 Smith & Wesson model 686 with a four-inch barrel was used to test the experimental pellets. The pellets with an average mass of 5.302 grams were tested with five propellant charges to determine the average velocity of each propellant charge. The average velocity for pellets loaded with 0.5-grains of Hercules Unique powder was 45 m/s (149 ft/s); 1.0-grains was 213 m/s (697 ft/s); 1.5-grains was 263 m/s (865 ft/s); 2.0-grains was 273 m/s (897 ft/s); and, 3.0-grains was 379 m/s (1244 ft/s). The test determined that pellets loaded with less than 1.0-grains of propellant did not always have sufficient energy to exit the barrel of the weapon; this was possibly due to the amount of friction between the pellet and barrel. Pellets stuck in the barrel were removed with a bullet puller.

DiMaio, et al., have determined that the minimum velocity needed for a .38 caliber round nose lead bullet with a weight of 113-grains to perforate skin is 58 m/s (191 ft/s). The Formula, Kinetic Energy, $KE=\frac{1}{2} \cdot mv^2$, was used to convert the bullet mass and the minimum velocity to the amount of energy in joules needed to perforate the skin. The mass is expressed in kg and the velocity in m/s. The 113-grain bullet with a mass of 7.345 grams produces 12.5 joules (9.21 ft-lb) of energy. Therefore, the experimental pellets need to have at least this much energy or higher to perforate skin. Since the mass of the .38 caliber test pellets is less than 7.345 grams, they will need more velocity to obtain the minimum amount of energy to perforate skin.

Based on the KE needed to perforate skin, two propellant charges were selected for testing the experimental pellets. Four test pellets were loaded with 1.0-grains of Hercules Unique smokeless powder and four rounds were loaded with 1.5-grains of Hercules Unique smokeless powder. The range of mass for the test pellets loaded with one grain of powder was 5.302 grams to 5.436 grams with a mean mass of 5.370 grams. The average velocity for these pellets was 188 m/s (615 ft/s). The range of mass for test pellets loaded with 1.5-grains of powder was 5.388 to 5.670 grams with a mean mass of 5.480 grams. The average velocity was 273 m/s (897 ft/s). The pellets were fired at a distance of 7.62 m (25 ft) into a pine board 53.34 cm (1-¾ in) thick. A chronograph was used to determine the velocity for each pellet and the depth of penetration was measured with the depth gauge on dial calipers.

The average KE for pellets loaded with l.0-grains of propellant was 95 joules (70 ft-lb) and for pellets loaded with l.5 grains of propellant, it was 205 joules (151 ft-lb). Even though 1.0-grains of propellant produce more than the minimum amount of energy required to perforate the skin, the load with 1.5-grains was determined to be more reliable during the testing. The ammunition containing 0.5-grains more propellant had more than twice the amount of energy needed to perforate skin, but performs more consistently in the weapon than the 1.0-grains load and has considerably less energy than a .38 caliber factory load. A .38 special factory load with a 158-grain lead round nose bullet with a mass of 10.24 grams produces 271 joules (200 ft-lb) of energy. This is 71 joules (52 ft-lb) more than the experimental pellet. The degree of penetration in the pine board was obtained by measuring from the surface of the wood to the base of the pellet. The range of depth for pellets having an average energy of 95 joules (70 ft-lb) was 8.25 mm (.325 in) to 12.22 mm (.481 in) with an average depth of 10.16 mm (.400 in). The range of depth for pellets having an average energy of 205 joules (151 ft-lb) was 18.21 mm (.717 in) to 25.27 mm (.995 in) with an average depth of 21.34 mm (.840 in). Reliable .38 caliber pellet ammunition delivering approximately 200 joules (148 ft-lb) of energy would give law enforcement officers an option when limited penetration is required.

Pellet, Firearms, Ammunition

D6 The Potential Value of Ejected Cartridge Casing Impact Marks in Shooting Scene Reconstruction

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The goals of this presentation are to raise awareness of the potential value of ejected ammunition cartridge marks at shooting scenes. This presentation proposes that scene investigators should consider the possible presence, and potential value, of ejected cartridge impact marks at shooting scenes.

According to the Federal Bureau of Investigation's 1999 Uniform Crime Report statistics, 65.2 percent of all murders committed in the U.S. involve the use of a firearm, and 78.6 percent of those were committed with a handgun. The study of matters related to firearms use during the commission of offenses is vitally important to the successful investigation and accurate reconstruction of these crimes.

Post-event reconstruction requires a thorough scene examination, comprehensive scene documentation, interviews of eyewitnesses, and the careful collection and examination of physical evidence. In cases where firearm discharges are involved, forensic examinations of weapons, projectiles, and ammunition casings are commonly conducted. In addition, trajectory assessments, range-of-fire determinations, blood-stain patterns, and gunshot residue findings are oftentimes considered in reconstructing events.

Stemming from observations made at a police firing range, this study sought to determine if ejected cartridge casings leave characteristic marks when they impact nearby materials. This paper will present information and images pertaining to marks made when expended 9mm ammunition cartridges were ejected from a handgun. The dynamics and mechanical processes at work when an expended cartridge is ejected from a pistol will be reviewed. The results of test firings from a Sig-Sauer model P228, 9mm pistol, where ejected casings were allowed to impact 3/8-inch wallboard, will be summarized. Photographic images showing four characteristic impact marks will be presented.

In conclusion, hypothetical examples of how the presence of casing impact marks might be helpful in scene reconstruction will be presented and discussed.

Shooting Scene Reconstruction, Ammunition Cartridges, Impact Impressions

D7 A Report of the First AAFS Forensic Science Education Conference

Mary Fran Ernst, BLS, Saint Louis University School of Medicine, Division of Forensic Education, St. Louis, MO*

The goals of this presentation are to explain the Academy's new Forensic Science Education Conference project. Attendees will learn details of the Academy's initiative to provide forensic science knowledge to the nation's middle- and high school science and math teachers.

In July 2002, one hundred twenty middle- and high school teachers attended the First Forensic Science Education Conference in St. Louis. The conference acquainted the teachers with all the forensic sciences and the American Academy of Forensic Sciences.

In December 2000, the results of the Third International Mathematics and Science Survey (TIMSS) were released comparing U.S. students with those of 41 other nations. At the fourth grade level, U.S. students scored in the top quartile in both math and science. At the eighth grade level, U.S. students scored slightly above the international average in science and below the international average in mathematics. At the end of 12th grade, the performance U.S. students in both math and science ranked among the very lowest in math and science of the 42 countries, including the performance of the most advanced students. At the Council of Scientific Society Presidents meeting in December 2000, attendees agreed that few of today's U.S. middle- and high school students showed interest in the basic sciences, but the vast majority of middle and high school students were enthralled with the forensic sciences.

In February 2001, recognizing that the American Academy of Forensic Sciences was in a pivotal position to promote the forensic sciences to America's youth, discussions of a collaborative initiative between the AAFS and middle- and high school science and mathematic teachers was initiated by the AAFS. Volunteers were recruited via the *Academy News* from among the membership to assist teachers requesting technical assistance in introducing the forensic sciences to their students. At the 2002 AAFS annual meeting in Atlanta, Director of Development Jim Hurley met with interested members and began the formation of a mentoring network. The Trustees of the Forensic Science Foundation also gave their support to the concept and agreed to revise the Academy's "So You Want To Be A Forensic Scientist" booklet.

In March 2001, AAFS members were spotlighted in a workshop that was held at the National Science Teachers Association annual meeting in St. Louis. Approximately 100 science teachers attending the workshop showed very strong support for additional information regarding the forensic sciences. Virtually all in attendance said that they would attend a summer conference in 2002 if AAFS members would provide them instruction as to how to incorporate forensic science applications into their classrooms.

In April 2001, an application was submitted to The Saigh Foundation to support a conference to inform middle- and high school science teachers of the disciplines that could be introduced into their science curricula. In October 2001, The Saigh Foundation did award a $50,000 grant to the AAFS to conduct a three-day conference in July 2002, at Saint Louis University in St. Louis, MO.

The three-day conference was held July 25-27, 2002. More than 120 middle- and high school science teachers attended from 30 states and Poland. Fifteen AAFS members provided presentations and fourteen workshops were conducted to illustrate forensic science experiments that could be conducted in middle- and high school science laboratories. All sections of the AAFS were featured to ensure that teachers were aware of the variety of forensic specialists that compose the world of forensic science. A four hundred-page manual was developed and distributed to teachers that included a lesson plan for each discipline's workshop.

A description of the conference program and workshops will be presented. Results of conference registrants' evaluations will be provided. A template that has been developed to assist designers of future conferences will also be explained.

Education, Forensic Sciences, Conferences

D8 Forensic Use of Biometric Access Devices

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The goals of this presentation are to **increase** awareness of forensic evidence from biometric access devices and methods of tampering with these devices that have to be taken into account before drawing conclusions.

Over the past few years, both large multinationals and governments have begun to contribute to even larger projects on biometric devices. Recent terrorist attacks in America and in other countries have highlighted the need for better identification systems for people as well as improved systems for controlling access to buildings. Another reason for investment in Research and Development in Biometric Devices is the massive growth in internet-based systems – whether for e-commerce, e-government, or internal processes within organizations. The interface between the system and the user is routinely abused, as people have to remember many complex passwords and handle tokens of various types.

Many users fall prey to socially engineered attacks, or choose easy-to-guess passwords and then write them down. For the reason of security, biometric systems are used. Systems with fingerprints, iris, hand scans, and faces are commercially available and are also used at airports. Many other biometric data are under investigation for commercial systems, as ears, gait, keystroke, odor, etc.

Testing and comparison of biometric systems has been an issue. Comparison of algorithms used in facial recognition is undertaken in the FERET program. Often of more interest is the "real life" performance in a situation approximating that of future deployment. New suppliers are often tempted to make claims of excellent performance based upon a small laboratory test or mathematical simulations. In practice it appears that face systems are still not good enough for many applications, since faces change in time, and they are difficult to acquire in a standardized way. New developments are in heat maps and thermograms, and developers claim that easier identification of individuals is possible. The BIOTEST project led by the National Physics Laboratory has produced a set of best practice guidelines for these systems that can be used for examining biometric systems. Also NIST is involved in developing standards for biometric systems.

The literature in this field is mostly focused on a well-engineered sensor, or the algorithms that are used. Less well-described are the systems of which biometric is a small part. If it is not integrated

securely, or if the system is vulnerable to an unexpected attack, even the best device will be compromised. Often the biometric system compromises a smart card with data of the finger print or the iris scan which is compared with the data of the person that would like to have access.

For forensic evidence the biometric devices can be important, since more information is available of the person who tries to access a building or a computer. They may also be helpful in cases of hacking if a suspect has been logged on with biometric data (e.g., a fingerprint).

With biometric devices it is still possible to have unauthorized access. Depending on the chip card that is used, someone can tamper with the data. Furthermore, it is also possible to copy the data from a person (e.g., a silicon cast of a finger). The problem with spoofed biometric data is that they cannot be revoked and renewed, as would have been done with a stolen key. Another reason for unauthorized access is that there are false acceptance rates, depending on the settings of the biometric device. Often the setting of the biometric device will be changed to have less false rejects, and this might cause the system to fail. In practice, biometrics is not more secure than PINs. For this reason it is good to have a combination of biometric data and PINs for access.

In forensic evidence with biometric devices the forensic examiner should consider the possibilities of tampering with the biometric systems or the possibilities of unauthorized access before drawing conclusions.

Biometrics, Tampering, Fingerprints

D9 Meta-Sadism vs. Clinical Sadism

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The goals of this presentation are to differentiate conceptual and practical uses of sadism in criminology and psychology.

This paper will examine the underlying issues at hand in an effort to make conceptual and pragmatic sense relative to "Sadism" and to offer an alternative to the misuse and torture of "Clinical Sadism" as understood in DSM-VI. Clinical Sadism, as a psychological/psychiatric concept, is a specialized body of knowledge that is relative to the diagnosis and treatment of the individual. Alternatively, when the issues are crime analysis, crime behavior, and probabilities for a crime typology, the focus should be appropriately changed to a criminological assessment and the psychologist/psychiatrist should utilize the concepts of deviancy. This continuum and these learning curves are called Meta-Sadism. Accordingly, when the continuums are appropriately referenced and differentiated, the clear separation allows for a dynamic understanding of sadism.

Sadism, Crime, Deviancy

D10 Characterization of Condom Lubricant Traces Using Raman Spectroscopy and Raman Chemical Imaging

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The goal of this presentation is to acquaint the forensic community in using Raman Spectroscopy and Raman Chemical Imaging for identifying condom trace evidence.

This presentation will address the use of Raman spectroscopy and Raman chemical imaging as primary methods in identifying condom lubricant traces such as polydimethylsiloxane (PDMS), polyethylene glycol (PEG), nonoxynol-9 (N9), and fine particulates. Chemical imaging possesses the ability to identify these materials in the presence of one another, providing they possess unique Raman spectra, thus minimizing sample preparation that is needed with current methods, namely Fourier Transform-Infrared (FT-IR) analysis. The focus of this experiment lies in applying this methodology to real world samples and demonstrating the use of Raman analysis as a primary analytical technique.

Dispersive Raman spectroscopy in conjunction with wide field Raman Chemical Imaging was used to analyze all samples. PDMS, PEG, N9, and lycopodium spore standards were analyzed, as these are all common lubricant traces. Trojan ultra thin spermicidally lubricated (Carter Wallace, Inc., Carter Products Division) and Plus Beyond Seven SheerIon spermicidally lubricated (Okamoto Industries, Inc.) condoms were also analyzed. Small amounts of raw material from these condoms were examined, and extraction experiments were also carried out according to a protocol set up for FT-IR analysis.

Dispersive analysis of pure components revealed most were Raman accessible. Lycopodium was found to be extremely fluorescent; however, this feature can still be used to characterize it on a Raman system in imaging mode if surface morphology is also considered. All of the other standards exhibited unique Raman spectra, which indicates chemical imaging will be capable of identifying each component. Next efforts focused on differentiating spermicide and lubricant in the presence of one another, namely PDMS and N9, since these are known to be immiscible. Optically the mixture looked no different than the pure components, a transparent liquid, save a few structures that resembled bubbles. Chemical imaging revealed the bubbles were actually emulsions of PDMS in N9.

Analysis of raw material from the Beyond Seven condom optically looked very similar to the mixture of pure components. The lubricant was a transparent liquid with bubbles. In this case, chemical imaging showed the bubbles to be N9 emulsions in PDMS. This is a prime example of how multiple lubricant components can be identified with Raman chemical imaging without first having to extract the sample and isolate the materials.

Analysis of the raw material from the Trojan condom showed predominantly PDMS; however, some weak Raman bands can be seen that are consistent with N9. Dichloromethane and water extracts of the raw material were analyzed. Raman chemical imaging was able to identify PDMS and starch from a dichloromethane extraction. N9 was identified in a water extract as well as calcium carbonate.

This experiment indicates that some of the most common materials found in lubricants are very Raman accessible and can be accurately analyzed by Raman spectroscopy. Furthermore, the analysis can extend to Raman chemical imaging possibly eliminating superfluous sample preparation and multi-instrument analysis.

Condom Lubricants, Raman, Trace Evidence

D11 Bilateral Perforation of the Tympanic Membranes in a Tornado Victim: An Under-Reported Injury?

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The goal of this presentation is to present the audience with autopsy findings in a tornado victim, to increase the level of awareness of tornadoes and their potentials to cause injuries.

Perforation of the tympanic membrane is a predictable outcome of drastic shifts in atmospheric pressure, creating a differential between atmospheric pressure and air pressure of the middle ear chamber. Tympanic perforation due to barotrauma is most commonly encountered in deep sea diving or exposure to bomb blasts. Lightning victims, exposed to rarified air and altered atmospheric pressure, have sustained injuries to the tympanic membrane. The enormous changes of

atmospheric pressure in gale-force wind conditions such as tornadoes and hurricanes have not been reported to associate with rupture of the tympanic membrane.

Case Presentation: A reported a case of barotrauma with perforation of bilateral eardrums in a 76 year-old female, victim of a recent tornado in Maryland. The victim suffered multiple injuries after being swept up and thrown 150 yards in a F4/F5 (most severe on the Fujita-Pearson scale) tornado, with winds in excess of 275 mph. The victim was in her kitchen when the tornado struck her house. Her body was found under a pile of debris that were the remnants of her house, by a ravine, 150 yards from the cinder block foundation, the only part of the house remaining. In addition to having extensive blunt force injuries, the body was covered with mud. Mud was especially dense around the mouth, nose, and ears, an additional indication of the force produced by the pressure differential between the atmosphere and the body cavities.

Conclusion: Tornadoes harbor powerful destructive forces. Their mechanics and physics are still being explored and slowly understood. This case is reported in the hope of adding to understanding the effects of these forces on the human bodies.

Tympanic Membranes, Barotrauma, Fujita-Pearson Scale

D12 Autoerotic Death Investigations—Validating Training Doctrine

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The goal of this presentation is to report findings of research and case studies to validate investigative training to ensure investigators properly recognize the signs of an autoerotic death.

The U.S. Army Criminal Investigation Command (USACIDC) investigates unattended deaths on Army installations and active duty soldier deaths wherever they occur, assisting medical examiners in determining the manner of each death.

The U.S. Army Military Police School is responsible for agents' institutional training and develops doctrine covering the manner in which investigations are conducted by identifying characteristics of types of deaths. Per current doctrine, investigators are taught that autoerotic deaths are accidental and can be recognized by identifying the following characteristics: 1) male, 2) secluded area, 3) padded ligature, 4) escape mechanism, 5) signs of prior use, 6) nudity or female clothing, and 7) pornography. This doctrinal guideline was established over 20 years ago and has changed little. Students are also taught to investigate all deaths as homicides until proven otherwise. The cause and manner of death determinations must be based on the entire investigation, and the presence of these seven characteristics at the death scene should not inappropriately focus the investigation to the exclusion of any other possible outcomes.

This paper will describe different types of hypoxic autoerotic activity, including ligature strangulation, inhalant use, suffocation, and electrocution, and define each criterion as it relates to the cause of death.

A retrospective study was conducted of Army CID reports of investigation initiated from Jan 1, 1990, through December 31, 2001. A total of 22 investigations concluded the deaths resulted from autoerotic activity. Demographic information, i.e., gender, age, race, and military rank and occupation, was extracted from each report and is presented in this paper. Each report was reviewed for the presence of characteristics meeting the definitions of the seven criteria.

This presentation will validate the training doctrine, in that the seven death scene indictors were present in one form or another in each case or in a majority of the accidental autoerotic deaths reviewed. Consideration should be given to replacing "padded ligature" with "hypoxic activity" since sexual asphyxial activity is no longer confined to ligatures. Ligatures and their padding would still be taught as examples of hypoxic activity.

This doctrinal approach has served the USACIDC well and has undergone Congressional scrutiny in at least one instance in the 1998 death of a soldier whose parents were not convinced with the outcome of the investigation.

Autoerotic Death, Crime Scene Examination, Army CID

D13 Genetic Structure and Evolutionary History of 14 Amerindian Tribes of the Amazonian and Orinoquian Regions of Colombia Based on Seven Loci Y-Chromosome STR Haplotype: A Comparison With the Linguistic Affiliation

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The goal of this presentation is to study the genetic structure of Amerindian populations based on Y-chromosome STR haplotypes.

The genetic structure and evolutionary history in 157 individuals from 14 Amerindian tribes of Colombia belonging to four linguistic families Arawak (Curripaco and Piapoco tribes), Macú-Puinave (Puinave and Nukak tribes), Guahibo (Guahibo and Guayabero tribes), and Tucano (Cubeo, Desano, Piratapuyo, Tatuyo, Tucano and Wanano tribes) based on 7 loci Y-chromosome STR haplotypes (DYS19, DYS389-I, DYS389-II, DYS390, DYS391, DYS392 y DYS393) have been determined. A total of 59 haplotypes were identified with a haplotype diversity of 0.9553. The most frequent haplotype was H29: 13,12,30,24,10,15,13 (14%); followed by H17:13,12,30,23,10,15,13 (8.92%); H45:13,13,30,24,10,14,13 (8.3%); and H10:13,14,32,24, 10,15,13 (5.73%). A comparison of the Amerindian haplotype with the Caucasian Mestizo and Afro-Colombian populations showed that only 2.75% of the Amerindian haplotypes were shared with these ethnic groups.

The AMOVA showed that 36% of the genetic differences were due to differences between groups (Fst= 0.3672, $p<0.00000$), a result likely due to genetic drift. In addition 25% of the genetic variation was due to differences in linguistic affiliation. The genetic data has been correlated with the geographic and linguistic classification using similarity dendrograms, Mantel test, and Multidimensional Scaling analysis. The results indicate that the Amerindian tribes have evolved in the genetic, linguistic, and geographic aspects in a highly correlated fashion.

A median network analysis for the entire continent was carried out in order to determine the Ancestral haplotype as well as the most recent common ancestor (time of entry into America) for the Amerindian population. This analysis included a total of 465 individuals from 35 Amerindian, Na-Dene, and Skimo-Aleutian populations described in the literature. The ancestral haplotype found was H45:13,13,30,24, 10,14,13, and the time of entry into the continent was 22300 ybp (15695-28905 ybp) corroborating previous findings based on archeological data and mtDNA analysis. Thus, Y-STR haplotypes represent a powerful tool for anthropological studies in order to reconstruct the evolutionary history of human populations.

Y-Chromosome, STR, Amerindians

D14 Forensic Reports: Addressing the Challenge of Clarity

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Participants attending this presentation will learn potential strategies to be employed when designing forensic biology laboratory reports. The focus is to ensure that data being presented in a report to clients are both scientifically accurate and understandable to the layperson.

A continuing and significant challenge to forensic scientists is the effective and clear communication of complex scientific findings to lay people in reports and through testimony, while stressing limitations. While challenging, it is arguably the single most important function of a forensic scientist.

During the mid 1990s a judicial inquiry into the wrongful conviction of Guy Paul Morin (The Kaufman report) was initiated. A lack of clarity of scientific findings and a misunderstanding of the potential significance of scientific evidence contributed in part to the miscarriage of justice.

Amongst the Commission's various recommendations, several dealt specifically with the issue of clarity in scientific communications (whether they be reports, case conferences, or testimony).

Recommendation 6: Forensic opinions to be acted upon only when in writing.

Recommendation 7: Written policy for forensic reports. CFS to establish a policy that reports must contain the conclusions drawn from the forensic testing and the ***limitations*** (emphasis added) to be placed upon those conclusions.

Recommendation 8: The use of appropriate forensic language. CFS to establish a policy for the use of certain uniform language, which is not potentially misleading and enhances understanding.

Recommendation 9: Specific language to be avoided by forensic scientists. CFS employees should be instructed to avoid demonstrably misleading language e.g., the term "consistent with."

Recommendation 10: Specific language to be adopted. Certain language enhances understanding and more clearly reflects the limitations upon scientific findings.

As part of its strategy to implement the recommendations, the CFS struck a cross-organizational committee of staff and managers to propose and review a variety of options. Part of this process involved canvassing stakeholder opinion from crown attorneys, defense counsel, police, coroners, and others, through the administration of focus groups.

Using the information gathered, along with the collective input from the management and staff (numbering approximately 175), a revised report writing policy was drafted. The policy standardizes the format of reports that originate from any one of a number of different disciplines within the laboratory, and requires that discipline-specific general information sheets accompany them.

The standard format of all CFS reports includes the following: i) a Purpose Statement, ii) a Results section, iii) a Conclusion section, iv) a Notes and Remarks section containing information on technical assistance, sample consumption, and reference to other CFS reports, v) a Continuity section containing details of item receipt and disposition, as well as vi) an Attribution Statement.

The information sheets, written at a basic level for the benefit of stakeholders, are formatted in a standard manner throughout the laboratory and include for each discipline: i) a brief introduction, ii) an overview of the process for examination including a description of the various tests used, as well as limitations of the tests, and iii) a glossary of scientific terms that may appear in the report. The example provided below is from the information sheet for blood.

This presentation describes the process undertaken to deal with this complex issue. A sample report from the Biology Section of the CFS involving results of body fluid examinations and STR DNA analysis will be included, accompanied by the appropriate information sheets.

The development of reporting formats and guidelines is an ever-evolving process that must be continually reviewed in the context of each laboratory's requirements. It is felt that the author's approach to the problem has been comprehensive while reflecting the needs of clients.

Exemplar Information Sheet for Blood

Introduction: Blood is a liquid that circulates through the body, transporting oxygen and nutrients and removing waste products. Blood consists of a liquid called plasma in which blood cells are suspended. Hemoglobin is a component of blood.

Examination For the Presence of Blood: Items are visually examined for any staining that may contain blood. Stains are tested using the Kastle-Meyer test. Stains may also be tested to identify the species from which they originated.

Tests For the Presence of Blood:

Visual Examination—May involve using a stereomicroscope (a magnifying tool) and enhanced light sources.

***Kastle-Meyer Test*—**A 3-stage chemical test that gives a pink colour reaction in the presence of hemoglobin, a substance specific to blood. This can be performed as a rub or direct test.

***ABAcard® HemaTrace® Test*—**Tests used to determine the species / family of origin of a body fluid or tissue.

***Crossed-over Electrophoresis*—**These tests use commercially prepared reagents that bind specifically to substances in a given species or family, allowing for their visual detection.

Limitations:

1. The sensitivity of the Kastle-Meyer testing is such that a positive result may still be obtained in the absence of visible staining.
2. Although false positive Kastle-Meyer reactions are sometimes obtained with other substances, such as certain fresh plants, as applied at the CFS this test is specific for blood.
3. The ABACardâ HemaTraceâ test is specific to human (higher primate) blood. False negative results are possible when dealing with severely degraded samples. False positive results have been observed when ferret blood is tested.
4. The species/families that can be identified using crossed-over electrophoresis are human (higher primate), dog (domestic dog, wolf, coyote), cat (domestic cat, cougar), cow, pig, horse, donkey, mouse/rat, deer/moose, sheep/goat, chicken, guinea pig, rabbit, and fish.

Glossary:

***Direct Test* —**Involves applying the Kastle-Meyer chemicals directly to a sub-sample from the area in question.

***Rub Test*—**Involves rubbing the area in question with paper and applying the chemicals to the paper.

Report Writing, Clarity, Limitations

D15 Genetic Admixture Based on Y-Specific STR Haploytpes in a Sample of Caucasian-Mestizo and African Descent Male Individuals of Colombia

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The goals of this presentation are to establish a population database of Y-STR haplotypestobe used in forensic work and to analyze the genetic structure and genetic admixture in the Colombian population.

Eight loci Y-Chromosome STR minimal haplotypes were analyzed in 134 unrelated African descent individuals collected in four different towns of the Choco department and 137 unrelated Caucasian Mestizo individuals from the east-central Andean region of Colombia, in order to

establish haplotype frequencies to be used in forensic casework and to evaluate their genetic relationship in order to correlate previous findings with autosomic markers. No evidence of population sub-structuring for the African descent population was found (θ_{st} value 2.6%, p 0.054). Only six out of 232 haplotypes were shared between these two ethnic groups (2.59%). Three out of these six haplotypes were the most frequent haplotypes found in Colombian Caucasian Mestizos implying a genetic flow from Caucasian into African descent individuals. Genetic distance analysis showed clustering between the Caucasian mestizo population with other Caucasian populations found in the Iberian Peninsula (Andalucia, Galicia, Portugal) and other European populations; these results are in agreement with historical data since the Colombian Caucasian population are descendants of Spanish conquerors that arrived more that 500 years ago in these lands. On the other hand, the African descent populations clustered with other African descent populations reported in the literature such as the Afro-American populations and the Afro-Caribbean population from Surinam.

The haplotype diversity for the African descent population was 0.9955 and 0.9971 for the Caucasian mestizo population. However, a lower Power of Discrimination for the African descent population (0.8082) than that obtained for the Caucasian mestizo (0.8905) was observed. The results for the Afrocolombian population of the Choco department could be due in part to a limited gene pool that has remained unchanged for the last 350 years with little admixture with other ethnic groups, limiting the effective size of Y-chromosome haplotypes in this population.

Y-Chromosome, STR, Genetic Admixture

D16 The Role of Radiography in the Forensic Investigation of Mass Incidents

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The goal of this presentation is to review the role of radiology in the forensic investigation of mass incidents and present guidance for planning of effective forensic radiology services within temporary mortuary situations.

This presentation will acquaint the audience with the work of the Trauma Imaging Group Forensic Radiography Sub-Committee (UK), which has reviewed the requirements and practical considerations for the provision of effective forensic radiology services within emergency temporary mortuaries to assist with the investigation of Mass Incidents.

The committee has produced guidelines for the design, equipping, and operation of on-site forensic radiology facilities within temporary emergency mortuaries, which it believes, will be of interest to the forensic community.

Radiological imaging is a powerful tool in forensic medicine. It is widely used to determine cause of death or injury, to assist in the identification of deceased persons, or in the investigation of non-accidental injury in children or the elderly (NAI). Whilst most cases involve the radiological examination of an individual, radiology is playing a significant and increasing role in the investigation of mass disasters, terrorist incidents, war crimes, and large-scale human rights abuses.

Large-scale investigations of this nature require detailed organization and the rapid deployment of teams of forensic professionals for the recovery of the deceased and their subsequent autopsy examination within a temporary facility designed for this purpose. The provision of appropriate radiological facilities within such temporary mortuaries is dependent upon the creation of a suitably designed and equipped operating environment which complies with health and safety guidance and statutory regulations for the use of ionizing radiations, together with the deployment of suitably trained staff working to well defined operational procedures.

The precise requirements for radiological facilities in the investigation of mass incidents will be dependant upon the nature of the incident under investigation. However, radiology frequently occupies a key role in the investigation or identification procedure. Despite the important nature of the role of radiology and the need for detailed plans to be in place, the provision of radiology facilities is often overlooked by those responsible for Emergency Planning, and has frequently relied on *ad hoc* arrangements for requesting equipment and staff from local health-care facilities.

It is important that those undertaking such forensic examinations are appropriately trained and equipped to practice in this challenging field, as they will often be required to work in less than ideal locations and circumstances. The operation of a successful radiology facility in field conditions requires detailed planning and training and many of the healthcare professionals called upon to assist are ill-equipped to respond to large scale incidents of this nature.

Drawing on experience of incidents in the United Kingdom, The Republic of Ireland, The Former Yugoslavia and Sierra Leone, the Trauma Imaging Group Forensic Radiography Committee has reviewed the requirements for the provision of an appropriate forensic radiology service within the temporary mortuary environment. The committee has produced guidelines for the design, equipping, and operation of on-site forensic radiology facilities within temporary emergency mortuaries, and has been called upon to advise a number of central and local government organizations within the United Kingdom.

This presentation will outline the history of radiography in the forensic investigation of mass incidents, its main uses and the potential for further development. It will examine the role of the radiographer/technologist within the forensic team, and the importance of training and familiarity with legislation and guidelines that underpin good forensic practice.

It will review the current organization of forensic radiography services for the investigation of Mass Incidents and highlight some of the practical problems encountered by those asked to provide the service. It will discuss possible solutions that may be adopted when planning for such incidents, detailing the necessary training, organization, protocols, and equipment to be considered.

Forensic Radiology, Mass Disasters, Emergency Planning

D17 The Triage Station: Recent Advances in Mass Fatality Incident Morgue Operations

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Participants will learn about mass fatality incident morgue operations, with a specific focus on the flow of human remains through the identification process. Emphasis is placed on the development of the

triage station and its role during the investigation of several recent mass fatality incidents.

1. Mass fatality incident morgue operations have evolved through time as the experience of responding agencies continues to grow. A cursory examination of mass fatality incident training manuals from the previous fifteen years indicates an increase in the flexibility of morgue design to address incident specific issues and challenges. In addition, morgue operation complexity has increased through time with the implementation of additional investigative disciplines. A relatively new development is the "Morphology" or, Triage station. When utilized, Triage is the first station to receive human remains after documentation at the Admitting/Processing station. Station staff may include a combination of the following specialties: a Medical Examiner's Office representative, a pathologist, odontologist, anthropologist, fingerprint analyst, DNA specialist, personal effects representative, law enforcement (ordinance detection expert, etc., as needed), and photographer. Triage stations have been incorporated into morgue operations during the initial stages of the 1999 Egypt Air Flight 990 crash investigation by Disaster Mortuary Operational Response Teams (DMORTs). This station was also utilized at the United Flight 93 investigation, and in a remote fashion (i.e., not in the same facility as the morgue), during the World Trade Center investigation. To date, there has been relatively little formal discussion concerning the operational focus and goals of this essential station, which can be defined as follows:

2. Development of a disaster specific numbering and tracking system in close collaboration with the Admitting/Processing section. This function ensures proper coordination of numbering systems developed and implemented independently during the recovery process. Different agencies are oftentimes responsible for the search and recovery, and for morgue operations (as was the case for the Korean Air Flight 801, Egypt Air Flight 990 and World Trade Center investigations). Proper coordination is essential for the maintenance of a chain of custody and any pertinent provenience data gathered at the scene, which could be useful for decedent identification.

3. Establish a proper chain of evidence within the morgue, in close collaboration with the Admitting/Processing section.

4. Address contamination issues before invasive study.

5. Determine if remains are human tissue, non-human tissue, or non-biological tissue.

6. Identify and maintain the integrity of non-biological evidence. For instance, wiring embedded within muscle tissue should be evaluated and taken into custody by the proper specialist at the Triage station prior to manipulation by other morgue workers, thus preventing the potential destruction of evidence during subsequent examinations.

7. Determination of commingling and separation of remains, with subsequent modification of the assigned tracking numbers. It is imperative that these functions occur as early as possible in the morgue operation to minimize the possibility of tracking errors, which could potentially weaken the proper chain of custody.

8. Classification of decedent remains as viewable vs. non-viewable before performing facial incisions, oral autopsy examinations, or removal of fingers.

9. Determination of common tissue classification. Which fragments are considered identifiable? What specific identifiable features are present on each tissue fragment? This function allows station personnel the ability to document tissue morphology, and decide on the potential for successful non-molecular identification of the tissue, and thus obviating the need for further examination at subsequent stations if deemed unnecessary by Triage station representatives. All policy issues concerning common tissue classification should be coordinated with representatives from the proper agencies (i.e., Medical Examiner's Office, etc.).

10. Determination by a DNA sampling specialist for the need to procure samples. A recent paradigm shift in decedent identification has placed increased reliance on DNA identification of decedents. The DNA sampling specialist will assess sampling potential and the need for immediate sampling to prevent the possibility of further degradation or contamination due to invasive study by subsequent morgue stations.

As outlined, the Triage station functions to streamline morgue operations, allowing investigators to rapidly assess the condition of remains and level of commingling, both key variables in identification success. Of paramount importance is the ability to modify the aforementioned functions based on incident specific requirements, as will be discussed during the presentation.

Mass Fatality Incident, Morgue Operations, Triage Station

D18 A Mass Fatality Identification Guide for Medical Examiners and Coroners

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The goals of this presentation are to discuss a new guide written by the Mass Fatality Incident Technical Working Group (MFITWG) of the National Center for Forensic Sciences (NCFS) and underwritten by the National Institute of Justice (NIJ).

The NCFS MFITWG first met in June of 2001 to prepare a guide tentatively titled, " Mass Fatality Incidents: A Guide for Human Forensic Identification." The intended audience was the smaller local medical examiner and coroner offices who had neither the physical plant nor financial resources to support the identification of a large number of human remains.

The members of the group included nationally recognized leaders in their fields with first-hand experience in the mass fatality arena. The MFITWG was divided into committees covering 1) Administration and operations, 2) Medical Examiner/Coroner, 3) Physical Anthropology, 4) DNA, 5) Fingerprints, and 6) Odontology.

The group met either in person or by conference calls over the past year to brainstorm ideas, formulate a rough draft, ask the forensic community for peer review, and finally complete a final consensus document for publication.

An overview of the completed document will be presented to the forensic community to familiarize them with its content.

The date of publication and how to obtain the document will be discussed. Other ongoing work of the NCFS will also be presented.

Guide, Mass Fatality, Identification

D19 The Use of Electronic Data Collection Technology in Crime Scene Documentation

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The goals of this presentation are to review the state of electronic data collection technology, explain its current applications in crime scene work, and propose potential uses that merit further development.

In the field of forensic engineering, particularly the specialty of vehicle crash reconstruction, the use of electronic data collection technology has been well known for several years. Foremost in this field has been the use of the electronic surveying package, commonly known as the "total station." The total station migrated from its non-forensic uses in civil engineering to the realm of forensic engineering, where it has been used successfully to map crash sites, measure crush depth of vehicles, and record data for later use in the creation of computer animations. Nearly all of the forensic literature on the use of the total station is related to its applications in accident reconstruction.

An underutilized application of the total station and other electronic measuring equipment is in the mapping and documentation of non-vehicular crime scenes. Despite its origins as a land surveyor's instrument, the total station is not limited to outdoor use. Compared to traditional tape measure methods of collecting data, the total station offers the advantages of faster data collection, greater precision, elimination of transcription error, and easier transport of data between systems as well as between agencies. Furthermore, the total station allows measurement of distances and angles in three dimensions as opposed to the two dimensions measured by traditional methods. The techniques of total station mapping during archaeological excavations have been borrowed for forensic use, and have proven to be invaluable in the documentation of clandestine burial sites, mass graves, and crime scenes spread over large areas. Other situations in which the total station has been used are documentation of shooting scenes and disaster sites.

An essential complement to the electronic surveying instrument is computer-aided drafting (CAD) software. CAD software permits the data collected at the crime scene to be analyzed quantitatively and provides a means of producing scaled diagrams of the scene, as well as three-dimensional digital models of the scene that may be used in computer animations. On its own, CAD software provides a precise means of making measurements of features depicted in crime scene photographs. This technology is ideal for crime reconstruction, bloodstain pattern analysis, photogrammetry, and creation of courtroom exhibits.

Other electronic data collection devices with forensic applications include laser-distance measurement units, global positioning system (GPS) receivers, and geographic information systems (GIS).

Crime Scene, Mapping, Technology

D20 Digital Evidence as A New Forensic Science Discipline

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The goal of this presentation is to inform the audience of courses of action for developing a new forensic science.

In the 1980s, law enforcement began to seize computers and other digital media as potential sources of evidence, just as they had seized business and personal records, letters, diaries, and ledgers previously. Law enforcement used commercially available software "tools" to assist in uncovering latent evidence on hard drives and other electronic storage media. Eventually they began to develop software themselves and vendors began producing forensic software tools. The capacity of computer drives increased and the magnitude of the technology increased. The seized information increased from gigabytes to terabytes, and the work became more complicated. Software was developed that could perform automated searches to elicit specified evidence from large amounts of data.

By the mid- to late 1980s, computers were beginning to show up in forensic laboratories as submissions. In the 1990s, this trend increased and by 1998, the FBI sponsored the formation of the Scientific Working Group for Digital Evidence (SWGDE) in order for the forensic science and investigative communities to develop definitions, best practices, and examination protocols for the collection, preservation, transport, and examination of digital evidence. In 2000, SWGDE approached the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB) concerning the possibility of developing an accreditation document for digital evidence. By fall of 2002, this draft document was ready to go before the ASCLD/LAB Delegate Assembly for a vote.

If the accreditation of Digital Evidence Sections in Forensic Laboratories is passed by ASCLD/LAB's Delegate Assembly, the next steps will follow as for all other disciplines: a Proficiency Advisory Committee (PAC) must be formed utilizing experts in the field, and quality assurance programs including competency testing, proficiency testing, and tool validation will follow. Other issues that may follow include:

- Degrees and certificate programs in Digital Evidence areas
- Continuing Education & Training
- Professional Certification
- Professional Journals
- Digital Evidence Sections in Professional Organizations

Computer crimes are a growing national and international problem, with the criminal being in one country and the victim in another country. In order to facilitate communication and the exchange of evidence, the law enforcement, forensic science, and legal communities from the various countries must be able to interact through a mechanism that is recognized by all participants. It is the author's opinion that an international consortium for digital evidence should be formed by existing organizations. This consortium could be a focal point for professionals involved in digital evidence collection, examination, investigations, and litigation.

Digital Evidence, New Forensic Science Discipline, Digital Media

D21 Second Impressions - Can Specific Murder Weapons Be Associated With the Gender of the Perpetrator?

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After attending this presentation, the participant will understand the importance of 1) the team approach to focus an investigation, 2) the development of an investigative strategy, and 3) conducting a thorough crime scene analysis.

Shauna Card was an attractive 17-year-old high school senior. She was a friendly girl who often did volunteer work at a local hospital. She had no known enemies. Her parents were divorced and she had previously lived with her father and stepmother. Due to conflicts with her father's new wife, Shauna moved in with her mother in a two bedroom, two-bathroom apartment. Their unit was located towards the front of a very large apartment complex. Shauna did not have a car and she rode the school bus each day along with many of the other students from the apartment complex.

Shauna was an only child and she was deeply troubled by her parents' divorce. Her grades were suffering from her inner turmoil. Shauna's psychology teacher suggested that she write down her thoughts in a journal to help focus her feelings.

Shauna was last seen at approximately 1430 hours on January 31, 1995, as she was walking from the school bus to her apartment. Her mother arrived home from work at approximately 1800 hours. She used her key to enter the apartment, but she did not note if the door was indeed locked. She noticed that the light was on in the hall bathroom and the door was slightly ajar. She called out Shauna's name but when she received no answer, she looked into the bathroom.

Shauna was lying on her back in a pool of blood on the bathroom floor. She was fully clothed in the same garments she wore to school that day. She had sustained a large bruise to the area of her right eye and she had been stabbed multiple times in the face, neck, and back. Two butter knives, one steak knife, and a pair of scissors were lying next to her body. A steak knife, a butter knife, and a potato peeler had been returned to the kitchen and placed in a cabinet under the sink. These items all contained the victim's blood. Numerous 90-degree blood drops were discovered on the kitchen floor. Blood was also found on a towel in the living room, on a sweatshirt in her mother's bedroom and in the sink trap in the master bathroom.

A motive for this crime was not readily apparent. There was no indication of forced entry into the apartment.

The victim was fully clothed and there was no indication of a sexual assault. The apartment did not appear to have been searched. No items of value were missing. None of Shauna's fellow students or neighbors knew of anyone who was angry with her.

The use of the kitchen tools, i.e., potato peeler, scissors, butter knives, and steak knives, became a potential stumbling block in the investigation. Did the choice of these specific weapons mean that this was a feminine crime?

This presentation will take the attendees through the crime scene, the forensic evidence, and the investigation that led to the arrest and conviction of Shauna's murderer.

Homicide, Blood Spatter Interpretation, Crime Scene Analysis

D22 Gestures: Their Linkage to Veracity and Accuracy

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The goal of this presentation is to examine how the assessment of hand and arm gestures can assist in determining the veracity and accuracy of a subject's recollection or accounts of a criminal event. This may help to provide Law Enforcement or the Forensic Behavioral Science Community a clinical and objective assessment approach to determining veracity and accuracy during criminal interviews and interrogations.

This presentation will discuss a pilot study and practical application that involve the assessment of hand and arm gestures to determine accuracy and veracity during criminal interviews and interrogations, identified by this author as "Gesticular Probing." This interviewing technique evolved from a theory suggested by Professor David McNeill, of the University of Chicago, that gestures, speech, and thought are a single integrated system, and that gestures exhibit images that cannot always be expressed by speech, as well as images the speaker thinks are concealed. McNeill further relates, "Gestures are like thoughts themselves . . . they belong, not to the outside world, but to the inside one of memory, thought, and mental images."

During the pilot study, the investigator attempted to determine the differences between deceptive and truthful subjects by (1) the prevalence of specific types of gestures (metaphoric, iconic, beats, cohesive, deictic, and other gesticular activity); (2) the presence of significant features during the three stages of gesticulation (preparation/beginning, stroke, retraction/return); and (3) the overall use of gestures during the account of a criminal event.

The pilot study had subjects view a video of a criminal event and describe what they observed while being videotaped. During the pilot study some subjects were instructed to lie about something they observed. Due to the small number of subjects used in the study, analysis of the study's findings was conducted through qualitative-observations.

The results suggested that there appears to be no significant correlation between a subject's veracity and the prevalence of particular hand or arm gestures during the subject's recollection of a criminal event. What was noticed was that observing the subject's entire sequence of gestures provided information that gave the interviewer a sense of truthfulness and/or deception. In addition, an identical hand gesture was observed in three subjects who provided spontaneous misinformation (lies). This hand gesture was a palmer side down than up just before the lie was provided by the subject and was identified by McNeill as a "presentation gesture." This particular palmer side down than up gesture was detected in slow motion and could not be easily observed in "real-time." Paul Ekman may describe such behavioral activity that an individual makes unknowingly when he/she lies as "leakages" of deception.

The "Gesticular Probing" technique was used during actual criminal investigations, probing witnesses and suspect's hand and arm gestures. The subject's gestures were assessed from a continuum (beginning to end) in which each gesture becomes more detailed than the previous during the interview/interrogation process. The subject is asked to describe and illustrate in more detail what he/she has already related to the investigator. The subject will initially display a minimum of gesticular activity and tend to display more gesticular hand and arm activity as the event is described in more detail. The interviewer will peal away at this added hand and arm gesticular activity frame-by-frame and begin to get a visual image of the subject's thoughts. The "Gesticular Probing" technique is a non-intimidating style of interviewing, minimizing gesticular influence from verbal intent by the interviewer or gesticular mirroring.

During the actual criminal investigations, the investigator was able to observe gesticular displays in real-time by subjects that tend to contradict spatial or gesticular activity that appears to be mismatch with the real circumstances of the criminal event, such as how a victim was found or how a weapon was used. The investigator also found that subject's tended to over or de-emphasizes gesticular activity when providing erroneous or inaccurate information.

The traditional observations by investigators of identifying good and bad gestures or the lying and truthful type of gestures, grouping these types of gestures into clusters to make assessments of deception and non-deception, still have value to the investigator. The "Gesticular Probing" technique does not assess what may be considered a good or bad gesture; instead, it attempts to isolate gesticular behavior from a continuum of gesticular activity that may illustrate discrepancies or information that is not in sync with the factual occurrence of a criminal event. The investigator may become a more objective inquisitor and begin to read the images of the mind as McNeill suggests.

Gesticular Probing, Peeling, Frame by Frame

D23 Characterization and Profiling of Illicit Methamphetamine Tablets Abused in Singapore

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The goal of this presentation is to provide law enforcement agencies with information in establishing possible links between different seizures of illicit methamphetamine tablets.

Outcome: Based on the methamphetamine content, the major components found and the minor impurity profiles, it is possible to classify the illicit methamphetamine tablets into groups for the purpose of providing a link between these tablets. Adopting an impurity profiling method similar to that of UNDCP Laboratory enables the laboratory to compare its results with those of UNDCP and other studies to shed some light on the origins of the illicit methamphetamine tablets abused in Singapore.

The abuse of methamphetamine in Singapore has been on the rise since mid 1997. While many of the exhibits submitted to the laboratory are in the crystalline form as methamphetamine hydrochloride, known commonly by its street name "ice," a significant number of the methamphetamine exhibits are in the form of tablets.

Most of the illicit methamphetamine tablets are believed to be manufactured in the "Golden Triangle" region and smuggled into the country. They have multi-colors and logos and are easily confused with the "Ecstasy" tablets that are also being abused in the country. This paper will present the results of a study undertaken by the laboratory on the char-

acterization and profiling of the illicit methamphetamine tablets. While it may be difficult to identify the possible sources of these tablets since they are manufactured outside the country, it is hoped that the information will be useful to law enforcement agencies in establishing possible links between the different seizures and identifying the distribution networks.

Approximately 200 samples of methamphetamine tablets were used in the study. These tablets were collected over a period of about 4 years, from 1998 to early 2002. Based on the methamphetamine content and the major components found, the tablets could be broadly divided into 2 groups. The first group of tablets had a methamphetamine content ranged from 3% to 29% and usually contained caffeine as the only other major component. This group of tablets came with few colors and only 2 logos were seen so far. The second group of tablets had a methamphetamine content varied from less than 1% to about 11% and consisted of tablets with a great variety of colors and logos. They generally contained several other major components other than methamphetamine. Components found so far included caffeine, diazepam, ketamine, dextromethorphan, ephedrine (or pseudoephedrine), lignocaine, midazolam, paracetamol, and triprolidine. Of these, caffeine and ketamine were the most commonly found. Many of these components were present at a much higher concentration than methamphetamine.

A detailed impurity profiling study was conducted on the first group of the methamphetamine tablets since they have relatively simple composition and are usually being trafficked in large numbers. The method of impurity profiling adopted by the laboratory was based on that reported by the United Nations International Drug Control Programme (UNDCP) Laboratory.(1) It involves dissolving the powdered sample in a phosphate buffer solution at pH 10.5 and extracting the solution with ethyl acetate. The extract was then analyzed by GC/FID and GC/MS using n-tridecane, diphenylamine, and n-tetracosane as the internal standards. Using this method, the impurity profiles of a total of 46 samples were studied. The results show that over the years from 1998 to 2002, the main impurities found in this group of tablets appeared to be similar. Some of the common impurities found were benzaldehyde, 1,2-dimethyl-3-phenylaziridine, amphetamine, N-acetylmethamphetamine, N-formylmethamphetamine, ephedrine, N-acetylephedrine, acetyl-codeine, codeine and ethyl vanillin. Of the common impurities, codeine and acetylcodeine appeared to be not related to the manufacturing process. They were likely to be contamination from utensils from premises that were also used in the manufacturing of heroin. In the case of ethyl vanillin, it was probably added as a flavoring agent.

To have a better understanding of the synthetic route used in the clandestine manufacturing of methamphetamine, the optical purity of the compound in 26 samples was determined using GC/FID fitted with a chiral column. The results show that in all samples, only the more potent *d*-methamphetamine was found indicating that either the optically pure *l*-ephedrine or *d*-pseudoephedrine was used as the starting material.

An impurity profiling study was also carried out on selected samples of the second group of methamphetamine tablets which had higher methamphetamine contents (8-11%). In addition to the major components described earlier, some minor impurities found were benzaldehyde, amphetamine, N-formylmethamphetamine, MDMA, and 1-(3, 4-methylenedioxyphenyl)-2-propanol.

Based on the methamphetamine content, the major components found and the minor impurity profiles, it is possible to classify the illicit methamphetamine tablets into groups for the purpose of providing a link between these tablets. Adopting an impurity profiling method similar to that of UNDCP Laboratory enables the laboratory to compare its results with those of UNDCP and other studies[2] to shed some light on the origins of the illicit methamphetamine tablets abused in Singapore.

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Methamphetamine, Impurity, Profiling

D24 Therapeutic Accident With Antibiotics and Lyell's Syndrome

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Lyell's syndrome almost always occurs after taking medication and mortality is high, particularly due to infectious complications. Despite spectacular clinical signs, it is mainly diagnosed with pathologic techniques. The involvement of a drug as sole cause of such an allergic reaction must be demonstrated, especially since the molecule incriminated is not generally known to be a classical cause of this reaction. The imputability is based on a number of clinical arguments. The present study describes a female patient who rapidly developed an extensive bullous toxidermia after taking clarithromycin for tonsillitis. The case illustrates the process involved in attributing imputability to a molecule.

Lyell's Syndrome, Imputability, Clarythomicine

D25 Voluntary Community DNA Testing

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The goals of this presentation are to describe the best practice and procedure for Law Enforcement Agencies in conducting a voluntary based DNA screen in a serious crime.

During the early hours of New Years Day 1999, a 91-year-old resident of the township of Wee Waa went to bed. Rita Knight had lived all her life in the outback town of Wee Waa, some 600km NW of Sydney, New South Wales, Australia. She was a highly respected person who had lived all her life in the same house. A regular churchgoer, this wonderful woman did not have an enemy in the world.

Later that night, someone broke into her house and attacked her in bed. She was beaten and then suffocated unconscious, and as a final indignity raped whilst unconscious. Despite her appalling injuries she survived. The shock and horror of this attack stunned the community. A massive police investigation worked for many months, but sadly failed to trace the offender. The only clue left to the police was a DNA profile from semen in the vaginal swab.

Due to community pressure, 16 months later the police set about taking voluntary DNA samples from all 600 males in the Wee Waa community. A criminal and geographic profile set guidelines for the screening. This screening was the first intelligence led DNA screen in Australia. The exercise received enormous media coverage in Australia and worldwide including the U.S., in particular NBC news.

There was no legislation at that time in Australia to force men to give a DNA sample. The screening was based on best practice techniques the author had employed in similar investigations in the U.K.

Set criteria have to be met before such a screening is embarked upon. Namely there must be a compact geographic area. The crime scene DNA sample must be attributable to the offender. Most importantly there must be a supportive community. A media strategy is formulated between the investigating officers and the criminal profiler.

In April 2000, a team of police went to Wee Waa and invited men who fitted the profile to volunteer a DNA sample. The community response was incredible. Over 95% of the eligible male population volunteered samples. They were queuing up outside the police station before opening at 8:00 a.m. each day.

Local detectives already had a list of suspects, but insufficient evidence to support an arrest and interview. Part of the investigating

strategy was that these suspects would be invited to give a DNA sample along with a SCAN (scientific content analysis) questionnaire.

One of the suspects left town the day before the police team arrived. Stephen James Boney lived 300 meters from the victim's house. On 11 April 2000, he was traced working on a farm 50 km from Wee Waa. A local Officer interviewed him and requested a voluntary DNA sample. After a minute thinking, Boney gave the sample and completed the SCAN form.

All the samples were then transported back to Sydney for testing and comparison with the crime scene sample. The day before this testing was due to commence, 17 April 2000, Boney surrendered himself to the police at Wee Waa. He admitted being responsible for the attack. A further DNA sample was taken from him along with a full written confession. Comparison of Boney's sample with the crime scene sample proved to be a perfect match. He was then charged with the attack and rape of Rita Knight.

On 20 October 2000, Boney appeared before the Moree District Court and pleaded guilty to all the charges. He was sentenced to 12 years imprisonment. The public of Wee Waa gave unqualified support to the methods used by the police to capture Boney. The template of joining traditional policing with a forensically led approach based on criminal and geographic profiling proved highly successful. This template could be adapted for use in the U.S. in communities where the criteria for such a screening are met.

At the time of the investigation the author was a Detective Superintendent seconded from the U.K. to the New South Wales police in Sydney. He currently works in Perth as Director of Research and Development at the Centre for Forensic Science, University of Western Australia.

Voluntary, DNA, Screening

D26 The Political Realities of Building a High-Tech DNA Identification System in a Post-Conflict Society

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The participants will be given an overview of the inherent difficulties and political realities of building a high-tech DNA identification system in a post-conflict society. It is hoped that the model employed in the regions of the former Yugoslavia could be built upon in other regions of the world.

In the regions of the former Yugoslavia affected by the conflicts beginning in 1991 and continuing, to a lesser extent, in the Former Yugoslav Republic of Macedonia, the International Commission on Missing Persons (ICMP) estimates that there are up to 40,000 persons missing. Most of these persons disappeared as a consequence of actions committed by the regional governments or agents acting on their behalf. In the majority of these cases of "enforced disappearance," governments in the region went out of their way to hide bodies and conceal material evidence that could later be used in court, or more specifically, by the International Criminal Tribunal for the Former Yugoslavia (ICTY).

There is growing consensus that in cases of enforced disappearance, the use of sophisticated DNA technology as a tool to uncover the identity of victims is the most scientifically accurate method. However, in addition to the scientific challenges of implementing a large-scale process of DNA identification in a war torn region, another concern of the ICMP has been how to create a process that is not only scientifically accurate, but also politically neutral in a politically charged atmosphere.

In addition to these hurdles, the ICMP faces the task of introducing a new methodology to a society that has a tradition of deferring to authority.

Addressing these difficulties has ramifications on many aspects of the ICMP's work. These include educating local pathologists regarding evolving identification techniques to encouraging government officials to view the construction of DNA laboratories as a tool to assist the families of the missing, rather than a tool to politically manipulate them. Other difficulties include helping the families through the labyrinth of information and misinformation they are fed regarding the legitimacy of DNA technology in the identification process.

The technical solution to these issues was to create a centralized system that would expedite the process of addressing the approximately 40,000 persons missing from the conflicts in the Balkans. As a consequence, ICMP has constructed five DNA laboratories in the regions of the former Yugoslavia, with one central location for submitting, blinding, and distributing biological samples to the five laboratories. This regional system requires that the governments in the area move away from viewing the labs as "national" centers of identification, to accepting that the laboratories work together on identifications, regardless of the ethnic, religious or national origin of the missing person.

Despite on-going obstacles, the governments in the region have largely agreed to the centralized system. ICMP hopes that the increased levels of identifications now being realized will fully validate the credibility and legitimacy of the DNA-led centralized process, thus allowing the cooperative process of DNA identifications of mass casualties from a recent war to become sustainable.

NA, Politics, Identifications

D27 The Effect of Short Wave Ultraviolet Light on Latent Fingerprints

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The goals of this paper are to present to the forensic community the observed effect of short wave ultraviolet light on latent fingerprints.

This oral presentation will introduce observations of latent fingerprints on non-porous surfaces that received prolonged exposure to short wave ultraviolet light (254nm wavelength). It was hypothesized that effective documentation and recovery of latent fingerprints exposed to short wave UV light for 10 minutes or more may be inhibited due to a chemical breakdown in the protein compounds that compose friction ridge detail in latent fingerprints.

Background: During a project constructed to test the effectiveness of various forensic light sources on biological fluids, the friction ridge detail on latent fingerprints was observed to have darkened after exposure for approximately ten minutes to short wave (254nm) ultraviolet light. However, the shading of the prints, as observed and documented by digital photography, was altered as the UV light was moved at different angles to the fingerprints over the course of the project. At the time, it was not possible to confirm if the darkened fingerprint detail was a result of exposure to UV light or if other factors came into play.

Experimental Method: Latent fingerprints were deposited on non-porous plastic and glass substrates and exposed to a 12-watt germicidal UV light source for up to 1 hour. The observed appearance of the test prints was documented and preserved over time using a forensic light source, video and digital photography. ISO 200 speed film speed was utilized with a shutter speed of one-fourth of a second. The f-stop range for the project was 4.0, 4.5, 5.0, and 5.6. In each series of photographs, only one f-stop setting was used to ensure consistency. Physical recovery of the test fingerprints was accomplished with black fingerprint powder and brush techniques. In all cases, control prints were deposited and recovered from the same or similar substrates using the above techniques.

A darkening of the ridge detail was observed on the latent prints deposited on the glass and plastic substrates after exposures to short wave ultraviolet light of 20 minutes or more. The darkening initially made the ridge detail more apparent, but slowly began to blur the fine edges and eventually led to some of the ridge patterns to appear that they had thickened and joined together. However, there was no readily apparent degradation when the fingerprints were recovered using powder-lift techniques. In every case, the powder-lifted fingerprints were suitable for examination and did not appear to have lost any fine detail.

The friction ridge detail of the latent fingerprints deposited on non-porous surfaces and exposed to short wave ultraviolet light for an extended period of time darkened to the point that photographic documentation was adversely affected. These latent fingerprints were video taped and photographed in five-minute intervals for up to one hour, and gradual darkening and near obliteration of some of the friction ridge detail were documented. The cause of this darkening is unknown, but is hypothesized to be a result of deteriorating protein elements within the latent fingerprint due to prolonged exposure to short wave Ultraviolet light. However, since this darkening did not affect the powder lift method of recovery, it only appears to be problematic when the means of fingerprint recovery is exclusively video or photography. Furthermore, direct exposure to short wave ultraviolet light of more than 20 minutes is unlikely when processing fingerprints in the field. However, the findings reported here might be useful to forensics professionals to prevent any hindering effects short wave ultraviolet light exposure may have on the photographic documentation of evidence.

Further Testing: The effects of short wave UV light remains of interest, especially with regard to protein compounds within fingerprint ridge detail. The project is currently being expanded to include observations of the performance of protein reagents on latent fingerprints after exposure to short wave UV. Latent prints will be deposited on paper and will be chemically recovered using the protein reagent Ninhydrin. Additionally, latent prints will be exposed to other light sources to determine if radiated heat from normal household light plays some role in the observed darkening effect.

Short Wave Ultraviolet Light, Latent Fingerprints, Digital Photography

D28 Developing a Valid Data Base for Determining Crime Trends in Hospitals

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The goal of this presentation is to acquaint the forensic community with the problem of hospital-based crime and the current initiatives by the International Association for Healthcare Security and Safety (IAHSS) to develop a valid database to measure criminal activity, to detect crime trends, and ultimately to measure the effectiveness of hospital security programs.

This paper will first discuss the problem and extent of criminal activity at hospitals throughout the U.S. It will focus on the lack of a valid database for measuring such activity, and previous efforts to develop one using statistics collected by the International Association for Healthcare Security and Safety (IAHSS) and by the U.S. Department of Education under the Clery Act. The former is flawed because participation is voluntary and varies substantially from year to year, and the latter only includes academic medical centers (those affiliated with colleges and universities required to report campus crime).

The paper will then discuss the IAHSS current initiative, which is designed to obtain crime data from a statistically valid random sampling of hospitals over a ten-year period. The sampling design stratified hospitals based on three variables: bed size (staffed, not licensed), type (general, trauma center, public "safety net" and pediatric), and location (urban and suburban). Hospitals with less than 100 beds have been excluded, since they are typically in rural areas and do not have established security programs. This 3x4x2 matrix totals 24 hospitals. Multiplied by the five IAHSS regions in the U.S., this will provide survey data from a total of 120 hospitals.

All 120 hospitals selected have committed to provide annual crime statistics in a standardized format for a period of ten years. In addition, information regarding their security personnel (number of officers and support staff, level of training, type of vehicles and equipment, patrol methods, etc.), programs (crime prevention, investigations, etc.), and use of technology (access controls, alarms, CCTV, etc.) will be collected. This data will enable the IAHSS to measure the effectiveness of security personnel, programs, and technology in reducing crime in hospitals.

Participating hospitals have been promised anonymity so that their individual crime statistics and security resources will not be publicized. However, the IAHSS will release an annual report to acquaint hospital administrators, law enforcement officials, the academic community, and the general public with criminal activity, crime trends, and security programs in hospitals.

Crime, Hospital, Statistics

D29 An Analysis of Conjoint Roles in Hospitals: The Clinical Forensic Nurse, and Quality Management

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The goals of this presentation are to demonstrate the value of the Clinical Forensic Nurse (CFN) in the identification of staff members responsible for serial killing of patients.

This presentation will outline two cases of serial killings within VAMC settings. In both cases, the keen observations, the management of evidence, and suspiciousness of experienced nurses were key factors in solving the crimes. Due to on-going civil litigation proceedings, certain details will not be disclosed in this presentation.

The first case example includes that of former registered nurse Kristen Gilbert who was found guilty of four counts of first-degree murder and three counts of attempted murder of patients under her direct care. It was the astute observation and persistence of nursing staff that finally opened the door for an investigation.

The second example is that of the notorious Dr. Michael Swango. A nurse who noted highly atypical medical practice patterns conducted the forensic medical record review for the investigation. Her insights helped redirect investigation efforts that led to an eventual break in the case.

In the day-to-day activities of any medical center where patient care is provided, the potential for forensic issues to arise is greater now than ever. With the *do-more-with-less* mandates, high patient acuities, and a generalized shortage of personnel to manage the patients, personnel experience high levels of stress and often have little or no support or supervision. In addition, in the eagerness to get staff vacancies filled promptly, employee-screening procedures may be abbreviated and background checks, references, and employee histories may lack thoroughness. Furthermore, marginal performing staff members may be retained with the belief that they are better than a vacant position. The short staffing, hectic schedules, chaos and confusion in the highly charged work setting, and personal stresses combine to create the ideal environment in which both serious errors and personal misconduct may occur and yet may go unnoticed. Quality management (QM) has recognized that the employment of a CFN in the hospital setting is one way to

assist in the alleviation of preventable, adverse events. The Clinical Forensic Nurse may make significant contributions in patient safety as well as risk management within any medical facility. This nurse is an ideal compliment to any Quality Management Department or Process Improvement Team.

While QM staff of any medical facility may not play the same role as a court of law or jury, they do share one responsibility, root cause analysis (RCA). Sets of data or a collection of facts must be reviewed before a course of action or process improvement plan may be implemented. The plan may entail recommendations to monitor staff competency or a suspicious trend of events. In any case, all must be based upon accurate data and good evidence. Unfortunately, critical information does not reach the QM staff until long after the event. Opportunities to capture specific details about the scene and circumstances as well as the immediate recall of those involved no longer exist. In these litigious times, health care providers are hesitant to admit or to discuss activities that could be viewed as *an error.*

The CFN should be an essential part of any hospital staff charged with RCA in association with adverse patient events. Most medical errors and therapeutic misadventures are not criminal in either intent or nature. However, in all cases, the precise identification, collection, and preservation of facts, data and medical evidence are vital for appropriate resolution and follow-up.

The CFN serves as the critical link between medicine and law, having an increased awareness of forensic implications in every day patient care as well as working hand-in-hand with those charged with investigating patient complaints, suspicious patient events, unexpected death, questionable trends, and emergency / traumatic patient admissions. The CFN is in a position to provide vital protection to victims of foul play when they are at their most vulnerable. In today's health care system, all health care providers should have some level of awareness of what constitutes medico-legal significance. Ideally, facilities would benefit from having a core team of individuals knowledgeable in forensic principles and able to apply these principles to adverse patient care scenarios.

The astute forensic nurse practicing in a clinical setting maintains a professional balance between routine management of "natural" illness and consistently entertaining the possibilities of foul play. The CFN has no bias towards any one element of a patient's case. Human rights will be protected and laws will be upheld without regard for personal or institutional consequences.

As this specialty continues to evolve, clinical forensic nursing practice appears to be developing into 5 different roles: 1) the forensic nurse provider, 2) the forensic nurse examiner, 3) forensic psychiatric nurse examiner, 4) forensic nurse specialist, and 5) the forensic nurse investigator.

It has been established that the vast majority of law enforcement and investigative personnel are not trained to navigate through a complicated medical or surgical area, nor do most comprehend the medical /nursing jargon commonly used within medical facilities. The practice of clinical forensic nursing with its broad focus upon health care expertise, the ability to apply forensic science to the hospital setting and knowledge of justice system requirements, is the critical link between law enforcement and healthcare practice. Nurses, in general, are key players with immediate access to nearly every activity that occurs in a medical facility. Nurses know other key players, the environment, the language, and routines of daily scenarios with regards to patient care delivery; therefore, they are most likely the ones to recognize irregularities. A nurse who is indoctrinated in the forensic sciences will have an *edge* in spotting even the subtlest of inconsistencies. The unique vantage point and professional perspective of the CFN can serve law enforcement and the criminal justice system, while continuing to act in the best interests of the patients and the hospitals they serve.

It is also possible that in some instances, the administration of any given health care facility would prefer to keep some forensic cases or specific aspects of these cases *under wraps* and decline to report them to external authorities. The desire to handle problems discretely and internally is often akin to *cover-up.* The CFN would ideally be involved in case reporting and disclosure decisions.

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has the laid the groundwork for the roles of forensic nurse providers and examiners within hospitals in its published scoring guidelines for patient care assessment. Additionally, the Joint Commission includes the review of organizations' activities in response to sentinel events in its accreditation process that opens the door for a CFN specialist and/or investigator.

The unique vigilance of nurses, when combined with analytical skills, a natural curiosity, and a sense of duty, provides the necessary acumen for success in the clinical forensic nursing role.

Clinical Forensic Nurse, Quality Management, Root Cause Analysis (RCA)

D30 An Exploration of the Overlap Between Clinical Quality Assurance Activities and Forensic Medical Investigation

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In this presentation, the audience will gain a newfound appreciation for the nexus between clinical quality assurance activities performed in a medical setting, such as a hospital or clinic, and forensic activities performed in the setting of a potentially criminal event. The two activities and disciplines have infrequently been thought of as similar. However, both having patient safety as a common goal, it is argued that they are complementary. This presentation should stimulate discussion of this concept.

Safety is an inherent right within all healthcare facilities. Patients and their families expect that they will be cared for and perhaps even *cured*, without harm occurring as a result of being hospitalized. Even if there were some recognition that medical errors or accidents might occur, and that adverse medical outcomes are not outside the realm of possibility, the public has a right to expect that caregivers would not intentionally engage in acts of malfeasance or criminal behavior. Hospitals intending to reduce risks for patients must be willing to establish rigorous programs to oversee staff activities and to monitor clinical care routines as well as therapeutic responses. In addition, any suspicious behavior, adverse outcomes, or sentinel events must be thoroughly investigated in order that appropriate corrective actions be taken to prevent recurrences.

In 1988 Congress passed Public Law 100-322 that mandated the Veterans Affairs (VA) Office of Inspector General (OIG) oversee, monitor, and evaluate VA's clinical quality assurance programs. In trending data from OIG quality assurance oversight activities, it was found that numerous issues with forensic implications were identified. This was an unexpected finding, because medical quality assurance is a clinical and peer-based activity, as opposed to an investigatory activity.

A retrospective review of clinical quality assurance oversight activities encompassing the period of May 1989 to May 2002 reviewed OIG efforts, activities, and products to identify those that had both quality assurance and forensic implications.

The findings revealed that quality assurance is primarily conceived and implemented by hospitals as an administrative and clinical activity. On a "small scale," for example, a single hospital or ward, quality assurance is clearly a clinically oriented behavior as demonstrated by the manner by which such cases enter the quality assurance process (peer

review, drug utilization studies, etc.) and the nature of cases that come to oversight attention. However, also found when assessed in the context of a vast healthcare network such as the Veterans Health Administration (VHA) of the Department of Veterans Affairs (DVA), forensic issues emerge prominently.

Forensic issues brought to oversight attention via clinical quality assurance processes fall into several major categories:

- Patient abuse
- Suicide
- Assault
- Homicide
- Medication related concerns including medication or delivery system tampering, improper medication administration, and grossly negligent medication errors
- Medical equipment and device tampering
- Problems with restraints
- Problems in search and rescue procedures for eloped patients

The implications of this finding are important. Since QA has traditionally been perceived in clinical and administrative terms, this recognition of the forensic aspects of QA oversight has been unreported, and not explicitly identified. However, recognition of this link may greatly facilitate patient safety activities. Likewise, these findings suggest the need for closer collaboration and cooperation between quality assurance specialists and forensic specialists. The term "forensic QA" is appropriate to apply to this overlap. "Traditional" QA activities such as the Morbidity and Mortality Conferences may also have important forensic value.

Finally, understanding this link between quality assurance and forensic medicine may also make caregivers more sensitive to the importance of preserving potential medical evidence for both quality assurance and jurisprudential purposes.

Conclusion: The link between forensic medicine and quality assurance should be recognized and explored further.

Medical Investigation, Quality Assurance, Patient Safety

D31 A Review of the Operations of the Center for International Forensic Assistance (CIFA)

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At this presentation, the participant will learn about CIFA which is an international effort aiming to make available independent forensic assistance at a short notice wherever that may be needed for humanitarian purposes. A brief review of some of CIFA's most recent missions will also be presented for the participants.

The Center for International Forensic Assistance (CIFA) is based at the University of Glasgow in Scotland, U.K., within the Department of Forensic Medicine and Science. Established in 1839, it is one of the largest and oldest departments in Europe. The Center has continuously served the community and contributed to the development of forensic medical sciences. It has already been actively involved in the provision of international forensic expertise in a broad range of missions. These include investigations of war crimes, mass disasters, human right abuses (including the identification of victims for humanitarian purposes), individual cases internationally, and assistance with training of experts abroad and development of their facilities.

The Center maintains a database of experts ready to deploy on a mission when this becomes necessary. Experts have access to the web domain (www.forensicassistance.org) where they may obtain all the latest information on missions. Ready to deploy in missions around the world, the Center has experts from almost 30 countries including the U.S., U.K., Mexico, Canada, Costa Rica, Argentina, Australia, Italy, Poland, Portugal, Greece, Turkey, Austria, New Zealand, Pakistan, South Africa, Denmark, Norway, and Malaysia.

Such forensic investigations have already taken place in several countries, including Bosnia-Herzegovina, Croatia, Kosovo, Georgia, Kazakhstan, Rwanda, Sierra Leone, Cambodia, Sri-Lanka, Cyprus, Chile, South Africa, El Salvador, Guatemala, Romania, Nepal, The Philippines, Italy, Germany, Greece, Saudi Arabia, United Arab Emirates, and Gibraltar.

The personnel associated with the Center comprises of Forensic Pathologists, DNA Experts, Forensic Toxicologists, Forensic Odontologists, Forensic Anthropologists, and Archaeologists, International Law Specialists, Psychiatrists, various technical experts, and others belonging in disciplines related to the forensic work. All of them are committed to achieving high standards of forensic expertise and academic excellence through participation in training courses as part of a continuing professional development program, assisting other countries to improve or establish their forensic capabilities, and participation in research projects as appropriate.

The overall role of the Center is to facilitate the planning and execution of the international forensic work and provide assistance to the humanitarian aspects involved in this field. The Center lends forensic assistance to the International Community by providing forensic science expertise to assist in the investigation of war crime atrocities, mass disasters, individual cases of a political nature and/or human rights abuses and other cases as appropriate.

CIFA formally interacts with other organizations and individuals both nationally and internationally to facilitate mission planning and execution. Moreover, an educational role is provided for the dissemination of knowledge through conferences, seminars, workshops, and other customized institutional, and individual training programs. Finally, the improvement or establishment of forensic capabilities in various countries is assisted and research and evaluating activities in all areas of forensic expertise and other related disciplines are carried out in accordance with the aims of the Center.

Our efforts also include the identification of humanitarian needs in relation to the execution and planning of missions and acting as liaison with other associated disciplines such as the Social Sciences and Mental Health. CIFA provides impartial forensic scientific assistance worldwide at any time.

Center for International Forensic Assistance, Humanitarian Missions, International Database

D32 Alcestis: A National Network for Mortality Data Collection and Bio-Terrorism and Injury Surveillance

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The goals of this presentation are to educate the forensic community of the existence of a bio-terrorism and injury surveillance program administered by the Center for Collaborative Research in Health Outcomes and Policy (CRHOP). Participants of the poster session will see the benefits of collecting data via the Internet, will realize potential research topics, and will learn about research currently underway from data collected by this initiative.

This poster will present an overview of Alcestis as well as the benefits that can be obtained by medical examiners, coroners, and death scene investigators, including preliminary findings of analysis conducted from data collected by Alcestis in Michigan.

Medical examiner and coroner investigations produce valuable information useful to health officials, the criminal justice system, and families of the deceased. Alcestis creates uniform standards and establishes data collection and reporting procedures for medical examiners and coroners at the state and county level nationally.

Alcestis bridges the gap between surveillance and research with the creation of an electronic system storing in-depth data on the circumstances and social factors surrounding fatal injuries and unexpected deaths. Hosted on the Internet, the database provides health professionals with a valuable tool for community health assessments, injury prevention efforts, organization of EMS services, and other statewide efforts.

With the continued expansion of Alcestis nationally, the value that states and researchers derive from the database will expand. This initiative will allow states to standardize and establish data collection procedures as well as make possible nationwide research opportunities that, heretofore, were unfeasible. The primary benefit to be obtained from Alcestis is its ability to serve as a tool for county, regional or state surveillance of bio-terrorism and injuries.

Alcestis will provide medical examiner/coroner offices a fully supported package that includes secure Internet access to the on-line database, paper data collection forms, and data analysis tools. Training, tech support and quality improvements will be on-going. Medical examiners and coroners benefit from *Alcestis* through quick and easy access to their mortality data, instant reports, and the ability to share data among counties and with other colleagues.

The system consists of three components: a death scene investigation report, an Internet-based database container for medical examiner data entry, and county profile pages connected to the database that automatically aggregate and chart the data for reporting. Samples of these components are provided in Appendix B. When compared with traditional medical examiner data collection and storage methods, Alcestis offers the following advantages:

- *Alcestis* staff conducts system maintenance and backups centrally.
- There is no need to install software on the user's machine or allocate hard-drive space for data storage.
- Users receive routine upgrades to the database as it is continuously improved.
- The system can be accessed at any time from any computer with Internet connectivity.
- If a person can "surf the web" he/she can use the system. There are no new programs to learn.
- Proven public/private key security features and encryption are in place to make submission of information secure.
- Additional products/services include a user manual, data dictionary, codebook, training materials, data integrity checks, and technical support.

The software is managed and accessible via the Internet; it is written in common programming languages, compatible with the majority of off-the-shelf products, scalable based on office size, and requires no hardware allocation by the end-users. Additional services are provided that include a data collection form that mirrors the electronic database, an easy-to-read user manual explaining the system design and functionality, a codebook and data dictionary, and a staffed technical support hot line.

Currently, Alcestis is working with the CPSC, Kids-N-Cars, MIFACE, The Firearms Surveillance Initiative, and the CDC as well as research oriented ME/coroner offices in Pennsylvania, Florida, West Virginia, and California to establish initial memberships with ME/Coroner offices for Implementation of *Alcestis*.

Bio-Terrorism, Injury Surveillance, Data Collection

D33 Epidemiological Study of Alcohol Consumption in General Population of Dharan

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The goals of this research project are to study the epidemiology of alcohol consumption in general population of Dharan and to plan effective measures to control the menace of alcohol abuse in Nepal.

Of all the drugs which human beings have used and abused in the course of their checkered history, alcohol is almost certainly the oldest and also the most widely used because it is so easily produced.

Alcohol has always been used in Nepal. Alcoholic beverages are culturally accepted and social tolerance for alcohol use and alcohol dependence is quite high; therefore, alcohol has not been considered a drug for serious concern either by the Government or by any social organization. Alcohol could be the number one problem (drug) if one seriously considers the magnitude and extent of the problem it has created in Nepal. Alcoholic drinks in various forms have long been consumed in Nepal. Alcohol is necessary on most occasions among men, is relatively frequent, and is well tolerated by many communities. However, there is strong social disapproval of female drunkenness. It is not uncommon to see female alcoholics in the country especially in the hilly and mountainous regions.

A "Matwali" is a person who is allowed to drink alcoholic beverage by virtue of his birth. A high percentage of the Nepalese population belongs to this category and many of them take alcoholic beverages either on social occasions or on a regular basis. People who do not belong to this category are not supposed to consume alcoholic beverage even on social occasions. But there seems to be very steady rise in the number of people belonging to this category who consume alcoholic beverages.

People in Nepal generally believe that alcohol is remedy for cold, pain, physical tiredness, and so on. In fact, alcohol is extensively used for many ailments, especially in the rural areas. Most of the unskilled and semi-skilled workers in Nepal believe that they can function better if they take small amount of alcohol form time to time. Moreover, alcohol has become a status symbol for many people. Parties, get-togethers, or festivities are considered incomplete if alcoholic beverages are not served.

According to the 1991 figures form the Department of Excise, the sale of alcoholic beverages seems to be increasing rapidly. Since there is no export of alcoholic beverages from Nepal all beverages are sold and consumed within the country. If home production is taken into account, under-reporting of commercial production, liquor brought in form duty free shops and liquor imports, even more alcoholic beverage are consumed in Nepal. The number of distilleries and breweries is also increasing.

Even light drinking may adversely interact with other medication; temporary heavier drinking can exacerbate most medical illness; and alcoholism can masquerade as many different medical disorder and psychiatric syndromes. Alcohol abuse is a generally acknowledged cause of, or to say the least, an important contributing factor to, accidents, homicides, and suicides.

Therefore, it is felt that the study of the overall prevalence of alcohol consumption, the vulnerable age groups, the ethnic distribution, the role of socio-economic factors, age, sex, and type of liquor shall help to find out the quantum and magnitude of the problem so that the government can plan effective measures to control the menace of alcohol abuse in Nepal.

Alcohol, Drug, Drinking

D34 Practical Applications of Forensic Botany

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The goals of this presentation are to illustrate to the forensic community some specific uses of botanical evidence and to highlight resources that are readily available.

Forensic botany is based upon the knowledge and techniques of plant science to legal matters, especially those related to crime. This presentation is based upon actual experiences with applications from three aspects of botany in criminal, especially homicide, investigations. These areas include Plant Anatomy, Plant Taxonomy, and Plant Ecology.

Plant Anatomy. Because of the indigestible nature of plant cell walls, they pass through the entire digestive system intact. Furthermore, many of the plants eaten (i.e., fruits, leaves, stems, roots) are composed of cells with unique cell wall features and/or particular combinations of cell types that make it possible to identify the source food plant from small pieces of plant material consisting of a number of cells. Occasionally, isolated cells may be useful. Specific plant food sources may often be identified after examining stomach, intestinal, or fecal samples. Vomit can also provide a rich source of plant tissues. The utilization of plant cell matter in the human digestive tract requires some special training, but the laboratory techniques are simple and employ accepted practices of identification of unknown samples by visual comparison with known samples using a compound microscope. Stomach contents or vomit may be used to reconstruct a victim's last meal and may be useful in determining time of death with respect to the last known meal a victim may have eaten. Two fecal samples may be examined and determined if they came from the same source. Unlike stomach contents, feces often are a unique mixture of several meals, and there are marked differences among unrelated samples with respect to frequency and identify of specific items. Fecal material on a suspect's clothing may link him/her to a crime scene. Plant material embedded in human tissues has also been identified. Photomicrographs depicting the distinct nature of these materials as well as information on processing of samples will be presented.

Plant Taxonomy. Beyond the identification of plants as specific drug sources, a second kind of botanical evidence in crime scene investigation comes from plant taxonomy. Specific plant materials associated with vehicles have been used to link suspects to a crime scene, to connect a suspect to a victim, and to verify that a body was transported from the original crime scene to where the body was found. Information on collection, preservation, and identification will be provided.

Plant Ecology. In the search for clandestine graves, ecological knowledge of patterns of plant succession is useful. Disturbance patterns of ground and vegetation over graves vary in known ways and are dependent upon time since burial, decomposition of the corpse, and regional climate among other factors. Knowledge of species that characterize specific habitats also may be useful in linking a suspect to a crime scene.

Resources. Virtually any college or university will have people trained in one or more of these botanical disciplines to aid in gathering evidence. Local experts are especially helpful for taxonomic and ecological evaluations. Specific help with food plant identification from digestive tract samples may be provided.

Education. Presently there are no formal training programs and no board certification available for forensic botany. Advanced education in botany is essential (MA or PhD) with some training in crime scene investigation, evidence procedures, and courtroom testimony, as well as appropriate professional affiliation.

Summary. Many aspects of botanical knowledge are useful in detection and in courtroom testimony in criminal cases. Some witnesses may require specialized training to be received as experts in courts. Botanical evidence as described here calls for relatively inexpensive traditional scientific techniques to produce credible evidence.

Forensic Botany, Techniques, Education

D35 Community Bio-Surveillance: A Role For the Medical Examiner in Enhanced Public Health Surveillance

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The attendee will understand the role of a medical examiner in an enhanced community-wide bio-surveillance model.

Objective: Establishment and dissemination of real-time, multi-jurisdictional, low cost healthcare and medical examiner surveillance of six sentinel syndromes and unexplained/sudden deaths by the City of Milwaukee Health Department (MHD) to detect an event or trend signaling possible bioterrorist activity or natural disease outbreak during high profile public events in Milwaukee.

Background: In June-July of 2002, 1.2 million visitors visited Milwaukee for the Major League Baseball All Star Game, Greater Milwaukee Open golf tournament, Great Circus Parade and Summerfest. Enhanced disease surveillance was already operational and included: regional laboratory information[1], communicable disease reporting network[2], poison control and nurse hotlines, qualitative reporting of sale volumes for OTC[3]/prescription drugs by category, and reports of illness at select long-term care facilities. Timely statistics on syndromes suggestive of bioagent exposure were desired, but the MHD lacked staff resources and systems for on-site chart abstraction similar to that employed at the 2002 Salt Lake City or 2000 Atlanta Olympic games[4]. However, the MHD had developed strong relationships with local emergency departments (EDs) that had experience using the secure, EMSystem™ website and with the county Medical Examiner (ME) through previous collaborations. EMSystem™ had been successfully used for interactively linking county EDs with local public health (i.e., ED diversions, extreme heat alerts) [5]. The MHD believed this infrastructure could be used as a platform to collect voluntary syndromic reporting by EDs, mortality data from the medical examiner, and ultimately be linked with existing community surveillance to create a daily "surveillance dashboard" facilitating review before, during and after high profile public events.

Planning and Methods: Syndromic surveillance forms used by the Salt Lake County Health Department during the 2002 Winter Olympics were revised to create simple checklists and tally sheets where the presence or absence of six sentinel pre-defined syndromes could be recorded. ED managers agreed to attach the forms to all charts for completion during or after evaluation by medical personnel. Similar collection of syndromic data was arranged on a voluntary basis at select urgent care sites and primary care practices. ED staff were prompted daily by EMSystem™ to report 24-hour counts of patients meeting syndrome criteria, as well as total patients seen. Patient identification was not reported, but every syndrome checklist would be stamped with the information and maintained at the clinical site in the event of follow-up investigation. In addition, the county medical examiner agreed to report daily counts of "unexplained, sudden or suspicious death with fever," and total reportable deaths. Decedent Investigative reports meeting the case definition were provided to MHD for follow-up. This information was transmitted via email and fax to the MHD each 24-hour period. Project reporting included the establishment of baseline levels and occurred over a four-week period lasting eight days after the conclusion of the final special event. Absolute syndrome counts and the proportion of syndrome cases to all patients seen were calculated daily and collated with other disease surveillance and posted on the secure and dedicated EMSystem™ website.

Results: Eight EDs, two community physicians, two urgent care clinics, one county medical examiner and one large retailer of OTC/prescription pharmaceuticals participated throughout the four-week-

biosurveillance project. After some initial and minor inconsistencies in frequency and completeness of data, all sites routinely reported both syndromic case counts and overall site volumes to the MHD. The EDs reported a total of 314 cases meeting syndromic criteria out of 26706 patient encounters. In comparison, the community physicians and urgent care clinics reported a total of 214 cases meeting syndromic criteria (primarily pharyngitis associated with groups of patients seen from area youth camps and retreats) out of 2242 total encounters. The county medical examiner reported two cases of unexplained/sudden death during the four-week period that were reviewed and after further consultation found not to be unusual. No unexpected disease occurrences, clusters or other unusual surveillance data were observed during the biosurveillance project. The EMSystem™ website was also used during the pilot period to send e-mail/text pager alerts related to extreme heat conditions and the region's first 2002 finding of avian West Nile Virus. Survey findings about participants' experiences with the program will be evaluated and used in future modification of the model. Early on, staff identified problems with standardization of syndromic reports by clinicians and the completeness of case (numerator) as well as patient encounter (denominator) totals. The ability to develop this type of system required, but also strengthened, meaningful collaboration between public and private healthcare entities. The existence of a regional and familiar Internet-based link between EDs and public health (i.e., EMSystem™) greatly facilitated the ED surveillance effort.

Conclusion: Real-time syndromic surveillance by hospital EDs and other healthcare providers and routine sharing of data between other public health community partners such as the medical examiner, pharmacies, and poison control may reduce the lag between onset, recognition and response critical to effective control of man-made or natural epidemics. At very modest cost, the City of Milwaukee Health Department established and sustained a daily voluntary reporting system over a four-week period and created a "surveillance dashboard" using secure website communications provided by EMSystem™. While this pilot demonstrates that meaningful quantities of information may be collected and transmitted by health providers for finite periods, insufficient information is available to evaluate the sensitivity, specificity or predictive value of the syndromic surveillance tools used. However, it is believed that the model validates implementation of a biosurveillance system for a limited duration in preparation and as a backdrop to high profile public events. As such, the model underscores the importance and need for active surveillance as a component in preparation and response to public health emergencies.

[1] E*lab fax network links labs serving 35 hospital and 50 clinics.

[2] SurvNet County-wide Communicable Disease Surveillance Network facilitated by the City of Milwaukee. Excellence in Information Technology Award (1999) National Association of County and City Health Officers.

[3] Over The Counter

[4] Risk I and Stevens M. Analysis and reporting of data during the Olympics. 3rd National NEDSS Stakeholders Meeting, Atlanta, GA May 8-10, 2002. Heryford, A., Boodleman, L., "Public Health's Winter Games: Bioterrorism Surveillance in Wyoming". Northwest Public Health, Spring/Summer, (2000): 16-17.

[5] EMSystem. Real-time web-based Diversion and Disaster Information Management. http://www.emsystem.com.

Public Health, Bio-Surveillance, Syndromic Surveillance

D36 Staging a Crime Scene: The Intentional Manipulation of the Scene to Divert Attention Away From the Killer

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This presentation will demonstrate the ability to determine the elements involved in staging a crime scene by the killer.

Test: The act of staging a crime scene is very rare. It occurs in less than two-tenths of one percent of all murder scenes. "Staging" is the purposeful alteration of the crime scene. It consists of manipulating the elements of the scene to make it appear to be something it is not. Staging has been widely written on and has been accepted by the courts as a definable characteristic of a crime scene. The basis of staging is to direct an investigation away from the person who stages the crime scene, because the person feels he or she would be a likely target of the investigation. Staging may be as simple as the owner of a car setting his car on fire to collect insurance and reporting his car as stolen. In another example, in 1974 convicted murderer Tony Fernandez bludgeoned his wife to death. To cover up the murder and prevent the notice of a crime, he placed her body behind the steering wheel of their motor home and pushed it over an embankment, hoping to make the murder look like an accident to redirect the investigation. Another motivation for preventing detection by staging is altering a murder scene to look like a burglary or robbery gone awry. Staging a murder scene requires the killer to spend time after the victim's death arranging things in a certain way. The person who stages a crime scene does so based upon experiences and perceptions of how certain crime scenes should look. These actions go beyond the actions necessary to commit a murder.

In the murder of Lisa Carlson, the crime scene was staged. The purpose of the staging was to direct suspicion away from the identity of the perpetrator by making a murder look like a "burglary and/or rape gone bad." A multitude of factors describes the killer's efforts to stage this murder scene. First, the most egregious staging factor is the discontinuity between the actual cause of death and staged crime scene. The two are not reconcilable. For three gunshot wounds, one to the body and two to the head, without any percussive violence, is albeit a conceptual motive of power, control and problem resolution. Conversely, the victim is staged in a setting that pretends to portray a sex murder through the use of sexual paraphernalia, sex videos, disarrayed pants, and covered genitalia to sate the primary needs. In this case, there is no evidence of percussive touching of the victim, until after the killing, the perpetrator manipulated the body for staging of a greater and different type of murder. Again, by the lack of antemortem, perimortem, and/or postmortem percussive activity on the body of the victim, the perpetrator inadvertently exposed the fraudulent attempt to disguise the original simple motive and executed plan. Notwithstanding, it should be clear that a wandering psychopathic sex-killer would not be concerned with staging and/or focusing the law enforcement attention elsewhere. In fact, the manner of death in this case is clearly an issue of ending the victim's power and control. Of course, this would only be true for those who she had the ability to resist.

Second, Lisa Carlson was not shot in the position she was found. She had been moved to that position after being shot. Typically, murder victims are discovered in the position where the death producing injuries occur, and their killers are unconcerned about how the victims are found. The victim was moved to her final resting place. The victim has been pulled back to her position on the couch. The killer grabbed the victim's sweater causing it to bunch and enabling the killer to pull the victim to her place on the couch. The victim could not have caused the bunching to occur.

Third, after the shooting, the victim's pants were pulled down. This occurred by someone standing at the victim's feet, pulling on the pants, thus causing the pants to turn inside out. There is no credible evidence

that shows the victim could have pulled her own pants down in that position.

Fourth, blood spatter evidence demonstrates that the victim was fixed in place after the shooting and then moved. In order for the hair swipe to occur on the couch, the victim's hair must accumulate blood for a period of time. After this, then the blood swipe from the hair could occur. Additionally, the swiping blood pattern on the victim's inner arm is evidence that her right arm came in contact with her hair while being pulled back to her final resting place.

Fifth, the blood transfer evidence on the sexual device indicates that the device was placed there after the shooting. There are sweeping blood transfer stains present on the cord and device that occurred while they were being positioned. Also, the device was placed in her left hand, but she is right-handed.

Sixth, the blanket found on top of the victim was placed there after she was shot and the transfer stains had occurred on the sexual device and cord.

The number of blood stains on and around the victim contrasts with the neatness in the application of the placement of the victim, sexual device, and blanket. The body was moved from the position that it was in prior to the blood spatter patterns to the position it was found at discovery.

Seventh, the ransacking of the chest of drawers in the victim's bedroom was a solitary event, not consistent with ransacking done in the normal burglary case. It was not consistent since there was no other ransacking done in other rooms with valuables obviously present. Also, there was no apparent loss of any valuable items. Traditionally, televisions, video recorders, and computer equipment would have been moved or removed. But these items appeared untouched and were not disturbed.

Additionally, more inconsistencies in the ransacking were present. The drawers were removed from the chest of drawers. One drawer was not overturned and another blocked the removal of a drawer from the second and third level of the chest of drawers. The blocking drawer would have been thrown out of the way by a curious burglar. The contents of these drawers were not gone through in a typical manner. One drawer was just pulled out and set on top of other contents, but not overturned. The bottom drawers did not appear to ever have been opened. In burglary crimes, when there is rifling through drawers, contents are usually disturbed, even dumped out or strewn about. But in this case, there was no noticeable disturbance of the contents of one drawer that was removed from the chest. Only drawers containing items belonging to Lisa Carlson were rifled through in the house.

Finally, the telephone answering tape was tampered with. There was an expectation there would be a sequence of messages that were left on the tape. It was detected that two messages overlap, and this could only occur if someone tampered with the tape recording.

A killer's method of operation contains those actions that are necessary to commit a murder. Whatever this killer did beyond committing the murder, such as moving the victim from the place she was shot to her final resting place, placing the on/off switch to the electronic dildo in her wrong hand, placing a blanket over her lower torso after smearing blood on items and clothing under the blanket, leaving drawers open with atypical burglary and theft disturbance, manipulating the tape on the victim's telephone messaging machine, and either not removing anything or removing only small items with other typical burglary loot in plain sight ready for the taking, was the killer(s) highly personalized effort to stage the scene.

Staging, Profiling, Modus Operandi

D37 Medico-Legal Aspects of Road Traffic Accident and Insurance in Nepal

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The goals of this paper are to present to the community and the government of Nepal a need to institute proper road safety measures and to promulgate appropriate law and insurance policies so that in the future the country and society may lessen human suffering and decrease the negative economic influence of road traffic accidents.

Nepal is a land-locked country nestled in the midst of the world's highest mountains, strategically situated between the vast plains of the Indian subcontinent to the south, east, west, and the high Tibetan Plateau of China to the north. The total land area is 147,181 square kilometers. The population is estimated at about 22 million; about 90% are Hindus, and more than 90% live in rural areas.

Topographically, the country can be divided into three well-defined physical/geographical belts running from east to west. The terrain (plane land) contains 23% of the land area and 45% of the population; it is 200-1,000 feet above sea level. The hills contain 42% of the land area and 47% of the population; this area is 1,000-16,000 feet above sea level. The Mountain covering 35% of the land area and the remaining 8% of the population lies above 16,000 feet.

Administratively, the country is divided into five development regions and 75 districts. The economy of Nepal depends heavily of agriculture, which provides employment of more than 91% of the economically active population and account for about 60% of export earnings. Tourism plays an active part in foreign exchange earnings. Approximately 25% of tourists come from India, 38% from Western Europe and 37% from the rest of the world. Many Nepalese also have relatives in adjacent states of India and both sides move freely across the border.

The total roads in Nepal are 13,223 km; the national high way is 2,905 km; major feeder roads, 1,656 km; minor feeder roads, 179 km; district roads, 6,615 km; and, urban roads, 1,868 km. Of the total roads, 4,073 km are blacktopped; 3476 km, graveled; and, 5,674 km are dirt roads. Most of the roads do not have proper traffic signals and poor speed breakers and humps further contribute to accidents. There are hardly any motor-able roads in many hilly and mountainous areas to the north and so people have to walk miles through the narrow passage for days where hardly two persons may encounter one another. Some head-quarters do not have roads and access is only possible by air.

Public insurance is not mandatory in Nepal and therefore hardly 2% of the population is insured. The reasons are poverty, illiteracy, and ignorance of the people and lack of proper planning and management by the government because of rivalry between the political parties, mid-term multiple election, and economic failure leading to instability of the government. Similarly, not all vehicles have been insured and only recently has insurance become mandatory for all four-wheel vehicles. Most of the two-wheel and four-wheel vehicles still remain to be insured.

Beside Ethiopia, Nigeria, and Ghana, Nepal has the dubious distinction of having one of the highest accident rates in the world. It is estimated that about 1,400-1,500 persons die and 4,000 are injured annually where approximately 4,000 vehicles are involved. Moreover, thousands of animals also die and many get injured because animals, like cows, buffaloes, horses, donkeys, bulls, oxen, goats, pigs, dogs, cats, and other domestic animals, also use the same roads and many times vehicles run out of control and injure or kill people while trying to save animals. Most of the motorcyclists encounter such a problem and meet an accident.

Disproportionately high percentages of these annual deaths, injuries, and permanent disabilities are borne by the citizens of developing nations. Statistics show that, while the people of developing

countries own only 32% of the world's vehicles, they account for 75% of the annual accident fatalities.

Commencing from the 1970s, road safety improvements in North America, Europe, Japan, Australia, and New Zealand resulted in significant reductions in the rates of motor vehicle fatalities. Control of drunk driving, the mandatory use of child-restraint devices and seat belts, and improvements in passive protection, such as airbags, have further reduced the number of deaths and the severity of injury. The situation is quite different, though, in the developing world where a growing number of accidents on the roads have caused the problem to reach epidemic proportions. In the highly motorized countries, the occupants of cars are the primary victims of traffic accidents. In the developing newly motorizing countries, vulnerable road users such as pedestrians, bicyclists, motorcyclists, and scooter riders, and passengers on public transportation sustain the majority of deaths and injuries. They travel together on the same roads with buses, trucks, and cars, in a chaotic traffic stream. Mismatched collisions between the unprotected humans and the heavy vehicles cause serious injury or more frequently death, even at lower speeds. Head-on collisions between vehicles are not uncommon because the traffic moves both ways on the same road in Nepal and many other countries in Asia. Moreover, a significant number of heavy and lightweight vehicles are 30 to 40 years old and are still cruising the road ignoring air pollution, sound pollution, as well as mechanical failure, all frequently leading to catastrophes.

Unlike the developed countries where cars are the predominant mode of private transportation, in the newly motorizing countries, more affordable motorcycles and scooters are being purchased and are joining the unregulated traffic stream in large numbers. The resulting explosive 16-18% vehicle growth rate in many Asian countries will lead to doubling of the fleet in five years and a trebling in eight years, causing even more severe problems. Not separating the various road users, sparse traffic safety laws, inadequate police enforcement, absence of pre-hospital emergency care, and limited resources for acute hospital and rehabilitative care are added factors explaining the frequency of accidents and their devastating consequences.

Road Traffic, Accident, Insurance

D38 A Study of Pulmonary Function in Workers at Flour Mills in Duhabi, Nepal

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The goal of this research project was to create awareness among the workers at flour mills about the health hazards and consequences of smoking so that the workers as well as government, in a developing country like Nepal, should take appropriate measures to prevent respiratory health hazards due to flour dust pollution.

Exposed to flour dust, 52 male workers were evaluated for pulmonary function, respiratory symptoms and smoking habits. The study showed a significant reduction in FVC, FEV1, PEFR, FEF 25-75%, and MVV. Flourmill workers who smoked showed further significant deterioration of lung function parameters when compared to non-smokers. From this study it can be concluded that those exposed to flour dust contract a combined type of spirometric deficit revealing obstructive disease and smokers working in such an environment are prone to develop further reduction in pulmonary function parameters.

Pulmonary Function, Smoking, Flour Dust Exposure

D39 No Crime, No Warrant, No Charge, No Arrest, But Excessive Force

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The goals of this presentation are to demonstrate the forensic evaluation of radiographs with reference to other evidence in determination of causation of injury.

This presentation follows the step-by-step reconstruction of such a case, copiously illustrated.

A 68-year-old male resident of a Mid-Western city suffered from progressive dementia or Alzheimer's disease. He previously had survived a cancer necessitating total removal of his left lung. Nevertheless, he was able to feed and dress himself, bathe and shave, and otherwise take care of his personal hygiene. He was able to converse, watch television, and go for walks (although he sometimes became confused or lost).

On a fall evening this elderly man walked several blocks to a neighborhood convenience store. There his activities and the subsequent actions of others were recorded by a surveillance video camera at 3 frames-per-second. He was seen to wander about the store a bit but mostly just stood around and watched other people. He didn't appear to speak to anyone or make a purchase. Apparently, after several minutes, one of the employees of the convenience store grew tired of having him around and called the city police.

Abruptly, on the surveillance tape, one sees a large officer approach the elderly man and, without warning, grasps him from behind. With arms locked around the old man's chest, the police officer lifts him off his feet, swings him around to the right, and then body-slams him to the floor. The old man lands on his right front and side with the full weight of the officer on top of him – a classic "take-down."

The officer and his patrol partner lifted the handcuffed victim to his feet and escorted him out to the patrol car where they had to help him into the back seat. The old man couldn't lift his legs into the vehicle and complained of his right shoulder. Although bleeding, he was offered no medical assistance.

The other patrolman recognized the victim, and he was driven to his home where he was assisted through a side door down three steps into a "club" basement and placed on a couch. His wife was told that he had "fallen."

After eating and drinking sparingly the old man fell asleep on the couch. Several hours later the wife found him on the floor in front of the couch, incoherent, incontinent, and short of breath. He was taken by ambulance to the hospital.

Multiple examinations revealed acute fractures of the right clavicle, the right second, third, fifth, sixth, seventh, and ninth ribs (some of them in two places), the right innominate bone, and the left transverse process of the first lumbar vertebra. A right-sided pneumothorax (undoubtedly caused by the rib-fractures) partially collapsed his only lung, thus compromising his respiratory capacity. His oxygen saturation values documented hypoxias. Finally, CT revealed a contusion and hematoma in the left lobe of his liver.

After extensive treatment the victim was discharged but was never able to go home again, being unable to care for himself, incontinent of bowel and bladder, and unable to walk or speak coherently. He has required additional hospitalizations for aggressive behavior and recurrent infections.

As a result of the above events and its sequelae, multiple complaints were entered against the police officer and the city. These charges were subsequently settled in favor of the plaintiff.

Excessive Force, Fourth Amendment Rights, Battery

D40 The Greyhounds and Me: Stories of a Forensic Nurse

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The goals of this presentation are (1) to examine some of the medico-legal issues that are present at a greyhound park and the necessity of proper nursing procedures and documentation to safeguard the corporation from civil and criminal issues, and (2) to recognize that the forensic nurse can capably carry out these functions.

The forensic nurse deals with clients and their significant others whose nursing problems bring them into actual or potential contact with the legal system. Among these clients are victims of interpersonal abuse and violence, victims of trauma, victims of drug abuse and misuse, those with undiagnosed health problems, those who fail to comply with their health care regimens, those involved in vehicular accidents, environmental hazards, and cases of sexual assault.

The following presentation represents a Greyhound racing park in New England, according to the State Pari-Mutuel Commission, where a registered nurse is required to be present whenever live racing occurs. A well-delineated job description does not exist for these nurses. But the nurse is given a well-equipped first-aid station that is located next to the security office and carries a walkie-talkie at all times. The site also hosts a well-known restaurant, bar stands, snack stands, and a banquet facility for hire.

Patron accidents and health issues as well as employee accidents or health problems are triaged, treated or referred to an Emergency Department when indicated. It is the duty of the nurse to collect evidence, document accident scenes, preserve evidence, and or institute what quality assurance measures are required to prevent further risk management for the corporation. This requires interfacing with administration, security, maintenance, and various liability carriers for patron liability, as well as Workman's Compensation. In fact, if proper reporting of Workman's Compensation cases is not made within 5 days the track owner is subject to fines.

It is sometimes difficult to convince non-medical personnel that "handing out an aspirin or giving someone Alka-Seltzer" may not be consistent with prudent medical practice in light of today's knowledge of adverse interactions. The bartender cannot be expected to discern which patron is on anticoagulant therapy or is subject to flash pulmonary edema, and administration officials must be convinced of that when they listen to the nurses' explanation of what O-T-C medications should or should not be available. One solution might be to shift the responsibility to the patron via the use of a coin-operated self-dispensing medication machine.

Similar to other tracks, heat exhaustion and collapse are common during the summer months with 90+ F. heat and 80%+ humidity. The differential diagnosis between adverse effects of environmental conditions and the patients' personal medical profile is a frequently encountered challenge, especially with the preponderance of Senior citizens frequenting the track. Assurance that the treated patron makes it safely home is another potential liability for the nurse and corporation.

Although altercations between patrons are infrequent, occasionally the local law enforcement officials need to be summoned; evidentiary data and documentation and photo documentation are critical to obtain at the time of the occasion. Preservation of this information is paramount for possible protection from possible legal action at a subsequent date.

The nurse who works in the first aid station must have not only emergency nursing care experience which includes CPR, automatic defibrillator knowledge, and trauma nursing knowledge but also knowledge of current medications, their interactions, and adverse effects. At times the nurse performs as occupational health nurse. But at all times the nurse must have a sound knowledge of evidentiary recognition, collection, and preservation, and a sound understanding of proper medicolegal documentation. Only in this manner can the nurse help to safeguard the employer from unwarranted liability.

Forensic Nursing, Sports Track Medical Liabilities, Vendor's Considerations for First-Aid Care

D41 STR Database Technology Improvements—Storage, Retrieval, Matching, and Reporting

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Upon completion of this course, participants will be given an overview of the software technology demonstrating the ability to warehouse, manipulate, search, and report STR data using "Off the Shelf" Personal Computers.

STR Technology does not have to be expensive.

It is estimated that up to 40,000 individuals are still missing from the armed conflict in the former Yugoslavia during the 1990s. One of the primary missions of the International Commission on Missing Persons' (ICMP) is to help provide closure to families by aiding in identifying their missing loved ones. Various groups within the Forensic Sciences Program are producing tremendous amounts of data and a need for some specific technology to manage this data is crucial. This is especially true within ICMP's large-scale DNA testing program that produces gigabytes of data every month.

Beginning in May of 2001, the first 16 loci STR profile from a blood sample was obtained and, over the course of the next ten months, the relatively low level of data produced from minimal throughput of samples was easily stored and managed using "Off the Shelf" spread sheet software. As methodologies and the scientific expertise improved, throughput increased. These improvements aided in transforming the ICMP's DNA laboratories into a high throughput DNA processing system in which the number of bone and blood samples being tested on a monthly basis increased from 100 and 200 to 500 and 3,500, respectively, from February to March of 2002. This increase in data quantity and the resulting need for the management of such data meant that spreadsheet technology would no longer be efficient for the task at hand. The technology created at ICMP allows STR data to be stored in either central or local locations and allows access to the data only by those with appropriate logon credentials. This technology has been dubbed "ICMP-IWH." (International Commission on Missing Persons Information Ware House). In order to access data from ICMP-IWH software, the user must first successfully log into the system. While the ICMP currently uses a 16-plex in obtaining the majority of its STR data, the ICMP-IWH system is adaptable to meet varying needs. The potential for future increases in the number of loci being used has been dealt with by allowing up to 24 loci per sample to be entered into the system, along with the corresponding allowable values for those loci. The order in which this information is displayed, edited, and reported is also configurable. The ICMP-IWH has two ways of entering data into the database: either by manual entry or computer downloads. During manual entry, if a loci value is "Out of Range" the operator will be notified and can choose to accept or reject that particular sample. Importing STR data needs to meet certain criteria. The file must be comma or tab delimited with sample ID and STR data. In order to insure that the correct loci value is imported to its corresponding location in the database, the import file must have a "header record, " i.e., first row of data, sample ID, D3S1358, THO1, D21S11, etc. The import engine does not require the import file to have any particular order for the columns of data, but they must be consistent in arrangement for that one file. Multiple sample categories are supported, i.e., staff, blood, bone, etc.

The STR matching component of this software allows the operator to choose what sample categories to compare against each other, or an individual sample to a group. There are settings to adjust the number of minimum required loci or maximum excluded loci in either a half-band or full-band sharing mode. The software will provide the operator with the included and excluded loci "Hits" on any matching report. Statistical calculations may be performed on all data or individual groups using allele frequencies from different populations as necessary. This software ICMP-IWH) runs the windows 32 bit operating systems. It has been tested on Windows95, Windows98, Windows98SE, Windows NT4.0 (sp5, sp6a), Windows2000 (sp1), and Windows XP and well as on Dell, AST, Acer and component-assembled computers. Minimum configurations that have been tested are PII-233Mhz with 32Mb ram and 4Gb hard drive. This software has also been tested on an Acer PIII 1Ghz (X2) SMP with 1Gb ram and 30Gb SCSI hard drives.

The development of a centralized computer system that receives all DNA data, a corresponding DNA matching program, a LIMS for the DNA system, as well as a universal bar coding system for all four of ICMP's DNA laboratories has been successfully implemented. These combined and integrated computer capabilities are an essential component to ICMP's DNA laboratory system and permit the ICMP to properly manage the gigabits of data that are produced each week and are critical when dealing with a system that produces an average of several hundred DNA match reports per month.

DNA, STR, Database

D42 Managing a Forensic Biology Laboratory in the 21st Century

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The goal of this presentation is to provide the participant with a range of strategies that may be employed by the managers of a forensic biology laboratory to ensure that services are delivered effectively and efficiently while addressing a myriad of demands and competing pressures.

Synopsis: In common with many forensic science labs, the CFS has faced a number of challenges during the last decade of the 20th century. These challenges have been multifaceted and have ranged from scientific, to legal, to fiscal.

The objectives of the presentation are to describe the various issues that have impacted the Centre of Forensic Sciences (CFS) Biology Section over the past decade and to demonstrate a more business-oriented approach to the delivery of scientific services.

Pressures: In the 1990s the effectiveness of the laboratory was addressed in judicial reviews of two different homicide investigations. The main elements of the two reports may be addressed in terms of quantity and efficiency of service delivery (Campbell report) and quality of service delivery (Kaufman report). However, both reports identified the need for additional resources.

Both reports included a number of recommendations that impacted the laboratory, some of the key issues being:

- Turnaround times
- Co-ordination of scientists and police
- Objectivity and independence
- Report writing and court testimony
- Training
- Quality Assurance
- Appropriate resources

The issues highlighted in these reports were further compounded by the increasing demands for service that resulted from an increasing awareness on the part of police services, the courts, and the general public of the potential for forensic biology to aid in the investigation of crime

The ability of the CFS Biology Section to participate in and contribute to the investigative process was further expanded when the Canadian National DNA Data Bank became operational in June 2000. This again placed additional demands on services both in terms of volume and efficiency.

Resources: In addressing these pressures and in recognition of the potential for forensic biology to be a cost effective component in police investigations, the Government of Ontario provided funding for a new DNA laboratory, an increase in the number of staff from 36 in 1995 to 72 in 2002, and for an increase in equipment.

The challenge for laboratory management is to ensure the effective utilization of additional resources to be able to increase the capacity of the laboratory in as short a period of time as possible.

Strategies: Through a process of intra lab consultations with staff, a model for the reorganization of laboratory staffing has been developed. The model included an expansion of the management group and a greater emphasis on the utilization of non-court going scientists (technologists). The following staffing ratios were devised: one manager for each group of 10-15 scientific staff, and, one screening technologist and one DNA technologist to assist each pair of court going reporting scientists. Technologists carrying out DNA analysis were deployed in a DNA Unit dedicated to the analysis of samples submitted by reporting scientists.

In addressing issues of efficiency and quality, the ability to recruit the appropriate scientists and technologists was an important first step in the evolution of the laboratory. The CFS developed a behavioral competency model for the positions of scientist and technologist. These models provided to the authors a description of the behavioral competencies required of an excellent forensic scientist and were incorporated into recruitment competitions.

In order for new staff to be trained efficiently and effectively, so as to become operational as quickly as possible, a modular approach was adopted. Managers responsible for training developed programs that incorporated lectures, practical written and oral tests, proficiency tests, and mock court exercises all delivered according to set milestones and all within the framework of mentor relationships. These programs ensured that staff members were trained according to the following timelines:

Reporting Scientists	6-9 months
DNA Technologists	3-4 months
Screening Technologists	6-8 weeks

Issues concerning clarity of information provided to clients were addressed by changing the formats and contents of reports. Standard formats for CFS reports now include:

1. Purpose statement
2. Tests conducted
3. Results
4. Conclusions
5. Information about the case scientist and other staff who assisted in the examination
6. Sample consumption information
7. Continuity
8. Information concerning the analysis written for the benefit of the client.

In responding to client requests for a more timely provision of information, the approach in large case submissions was changed. In place of a single large report provided on completion of the examination of all items submitted during the course of an investigation, multiple reports detailing results priority batches are now issued.

A number of initiatives have been implemented in order to be able to define services to clients and to be able to respond proactively to demands. As part of a province-wide major case management program,

police follow a set procedure. In order to take advantage of this, a process has been implemented whereby the investigating team meets with a consultant forensic biologist prior to the submission of a case. The consulting scientist directs the items to be submitted and the examinations to be conducted. This avoids the inefficiency of items being submitted but not examined and improves the flow of information between scientists and investigators. This process also facilitates a service contract that includes the number of items to be examined, the specific tests to be performed, and a timeline for the provision of results.

The advent of the DNA databank facilitates the use of DNA analysis as an investigative tool to allow the identification of suspects. In order to maximize this service, a number of programs in partnership with police services have been developed. These include the development of a formal process for the rapid dissemination of information to investigators when a "hit" to the databank is registered, a co-coordinated approach to the examination of DNA evidence in "cold cases," and the development of a service for the examination of evidence from break and enter cases. These services have been designed to facilitate the processing of cases in a timely fashion and have resulted in 147 investigations aided for a total of 1800 profiles entered onto the Crime Scene Index.

The number of samples being processed by technologists in the DNA unit varies between 600-800 per month. Through process review and change, the time required for analysis of a sample from 16 to 8 calendar days has been produced. The current process employs a production line approach that will in future be amenable to the incorporation of further automation.

Ongoing initiatives include process review to maximize the efficiency of item examination, and a Research & Development program that is process driven.

Summary: By employing a variety of different strategies, an increasing range of services to clients has been delivered while continuing to improve turnaround times and quality of the science. This has resulted in increased satisfaction levels on the part of the stakeholders and an improvement in the contribution that the laboratory makes to public safety in the province of Ontario.

Laboratory Management, Service, Resource

D43 Analysis of Ignitable Liquids in Fire Debris With Comprehensive Two-Dimensional Gas Chromatography-Mass Spectrometry (GCxGC/MS)

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The goals of this presentation are to discuss a new analytical technique, comprehensive two-dimensional gas chromatography-mass spectrometry (GCxGC/MS), for the forensic analysis of fire debris samples.

Comprehensive two-dimensional gas chromatography (GCxGC) is a new analytical technique with a demonstrated capability to separate and identify ignitable liquid compounds in complex fire debris samples. The increased separation capability of GCxGC represents a significant analytical advantage over traditional gas chromatography (GC) and gas chromatography-mass spectrometry (GC/MS) methods for fire debris samples containing abundant pyrolysates. In traditional GC analysis, chromatograms of the fire debris extract are used as a fingerprint to determine if a particular ignitable liquid is present. However, the determination is often impossible if an abundant pyrolysate background obscures the chromatogram. GC/MS methods improve detection because extracted ion chromatograms may be used to isolate specific ignitable liquid compounds like alkylbenzenes. The enhanced chromatographic separation achieved with the new analytical technique of comprehensive two-dimensional gas chromatography and the unambiguous identification provided by mass spectrometric detection permit the rapid detection and identification of the full range on chemical compounds present in ignitable liquids.

GCxGC uses two different chromatography columns coupled serially by a modulator to produce a volatility-by-polarity separation and distribute compound peaks across a two-dimensional retention time plane. The two-dimensional separation produces hundreds- to thousands of resolved peaks, a significant improvement over traditional GC separations. The two-dimensional separation yields a two-dimensional image that is well suited for fingerprinting. In addition, the grouping or ordering of the peaks in the GCxGC chromatogram facilitates the identification of specific compounds unique to ignitable liquids against a complex chemical background of fire debris pyrolysates. When coupled with a mass spectrometer detector, the GCxGC/MS method produces a single-component, interference-free mass spectrum for each resolved peak that leads to accurate matching with mass spectral libraries.

GCxGC/MS methods were used to produce a library of chromatograms for different petroleum-based ignitable liquids as well as chromatograms of pyrolysates for common fire debris materials. GCxGC/MS chromatogram images were used to rapidly detect and classify ignitable liquids in fire debris samples.

Arson Analysis, Fire Debris, Analytical Chemistry

E1 Is There a Terrorist Profile? Psychological and Legal Dynamics of Terrorism

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The goal of this presentation is to analyze the psychological and motivational dynamics of terrorism and their relevance for legislation and judicial due process.

Terrorism is the use of actual or plausibly threatened violence in the name of an ideological or political position, and has a long and evolving history. While in-depth psychodynamic investigations of individual terrorists are relatively rare, clear patterns have emerged.

While terrorism is a hate crime in that hate usually contributes to the driving force behind its violent acts, terrorism is a specific subset of hate crimes. Also, while there have been lone terrorists (Ted Kaczynski among them), most terrorists function as part of a tight-knit group that cultivates a unique world view and serves to block out or rationalize any information that may conflict with their own convictions. While most hate crimes are committed by lone individuals whose anger explodes into spontaneous and often random violence followed by an awareness of the inappropriateness of the actions and possibly even suicide, terrorists are usually systematic and calculated in their attacks, rationalizing and even relishing their crimes.

Terrorism is often exploited in support of broader national or political agendas, and attracts supporters and functionaries motivated by their own unique needs. However, when one thinks of terrorists, one is usually thinking of the people who plan and execute acts of violence against seemingly random noncombatants in order to generate fear and intimidation throughout a broader civilian population. These terrorist perpetrators are typically of average intelligence, come from comfortable backgrounds, blend in well and are usually seen as "normal" psychologically and otherwise, and therefore easily progress into some form of post-secondary education.

While this access to education has created an image of terrorists as "intellectuals," few complete their college education and it is difficult to find concrete examples of their professional or intellectual achievements. Instead, beginning at about puberty, these individuals view themselves as rightful heirs to a favored destiny that would have been theirs had it not been for some past act by a group that becomes increasingly despised. Most often this root act is obscured in history, vague, and not open to any plausible remediation. However, current events are typically viewed as a continuation of the legacy created by the root injustice. Terrorist perpetrators seek to gather into networks that share what becomes the collective focus of an obsessive rationalization that offsets and justifies their own shortcomings or feelings of inadequacy.

Although the terrorist's world view may bear some superficial similarity to the attitudes of their parents or other significant figures, this need not necessarily be the case; and parents and friends are genuinely shocked when they learn of the extremism of a perpetrator's views and the acts that those views are used to justify. While most terrorists, as with most criminals generally, show evidence of serious character disorders, they do not lack a capacity to distinguish right from wrong. They act with deliberate premeditation; are systematic and meticulous in their planning; and gather and act on information, altering their course of action based on their findings. They closely follow press coverage of their actions, use that coverage to glorify and justify their behavior, and screen out or rationalize anything inconsistent with their own views.

This is the behavior not of an insane person in the federal and most state definitions of legal insanity, but of a person who knows that his or her actions are wrong and nevertheless chooses to ignore that reality and act counter to its imperatives. It is often assumed that such actions must therefore be motivated by some deeply held ideological conviction or the result of unjust hurt or trauma. Neither of these assumptions finds much support in the facts.

While terrorist perpetrators clearly feel deep and seething hatred, it is rare that they have any plan for the future should their terrorist campaigns prove successful. In fact, since they are driven by the satisfactions that come from perpetrating terrorist violence, they have difficulty even conceiving a time or place in which those actions would not be justified. They come from privileged backgrounds, and often the links between the alleged root transgressions and their own lives and backgrounds are tenuous at best. This has led many terrorist groups to seek out allies among "workers" and the disadvantaged; but since this has often provided one of their few openings to police infiltrators, that practice has been largely discontinued.

In short, terrorist perpetrators are most likely to be people who by temperament and possibly critical-phase development are attracted to violence, and who are fortunate enough to have the time and resources to fashion an environment that affords opportunities to act on their base impulses. Since society has severe sanctions against anti-social conduct, terrorist perpetrators ally themselves with religions that can be interpreted to support the violent acts they wish to commit, and operate in the name of political ideologies – generally of the extreme left or right – that also glorify violence.

Obviously terrorist perpetrators lend themselves to exploitation by political regimes, and therefore it has been argued that terrorism has increased because terrorism "works." Shifts in the nature of terrorist activity are more complex, and are complicated by the shift to a post-Colonial era in the 1960s, and the fact that many regimes that harbor terrorists are among the remaining closed dictatorships and lack a free marketplace of information and ideas. One of the last gasps of Marxism in the Sixties was the fostering of a worldwide philosophy that all ideologies had equal validity; thus society has moved from a world of competing superpowers to a world of freelance anarchists. But while political leaders are thought of those who exploit terrorism as terrorists, most politicians do have a sense of future and a blueprint for what they think that future should resemble. Therefore they are leery of terrorist perpetrators, seeing them quite rightly as dangerous and unpredictable. Paths for advancement of perpetrators within political administrations are therefore limited, and they are often considered most useful as suicide bombers.

While the psychological profile of terrorist perpetrators is highly specific, it lacks the uniqueness required of a legal profile (see ***U.S. v. Sokolow,*** 490 U.S. 1 (1989); Edwards, C.N. Behavior and the law reconsidered: psychological syndromes and profiles. J Forensic Sci 1998; 43(1):141-150). Since terrorists quickly reach a point where they dismiss all outsiders are irrelevant and untrustworthy, they are not proselytizers; and since they have the means to blend in with the surrounding culture, their detection requires more sophisticated approaches.

Apprehended terrorists present unique judicial challenges. While it would be difficult to make a case that they were insane during the commission of a terrorist act, they are prone to an incarceration pseudo-psychosis that can result from the clash between their protected world view and the realities of capture and trial. They are likely to reject the authority of the courts, resist negotiated resolutions, seek to use the courts as a forum for their espoused ideologies, fail to cooperate with counsel, and be disruptive in court. Their trials tend to be high profile and require special care from all parties in order to assure not only the fairness that justice deserves but also the appearance of fairness essential to public confidence.

Terrorism, Psychological Profiles, Judicial Due Process

E2 Al-Qaeda's Operational Methodology: Implications for Counterterrorism Investigations

Michael G. Gelles, PsyD, U.S. Naval Criminal Investigative Service, 4400 East-West Highway, Bethesda, MD; and Russell E. Palarea, MA*, U.S. Naval Criminal Investigative Service, 16026 Burtons Lane, Laurel, MD*

Upon completion of this presentation, participants will understand Al-Qaeda's operational methodology and how it is applied to conducting counterterrorism investigations.

In order to anticipate and thwart future attacks, it is vital to understand Al-Qaeda's methodology. The paper will provide an analysis of Al-Qaeda's operational methodology and its application to counterterrorism investigations. The presenters will specifically discuss their analysis of the Al-Qaeda training manual, their review of the open source literature, and their experiences working counterterrorism investigations. The presenters will also discuss the life course of the Al-Qaeda operator, from recruitment, through training, to deployment, and ultimately, to the attack. Finally, the presenters will discuss issues involving Al-Qaeda operators' motivation, organization of thinking, progression from idea conception to attack, and violence risk assessment.

Al-Qaeda, Operational Methodology, Counterterrorism Investigations

E3 Sailing in New Waters: A JAG Officer's Perspective on the Detention of John Walker Lindh

Christopher H. Baugh, JD, 7324 Southwest Freeway, Arena Place Two, Suite 1888, Houston, TX*

The goal of this presentation is to inform forensic scientists and lawyers of the new legal issues confronting military and civilian Justice officials involved in the fight against terrorism.

As the Staff Judge Advocate, (JAG) assigned to the Commander Amphibious Squadron ONE (COMPHIBRON ONE), embarked aboard the USS PELEIU (LHA-5) during the 2001-2002 Western Pacific (WESTPAC) deployment it was the author's duty to advise the Task Force Commander on all applicable Rules of Engagement, Law of the Sea, Environmental and Operational Law issues. These are the primary duties of all deployed JAGs serving aboard U.S. Naval ships through out the world. The author's role in this arena was to be of special significance due to the immediate involvement in Operation Enduring Freedom, as a result of the terrorist attacks upon the U.S. on September 11, 2001.

Three Navy ships of the Amphibious Squadron, along with the 15th Marine Expeditionary Unit, comprised the Amphibious Ready Group. The Group was immediately ordered to the Northern Arabian Sea to conduct missions in Afghanistan in support of Operation Enduring Freedom. In late November it was determined that one of the captured Taliban fighters was American John Walker Lindh. Lindh was held at the Marine occupied Camp Rhino while higher command elements made a determination on what to do with him and the other enemy detainees. At some point in early December the decision was made to move Lindh and the other detainees to a holding facility on board the USS PELELIU. It was at this time that duties changed.

As the JAG, it was the author's duty to review and approve any plans the PELELIU had in its preparation for the housing of detainees. Initially the author was concerned with complying with the Geneva Convention prohibition against bringing enemy prisoners of war aboard ships unless for a temporary basis. As with many military plans, there often is a starting point, but the end or final solution is something that will come in time, or will be dealt with later. After much consternation and vividly worded emails it was decided that the detention of detainees would be in fact temporary.

The issue that surrounded these individuals from the beginning was to what official status they were to be entitled: prisoners of war or unlawful combatants (criminals). This distinction in status would have tremendous effect on the rights afforded to these individuals.

The raging debate in Washington on the status of these individuals did not cause a delay in their being processed to the PELELIU. As a result it was the author's duty to put together a hodgepodge of rights and privileges to be afforded these men. It was understood from the CNN feeds that no decision had been made in Washington as to their official status. Thus the author looked to the Geneva Convention and hand picked the rights that would be afforded these men. Often times decisions were rationalized to the commanders whose main concerns were not the comfort or well-being of the detainees.

In the history of the U.S., enemy prisoners of war have never been housed aboard Navy ships and from the moment he was brought onboard, the ship was "sailing in new waters." It was understood from the beginning that Lindh's case was destined for a courthouse…somewhere. Initial instructions were to begin interrogations without rights advisements or any type of Miranda. As a former prosecutor, the author found this very incredible. As is the norm, any attempt the author made for getting clearer guidance from higher command was contradictory - some wanted warnings given, others did not. The author's advice to the Commander was that no one should have access to Lindh until concrete answer of the approved policy was determined. Non-military criminal investigators were also now onboard the PELELIU waiting to debrief Lindh. The author had all investigators' access to the brig, where Lindh was being held, secured to ensure there would be no mistakes or slip-ups by law enforcement entities. These actions were not warmly received by either the Commander or the investigators, but were later passed as shipboard policy.

As stated earlier, the authors were blazing new trails. One thing was for sure: actions, *all actions,* would be scrutinized at a later date by a judicial body, if not the entire free world. It was because of that belief that the author chose to remain closely involved with all aspects of Lindh's and the other detainee's detention while they were aboard the PELELIU. This too was the author's reasoning for not having any conversations with Lindh or the others, direct or indirect, but daily visiting the brig to visually ensure they were in good physical condition and were treated properly. Instructions were to have the brig security personnel and only the brig security personnel converse with the detainees and then only to discuss their comfort and well-being.

The rudder found guiding the author through this period was the Geneva Convention. However, its provision regarding the prohibition against availing prisoners to public curiosity was one of the biggest fears. The U.S. follows the Geneva Convention for many reasons. One of them is the hope that other countries will also follow the treatment allocations it provides. Bringing enemy detainees onboard a Navy helicopter carrier with over 3000 young Sailors and Marines in a war zone during the digital age, one would not be prudent if he/she was not concerned with a photo of the detainees finding its way to the Internet. Several times the author found himself confronting a Sailor or Marine attempting to get that souvenir shot. The author recalls having to go out on the flight deck during flight operations to counsel a flight deck crewman on his inability to photograph the hooded detainees during their departure from the PELELIU.

The experience was that of a lifetime. At times the author was not the most popular person onboard. Often the Commander and/or the CO of the ship did not wish to hear that which the author was obligated to advise them about. However, the ends justified the means. During the preliminary legal investigation of U.S. vs. John Walker Lindh, many key figures who served aboard the USS PELELIU during this stressful time,

including myself, were interviewed by both the defense and prosecution teams. The investigators were in "uncharted waters" but accounts from both sides of the case have acknowledged that the process, manner and professionalism in which the men and women of the USS PELELIU (LHA-5) performed their duties in the detention of the enemy detainees was "the way it should be done".

Enemy Detainees, Geneva Convention, Combatants

E4 Defending the Terrorist: A Test of National and Personal Principles

David P. Baugh, JD, P.O. Box 12137, Richmond, VA*

The goal of this presentation is to inform and sensitize forensic scientists and lawyers to the unique challenges of representing those accused of terrorist acts.

Everyday in the U.S., from small county courts to the highest courts in the land, men and women are charged with offenses against laws which make them hated by most Americans. Murderers, child molesters, rapists, drug dealers and corporate swindlers destroying the futures of thousands of families, all are reviled, but entitled to the fundamental protections of the Constitution and laws. Among other protections, the accused are afforded the fundamental rights to effective assistance of counsel, to confront their accusers and to call for evidence in their favor. Although these criminal defendants may stand accused of vile and reprehensible conduct, few people would object to the application of constitutional protections required by the nation's commitment to the fundamental principles of due process and equal protection of the laws.

But can conduct be so evil that people refuse to extend to the accused the protections of the Constitution to which they have sworn allegiance? Are acts of terrorism against the U.S. and its citizens so vile that adherence to fundamental principles of justice must be relaxed or denied?

To answer these questions, one must consider whether extension of fundamental due process protections is governed by commitment to those who stand accused or commitment to the Constitution itself. Are these defendants protected with the Constitution because they are entitled to the protection or are these protections extended because the Constitution is what the U.S. is about? Consideration must be given to whether the criminal justice system was designed or intended to deal with individuals who are essentially acting pursuant to a declaration of war on the U.S.

Since the tragedy of September 11, 2001, Americans from all walks of life are being compelled to face, in application and as contributors to public opinion, the depth and vitality of commitment to fundamental principles of due process and justice. Ordinary people are being confronted with these issues to an extent not seen since the founding of this nation. Constitutional principles consistent with national interest must be considered. Some critics fear that adherence to these constitutional principles will lead to death and the destruction of this nation. Does the need for security require not only a reduction in civil liberties, but also compromises in or even abolition of customary due process for those accused of terrorist activity?

For those who argue against compromising constitutional principles, advocacy for these principles can be equally unpopular around the water cooler or on CNN. But can this nation be truly persevered if principles are compromised? At issue is the long-term effect of confronting terrorism. In the drive to protect this nation and punish those who act against us, will a weakening commitment to constitutional principles effectively destroy the constitutional fabric of this nation, thereby granting victory to its enemies?

This presentation will address these unique issues and the potential personal and professional costs associated with this advocacy. Topics will include understanding the client, advocating his protection, cultural differences, language differences, personal safety, and securing the cooperation of expert witnesses.

David P. Baugh of Richmond, VA, had the opportunity and challenge of defending a member of al-Qaeda charged in New York with bombing the U.S. Embassy in Kenya. He was able to prevent the imposition of the death penalty for a Saudi man charged and convicted of bombing the U.S. Embassy and killing 214 people, 11 of them Americans, men and women, military and civilian. During the representation he was confronted with the professional and personal task of insuring the application of the principles of the Constitution in the defense of someone who opposes Americans.

Constitution, Terrorism, Criminal Justice

E5 Is the "War on Terrorism" Killing Our Constitution?

Donald G. Rehkopf, Jr., JD, Law Offices of Brenna and Brenna, 31 East Main Street, Suite 2000, Rochester, NY*

The goal of this presentation is to present to the forensic community an insight into the realities (versus rhetoric) of how the legal aspects of the so-called "war on terrorism" is undermining and destroying key Constitutional rights.

No one can seriously question the need for better procedures to protect America after the tragedies of September 11, 2001. But, national response – the purported "war on terrorism" – is evolving into an overt governmental attack against core and fundamental Constitutional rights. The Fourth Amendment to the Constitution requires "probable cause, supported by Oath or affirmation," before an individual can be seized (incarcerated). The fundamental right to "Due Process of Law," *i.e.,* the right to notice of specific charges against one arrested and the prohibition against deprivations of liberty without due process, are guaranteed by the Fifth Amendment. And, the Sixth Amendment guarantees the fundamental right to counsel – an attorney advocate – for those arrested.

The government's handling of the cases of two American citizens allegedly with *al Queda* or Taliban connections – Hamdi and Padilla – shows how the Executive Branch has concocted a concept to eviscerate these core constitutional basics. Simply put, they have arbitrarily labeled Hamdi and Padilla as "enemy combatants" (a concept that has no specific *legal* meaning under international law), and based upon secret claims of "national security," have arrested, detained *incommunicado* and imprisoned in a military brig these two American citizens. All without charging them with any criminal offense or violation of international law. This is *not* a defense of them, their politics or of anything they may have done which may be criminal. It is simply a defense of Constitutional rights – rights guaranteed and applicable to all American citizens.

The U.S. Constitution is a majestic legal and political document, one that has endured the test of time and many wars. The history surrounding its drafting, debate, and ratification cannot be ignored, nor can one ignore the fact that nowhere in the Constitution are there any exceptions for "national security" concerns. That, it is submitted, was intentional as the Constitution was clearly intended to encompass any and all national emergencies.

To understand this and its contextual relevance, one must remember that the Declaration of Independence specifically targeted the terrorist acts fostered by King George III's support of "the merciless Indian Savages. . . ." History shows that the U.S. was conceived in terrorist acts – the Native American "wars," the Boston massacre, Lexington and Concord, etc., culminating in the Revolutionary War. However, it was with this "war" background that the Constitution was born. Yet the Drafters and citizenry were not satisfied that liberty was secure, both from abroad and from government, hence the Bill of Rights was incorporated into the Constitution.

Today Hamdi and Padilla – both U.S. citizens – are incarcerated incommunicado in a military brig by a "military order" of the Commander in Chief, the President. The Executive Branch has declared

that such orders are sacrosanct and immune from judicial scrutiny. That simply is totalitarianism at its worst and is something that James Madison warned against, "An elective despotism is not the government we fought for." The Commander in Chief is both subject to the Constitution, and also to the expressly delegated "War Powers" granted to Congress – *not* the President – in Article I of the Constitution.

Combating terrorists, militarily or criminally, is not the issue. But, such "combat" cannot and must not destroy the Constitutional rights uniformed men and women have fought, bled and died for since 1776. And, Adolph Hitler's warning must not be forgotten: "The greatest strength of the totalitarian state is that it will force those who fear it to imitate it." Those who have paid the ultimate sacrifice defending the Constitution and its fundamental guarantees must be honored by climbing to a higher plateau, *viz.* respecting the Constitutional rights of all citizens.

Due Process, Enemy-combatant, National Security

E6 Panel Discussion on "Prosecuting the Terrorist: Justice on Trial"

Carl N. Edwards, JD, PhD, Four Oaks Institute, Box 1776, Dover, MA; Michael G. Gelles, PsyD*, U.S. Naval Criminal Investigative Service, 4400 East-West Highway, Bethesda, MD; Russell E. Palarea, MA*, U.S. Naval Criminal Investigative Service, 16026 Burtons Lane, Laurel, MD; Christopher H. Baugh, JD*, 7324 Southwest Freeway, Arena Place Two, Suite 1888, Houston, TX; David P. Baugh, JD*, P.O. Box 12137, Richmond, VA; and Donald G. Rehkopf, Jr., JD*, Law Offices of Brenna and Brenna, 31 East Main Street, Suite 2000, Rochester, NY*

No abstract provided.

E7 Volunteer Opportunities for Forensic Scientists: What You Can Do to Fight Terrorism

Carl N. Edwards, JD, PhD, Four Oaks Institute, Box 1776, Dover, MA*

The goal of this presentation is to provide members of AAFS with information on volunteer opportunities in which professional skills can be applied to terrorism detection, prevention, and recovery.

Forensic scientists are well trained and experienced in job specialties that have particular relevance to the war on terrorism. Increasingly, members of the forensic professions are being asked to work on terrorism cases as a part of their occupational roles and are having an important impact on detection, investigation, evidence preservation, and prosecution. Nevertheless, many seek other opportunities to serve and find considerable satisfaction as well as a breadth of relevant experience by working as member of the many volunteer and public service organizations that have become overburdened by the demands placed on them a post 9/11 world.

Disaster and emergency services have undergone dramatic changes over the past several decades. The Civil Defense system, organized to meet community needs during the War years and the Cold War, has been largely supplanted by the Federal Emergency Management Agency (FEMA) and its state counterparts. While these were once secret agencies, operating out of closed bunkers, they have now transformed themselves into training and coordination centers dedicated to helping people plan for and address local emergency needs. These agencies serve as clearinghouses for information, assist in the location of essential emergency equipment and supplies, and help to assemble response teams and get them to where they are most needed.

Emergency response teams now operate under a uniform administrative structure known as the Incident Command System (ICS). ICS consists of a Commander and a command staff of Information, Safety, and Liaison officers; supported by Operations, Planning, Logistics, and Administration & Finance Sections with responsibilities similar to those of their military counterparts. The World Trade Center rescue and recovery efforts were organized under ICS, with operational units drawn from around the country. Each operational unit in turn has its own ICS structure, and its areas of responsibility closely parallel the sections of the American Academy of Forensic Sciences.

While people are all familiar with search and rescue teams, they have now been joined by federally designated Urban Search and Rescue Teams (USRT) that specialize in rescue and recovery from collapsed buildings such as Oklahoma City and WTC. These Teams rely upon skilled construction experts, and can use the services of engineering scientists. Both urban and rural search and rescue has evolved into reliance upon behavioral science data which is continually updated to show the most likely paths of movement and behaviors of people lost under specific circumstances, and forensic specialist with behavioral and statistical analytic skills can make significant contributions to their operations.

Terrorist attacks create important needs for medical practitioners and for the identification of human remains. FEMA and its local counterparts coordinate such teams, including DMORT teams typically operated by morticians; but there are obvious roles for forensic odontologists, pathologists, and physical anthropologists to support their efforts – particularly when their sites of operation are also classified as crime scenes.

Toxicologist, criminalists, and even question document experts and virtually all other forensic specialist bring both specific and general skills to disaster situations, recovery efforts, and crime scene investigations; and when not deployed by their official agency, can be of great help as volunteers.

Mental health has become an increasingly recognized specialty in disaster services, and there are several agencies that deploy licensed mental health practitioners. For psychologists, the American Psychological Association, in partnership with the American Red Cross, created the Disaster Response Network (DRN) in the early 1990s to make disaster mental health services available when needed. The DRN has chapters in most states, and welcomes volunteers. Psychiatric societies and social work associations have followed suit, and are forming similar volunteer support networks. Each of these disaster mental health networks can also work in conjunction with the Red Cross, which under federal legislation is the designated lead agency in aviation and certain other mass fatality disasters. Following 9/11, which was clearly aviation-related, Red Cross and its disaster mental health (DMH) units worked around the clock, and will continue to support the 9/11 survivors for years to come.

Finally, attorneys have a number of rolls. Everyone, on every side, needs lawyers; and FEMA deploys them on a regular basis. In Boston, and certainly other areas, the Bar Association deployed volunteers to Mosques where they helped to quiet fears and provided information on rights and on working with law enforcement to deal with threats against Islamic citizens and groups. Lawyers provided support to survivors of 9/11 on everything from obtaining death certificates to qualifications for survivor benefits. They worked with prosecutors and they defended the accused – helping to preserve the legal and political system that terrorists were determined to destroy, and assuring the highest possible level of fairness and justice.

Whatever citizens elect to do to support anti-terrorist and disaster efforts, it is critical that they become involved as soon as possible while this nation is not in a crisis. There is a saying in disaster services that the last place to meet is at the scene of a disaster. Operations progress smoothly when people know each other, have formed relationship, are well trained and prepared, and know what to expect.

Volunteer Opportunities, Terrorism, Forensic Skill Applications

E8 Medico-Legal Autopsy Trends at B.P. Koirala Institute of Health Science Dharan, Nepal

Bishwanath Yadav, MD, and Praveer Bodkha, MD, B.P. Koirala Institute of Health Science, Department of Forensic Medicine, Dharan, Nepall*

The goal of this presentation is to present to the government and law enforcing agencies the cause of unnatural and untimely death so that the government can plan effective measure to prevent unexpected death in the country and society.

Nepal is a land-locked country nestled in the midst of the world's highest mountains, strategically situated between the vast plains of the Indian subcontinent to the south, east and west and the high Tibetan Plateau of China to the north. The total land area is 147,181 square kilometers. The population is estimated at about 22 million; about 90% are Hindus, and more than 90% live in rural areas.

Topographically, the country can be divided into three well-defined physic- geographical belts running from east to west. The terrain (plane land) contains 23% of the land area and 45% of the population; it is 200-1000 feet above sea level. The hills contain 42% of the land area and 47% of the population; this area is 1000-16,000 feet above sea level. The Mountain covering 35% of the land area and the remaining 8% of the population lies above 16,000 feet.

Administratively, the country is divided into five development regions and 75 districts. The economy of Nepal depends heavily of agriculture, which provides employment of more than 91% of the economically active population and account for about 60% of export earnings. Tourism plays an active part in foreign exchange earnings. Approximately 25% of tourist came from India, 38% from Western Europe and 37% from the rest of the world. Many Nepalese also have relatives in adjacent sites of India and both sides move freely across the border.

So far no concrete data regarding unnatural deaths in eastern region of Nepal is available, therefore to find out trends of medico-legal autopsy at B P Koirala Institute of Health Science (BPKIHS), a retrospective study of 750 cases of unnatural death brought to BPKIHS mortuary for autopsy during seven-year duration (1993 – 2000) has been done in the present study. Age, Sex, Race, and Religion have been considered cause of death wise and incident wise. Data has been critically analyzed to find out death in different circumstances. Appropriate data would be of in immense help to the policy makers and law enforcing agencies to minimize and prevent such untimely and unexpected death in the country and society. It would also be a boon to the public in creating awareness to impending dangers.

Autopsy, Postmortem, Death

E9 Right Analysis, Wrong Picture

David J. Schorr, BS, MS, and Steven M. Schorr, BS, MS, DJS Associates, Inc., 1603 Old York Road, Abington, PA*

The goal of this presentation is to show the forensic community that indiscriminate use of modern technology, in this case computer animation, although accurate, may show the wrong picture. This paper will demonstrate how an accurate animation of the events leading up to a vehicular crash can create a miss-impression in the minds of a jury and why it is often better to supplement simple graphics and then to go with the more advanced technology.

Technology available today allows engineers to check their manual analysis of a collision using the computer, and to quickly animate their analysis in three dimensions consistent with the physical evidence and the laws of physics. Such three dimensional representation of a collision analysis can be extremely useful as a demonstrative exhibit, which, for example will aid a jury in understanding the facts of the case. However, sometimes the picture portrayed is not always what is wanted to be shown. View bias, depth perception and inconsistencies can result in misleading and confusing results. One must evaluate the strength of the animation; whether or not it illustrates the points of the engineer and attorney are trying to get across and whether or not the jury will see what the analysis revealed.

A person is driving a big rig down a two-lane, two-way road. As he enters a right curve, he becomes aware of a mail truck entering the roadway in front of him. He responds, not by applying his brakes, but by turning to the left and crossing the road. The result is a horrendous two-truck crash and a fatality. Analysis reveals that the relative movement of the mail truck to the big rig would have provided sufficient time and distance for the driver to stop without contact with the mail truck. What caused the response and who's at fault? But, most of all, how is it explained it to a jury?

Motor vehicle crashes are often precipitated by a so-called non-involved vehicle, object, or pedestrian. It is not unusual for a driver to respond to a situation that is not readily apparent to the investigator and does not appear on the police report. An awareness of the driver's response and an understanding of why is often critical to the analysis of the crash and to the understanding of the events leading up to the crash. It is essential that in preparing any exhibit to help a layperson comprehend what occurred, that these factors be built into the program.

The case used as an example in this paper lent itself, with great excitement and great cost on the part of the attorney, to the development of a computer animation of the crash sequence. It showed with effectiveness the effect of the conditions known as Fovea, and when coupled with what is accepted as good driver's training, precipitated the actions that resulted in the fatal crash, that need not have occurred.

The analysis shows how the physical evidence provided the data to reconstruct the crash sequence. But, the understanding of why it occurred was not apparent until the pre-impact conditions were established and evaluated. It is the demonstration of the pre-impact conditions and the driver's response that challenged modern technology to make it clear to the jury of demonstrating the pre-impact conditions clear. The presentation will show that although the time-distance-speed relationships are accurate, as hard as one tries, the "real world" view of the sequence cannot always be captured.

Computer Animation, Demonstrating Pre-crash Conditions, Demonstrative Exhibits

E10 Is This a Case of Prosecutorial Misconduct?

Peter Alexander, PhD, and John Smith, MSEE, Raymond P. Smith & Associates, 43766 Buckskin Road, Parker, CO*

Upon completion of this presentation, attendees will understand the application of forensic techniques to a recent criminal justice case.

An accident reconstructionist is occasionally presented with a situation in which the Police and the Office of the District Attorney appear to act in bad faith with regard to a defendant's ability to prepare a proper defense. Judge for yourself their behavior in this felony injury case.

Overview: This criminal case involved a teenage driver, traveling eastbound on a road with 2 lanes in each direction. The lanes were separated by a wide, raised median containing grass, trees and bushes. His vehicle veered sharply to the left, struck the median, rebounded, and struck the median a second time. The vehicle then mounted the curb, became airborne, rolled on its side, traversed the median, and struck an oncoming westbound vehicle. The collision caused the oncoming vehicle to roll on its side and seriously injured the other driver. Both vehicles came to rest near the point of impact. No drugs or alcohol were involved. The teenager was charged with felony reckless vehicular assault, reckless endangerment, and engaging in a speed contest. The data and evidence available to the defense is listed in Table 1.

Table 1 Data and Evidence

Accident report	Witness statements/Interviews
Photographs taken by Police	Teenager's statement
Photographs taken by witnesses	Driver's statement - vehicle the teenager was supposedly racing
Photographs taken by rescue personnel	Police laser measurements of the scene
Police file, Investigating Officer's field notes and calculations	Tire marks and disturbance of the median - still visible after 6 mo.
Both vehicles	

The Police Case: The State Patrol reconstruction of the accident placed the speed of the teenager's vehicle at 83 m.p.h., in a 40 m.p.h. zone, prior to the driver's losing control. Four of the nine witnesses said the teenager was racing with another vehicle while traveling at 80 to 90 m.p.h., lost control, and caused the collision. The investigating State Patrolman based his speed calculation on what he believed were slightly over 50 feet of yaw and scuff marks left by the teenager's vehicle. The Patrolman measured the middle ordinate (curvature) of the yaw marks. Originally, the patrolman stated that he never wrote down the middle ordinate but merely remembered it until he got to his computer. Eleven months later, in court, he remembered that he had written it on his hand. The District Attorney (DA) was adamant that a felony conviction was essential and refused to accept a misdemeanor plea.

The Teenager's Case: The teenager remembered very little about the accident but said he was not racing and was not traveling at 83 m.p.h. The teenager said he was passing a friend's car when the accident occurred. He indicated that he lost control after he swerved to avoid something in the road.

Our Reconstruction: Based on the available data the authors were able to define of maximum speed of the teenager's vehicle, prior to swerving, as 55 m.p.h. It was concluded that the impact speed of the teenager's vehicle was 36 m.p.h., consistent with the above pre-swerve speed. No evidence of a speeding contest at the time of the collision was found. There was no data recorded by the Police to support their contention that they had measured yaw marks rather than ordinary scuff-marks. Review of the witness statements suggested the possibility that some witnesses had been coached. Items that were important to reconstruction, such as photographs and access to both vehicles listed in Table 1, were withheld by the DA's office, until just before trial.

Problems and Issues: The sole basis of the State Patrol's speed value for the teenager's vehicle was their assumption that tire marks left in the road by the teenager's vehicle were yaw marks. The investigating Patrolman used the Critical Speed Formula to calculate the vehicle speed. Unfortunately, the Patrolman did not photograph or record the marks. He could not provide a justification as to why he thought they were not simple skid/scuff marks. The curvature of the marks was so shallow (6 inches over 50 feet) that they almost formed a straight line. The Patrolman seemed to ignore publications that demonstrated that the yaw method could estimate vehicle speeds with errors exceeding 80%.

Although the State Patrol performed a detailed laser measurement of the scene, containing over 50 survey points, they neglected to record the location of the point of impact. If the Patrolman had measured the points of impact and rest for the two vehicles, the pre-impact speed of both vehicles could have been accurately calculated. Fortunately, the Patrolman had previously manually measured one coordinate of the point of impact and recorded it.

Impact speed could have been independently determined by examining the damage to both vehicles. The DA had an obligation to preserve important evidence. Although both vehicles were put on a DA's "hold," the DA's Office released the second vehicle, for transport out of the country, before the defense team could examine it. In court, the DA denied that the second vehicle had ever been on "hold" despite documentation that showed there was a hold.

The State Patrol took numerous photographs of the collision scene but the DA's office "lost" them until shortly before the trial. The DA's Office told a witness, who had independently taken high quality photographs of the collision scene, that he could destroy those pictures before the defense had a chance to examine them. At the defense attorney's request, the witness was able to recover the pictures, which revealed information helpful to the defense.

The State Patrol refused to accept a subpoena to provide the defense with information the investigating Officer had collected at the collision scene, prompting the magistrate to offer to issue an arrest warrant for the Patrolman.

Four witnesses stated they saw the teenager engaged in a speed contest at 80 to 90 m.p.h. When four witnesses specify exactly the same speed range it suggested possible witness tampering. There was no possibility that the teenager's vehicle was traveling that fast on the winding road. Analysis of the witnesses' testimony revealed that their recollections of events were not possible.

The friend, whose vehicle the teenager was passing, gave a statement to the police admitting that he was speeding. During the trial it was discovered that the friend had originally asserted that he was not racing. It was revealed that the police had held the friend in the back of a hot patrol car until he agreed to admit to racing. It was discovered that shortly after the accident the friend had confessed to a witness, that he had swerved in front of the teenager's vehicle, forcing the teenager to swerve. This was probably the precipitating event that that led to the collision.

Outcome: The case was heard before a judge for four days spanning a period of four months, since each day of trial was separated by a continuance of weeks. The events described above make it appear that the case was skewed in favor of the prosecution. Despite strong forensic data pointing to his innocence of the charges filed, the teenager was found guilty of felony Vehicular Assault. He was sentenced to community service. He was not incarcerated, as he had just turned 18.

Accident Reconstruction, Forensics, Criminal Justice System

E11 Impact of September 11th Events on the Public Transportation System in New York

Danielle D. Ruttman, JD, MAFS, New York City Transit Authority, 130 Livingston Street, Brooklyn, NY*

This presentation will provide insight into the impact of the events of 9/11/01 on a public transportation authority.

The attack on the World Trade Center on September 11, 2001, profoundly affected New York, the U.S. and the world. Its effect on the New York City Transit Authority (NYCTA) and its legal operations are the focus of this paper.

The NYCTA is the largest public transportation system in the country. It is open twenty-four hours a day 365 days a year. Over 6 million people a day rely on this system for transportation. Annual ridership exceeds 2 billion passengers. The system has 468 subway stations, over 6,000 subway cars and over 4,000 buses. It employs more than 48,000 people.

On 9/11/01, virtually all public transportation in the five boroughs of New York stopped – stranding millions of people. Passengers were evacuated from train cars in collapsed tunnels and removed to safety. Within hours, substantial amount of NYCTA equipment and personnel were deployed to identify and contain the damage, assist in the rescue efforts and resume limited service.

As all were focused on the hope of rescue, normal legal activity stopped. Courts closed. Many Manhattan courts had to be relocated. Section 29-a of Article 2B of the Executive Law vested with the Governor the authority to temporarily suspend specific provisions of any statute, local law, ordinance, orders, rules or regulations, or parts thereof, of any agency during a State disaster emergency, if compliance with such provisions would prevent, hinder or delay action necessary to cope with the disaster. Effective 9/11/01, New York Governor George E. Pataki signed Executive Order 113 which temporarily suspended virtually every law, whether civil, criminal or administrative, of the State of New York that contained a limitation of time. The Executive Order was effective for 30 days. This protected those affected by the events whether they were damaged from the attacks or involved in the rescue efforts. As of this writing, parts of it have been extended seven times by seven additional Executive Orders.

The Torts Division of the Transit Authority has an inventory of approximately 10,000 personal injury matters. From the initial notices of claim through civil trials to appeals, virtually every matter was affected by the disaster. Litigants, employees and witnesses were unavailable to proceed because they perished, were displaced or involved in the recovery effort. Calculating statutes of limitation became a fluid process. The effect continues to be felt. It is interesting to note that there was only one minor personal injury action filed against NYCTA for injuries relating to the World Trade Center attack on 9/11/01.

While litigation matters were stayed, other matters had to be expedited. Creating, posting, bidding, awarding and performance of huge contracts to rebuild damaged and destroyed subway stations were done in record time.

Every day New Yorkers rely on the NYCTA. Its response to the events of September 11th serves as a reminder that that reliance is not misplaced.

Executive Orders, Statutes of Limitations, Public Transportation

E12 A Fundamentally New Way to View Pattern Images — Bite Marks

Ira R. Titunik, BS, DDS, John Jay College of Criminal Justice, 115 East 56th Street, New York, NY*

The goal of this presentation is to acquaint the viewer with another forensic tool for the interpretation of pattern injuries, specifically bite marks.

The Forensic Odontologist (DABFO) has available a number of tools to use in the protocol of pattern injury-bite mark analysis and the comparison process. The legal community needs to know that these tools and protocols exist and how they are used. The use of one tool in particular, Lucis Imaging Technology, has been used by the presenter for several years on a number of bite mark cases in several states.

Images often contain several hundred to thousands of contrast levels. The human eye can only differentiate thirty-two. Gross features in a photographic image are visually defined by gross contrast variations. The finer contrast variations are only partially recognized but much of the time eyes cannot resolve.

This technology compares on the monitor each pixel to every other pixel along hundreds of radial lines in two directions to map out contrast variances. These variances within a selected range are then enhanced and variances outside the range are diminished. The relative emphasis of the contrast information is shifted but never removed or lost.

The presentation will show several bite mark cases using Lucis Imaging and other tools and how they may aid the forensic scientist and the legal community.

Bite Marks, Lucis Imaging Technology, Odontology Tools

E13 Protocols and Tools for the Evaluation of Multiple Bite Mark Cases

Ira R. Titunik, BS, DDS, John Jay College of Criminal Justice, 115 East 56th Street, New York, NY*

Upon completion of this presentation, the viewer will appreciate the complexities of a multiple bite mark case and understand the protocols and tools used by the forensic odontologist (DABFO) in the evaluation, analysis, and comparison process.

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Forensic Odontologist, Protocols, Tools

E14 Overview of the Legal Issues Concerning the Discovery and Investigation and Prosecution of the Abuse of Elderly Patients in Healthcare Facilities and the Homicide of All Patients in Various Medical Treatment Facilities

Michael T. Kelly, JD, Medical Fraud Control, 107 Delaware Avenue, Buffalo, NY; Haskell M. Pitluck, JD*, 573 Lake Avenue, Crystal Lake, IL; Michael M. Baden, MD, Medico-Legal Investigation Unit, New York State Police, Albany, NY; Bruce Sackman*, U.S. Department of Veterans Affairs, Office of Inspector General, New York, NY; and Brian Donnelly, PhD*, FBI Laboratory, 9th and Penn Ave, Washington, DC*

The goals of this presentation are to recognize the many complex legal, social and forensic issues involved in incidents concerning the abuse and death of healthcare patients; to examine the necessary components for a comprehensive investigation, reconstruction and exhumation; to be aware of the legal issues and successful resolution of those issues commonly associated with the prosecution of healthcare professionals; and to share their experiences and concerns with the expert panel and to explore the options that may enhance the disco and investigation of the death of healthcare professionals and public confidence in the system to ensure that justice is accomplished.

This presentation will focus on the need to restore public confidence and trust in the placement of loved ones in the healthcare system. As society grows older, many families place their elders into the trusting care of healthcare professionals. When a loved one is sick in the U.S., they are placed with medical professionals in a hospital surrounding. Veterans who have served in wars are placed in special Veterans' Administration hospitals in order to pay them for their war

service. When this medical service goes awry, much is lost. Proper investigation, identification, and prosecution is best accomplished by ensuring a comprehensive objective and legally scientifically sound investigation in attempting to determine the true cause of death of a patient.

The proper recognition, documentation, review of documentation and usually exhumation and proper preservation of tissue for forensic purposes associated with healthcare crimes will be discussed. The value of this process is the ultimate successful and just conclusion of incidents, which cannot be over emphasized. Many families need to fee secure that when those in need of special care are entrusted to the healthcare workers, that their improper care is not further complicated by inadequate crime scene analysis. If it is, all investigations and deaths in such settings can be tainted with uncertainty and confidence is eroded and jeopardized.

The Veterans Administration has taken the lead in the U.S. in identifying clusters of deaths, which may indicate errant healthcare workers. Many such workers have been doctors. The essential components of such identification will be discussed in reference to several high profile charged incidents that usually have involved serial killers. Serial killers on the street are dangerous; serial killers in a healthcare setting are not only dangerous, but undermine the trust in the medical care establishment that all need. Critique of these cases and the effect of public perceptions and confidences will be discussed such as to explore and develop strategies and philosophies to reduce future problems and shortcomings.

Serial Killer, Healthcare Professional, Prosecution

E15 Why the Veterans Administration is so Far Ahead in the Detection and Investigation of Healthcare Professionals Who Abuse and/or Kill Patients—Specific Discussion Will Ensue Regarding Dr. Michael Swango

Bruce Sackman, U.S. Department of Veterans Affairs, Office of Inspector General, New York, NY*

The Veteran's Administration is one of the few entities that has been in the forefront of investigating deaths that occur in its hospitals. This presentation will show how administratively, suspicious deaths in a hospital setting should be managed, and the value of consulting with forensic science experts as a team. How a determination as to whether there is cause to believe that criminal acts have been committed and to prevent further criminal acts when the possibility of multiple deaths cause by health care provider will be reviewed. The social factors, which give rise to why this agency tries to reveal and prosecute deaths by caregivers, will be discussed.

Veterans Administration, Healthcare Professionals, Michael Swango

E16 Presentation of Specific Cases Through the Initial Contact by Prosecutors Concerning Suspected Criminal Deaths Through the Exhumation and the Trial

Michael M. Baden, MD, Medico-Legal Investigation Unit, New York State Police, Albany, NY

This presentation will discuss the forensic pathology aspects of evaluating potential suspicious deaths to determine whether further investigation is warranted, when to suggest exhumation, and will present through various specific cases what exhumations can reveal. The focus of the illustrations will be concentrated on cases involving multiple deaths in hospitals caused by health care professionals.

Suspicious Deaths, Exhumations, Healthcare Professionals

E17 The Role of Poisons in the Death of Patients and the Issues Surrounding Correct Identifications and Analysis

Brian Donnelly, PhD, FBI Laboratory, 9th and Penn Ave, Washington, DC*

This presentation will discuss the forensic toxicological aspects of investigating possible poison deaths, what tissues should be removed at autopsy, and how modern toxicological advances permit identifying lethal drugs in hair, formalin fixed tissue, and paraffin blocks many years after death of a patient. Specific examples of poisoning of patients with succinylcholine, epinephrine will be demonstrated.

Poisoning Patients, Forensic Toxicology, Lethal Drug Identification

E18 Understanding Handwriting Evidence

Joel S. Harris, BSc, Royal Canadian Mounted Police, Forensic Laboratory Services - Ottawa, Document Section, 1200 Vanier Pkwy, Ottawa, Ontario, Canada*

Upon completion of this presentation, the audience will learn the advantages and disadvantages of different types of handwriting evidence presented in legal proceedings. Methods for the collection and submission of such evidence will be discussed relative to maintaining the expert's objectivity. A suggested approach to the scientific examination of handwriting evidence and report preparation will show the audience how to limit opposing expert testimony, expedite pleas, reduce court time, and how to effectively present results that are court friendly.

Despite a world that is becoming increasing reliant on electronic means of correspondence, handwriting remains the quickest and least expensive method of communication. Although electronic forms of commerce have gradually increased and resulted in a reduction in some routine forms of handwriting evidence, there is still considerable documentation that uses handwriting and the signature as a viable security device. Handwriting examination is one of the few forensic disciplines that can directly associate a person with a crime. Therefore the requests for handwriting examinations remain in demand. Handwriting evidence also offers inherent benefits in court over other types of forensic evidence because most persons have used some form of handwritten communication at one time or another. The illustrative nature of handwriting evidence lends itself to courtroom presentation; however, the value of this characteristic has not been fully utilized to the benefit of the court or the profession. The frequent occurrence of opposing handwriting experts in the courtroom, suggests a lack of universal scientific validity in the profession. This presentation will discuss the value and limitations of different types of handwriting evidence in legal proceedings. The importance of objectivity when collecting and submitting handwriting evidence for expert examination will be reviewed. The preparation of reports and the scientific basis upon which these reports are based will be explained. The establishment of standard handwriting examination procedures based on a scientific method approach may ultimately expedite pleas, reduce court time, limit opposing expert testimony, and present findings which are both meaningful and lay friendly.

Handwriting Evidence, Objectivity, Testimony

E19 Where Medicine and Jurisprudence Meet — Two Case Reports: The London Nail Bomber - Mad, Bad, or Sad; and Tea With General Pinochet

Peter Dean, BDS, MBBS, DRCOG, Coroner's Office, Rochford Police Station, South St. Rochford, Essex, England, United Kingdom*

The goal of this presentation is to explore those areas where clinical forensic medicine and jurisprudence meet.

In Great Britain, the role of the "Forensic Medical Examiner" or "Police Surgeon" has long been established as the medical clinician actively involved in all aspects of Forensic Medical Practice ranging from care of detainees in custody and assessment of their fitness to be detained and interviewed to the examination of living victims of physical and sexual assault, collection of forensic evidence, and attendance at crime scenes.

Clinical forensic opinions are frequently sought before court, and clinical evidence on a broad range of subjects is frequently given and argued about in the course of civil and criminal hearings. This presentation will explore those areas where Clinical Forensic Medicine and Jurisprudence meet, illustrated by reports of two very different detainees that the author has previously looked after in custody.

The first examines the case of David Copeland, known as the London Nail Bomber after his homophobic and racially motivated bombing campaign in 1999 left three people dead and over one hundred injured, and focuses on how clinical assessment of his mental state subsequently became the key feature of his trail at the Old Bailey.

The second looks at aspects of the case of General Pinochet during some of his time in custody, and how opinions based on clinical assessment of medical conditions can subsequently become crucial in determining fitness to stand trial.

Clinical Forensic Medicine, Jurisprudence, London Nail Bomb

E20 How Good is That Laboratory? Accreditation Standards: Comparing ASCLD/LAB, ISO Standards, and CLIA

Gregory W. O'Reilly, JD, MA, Attorney, Suite 1600, 69 West Washington Street, Chicago, IL*

Upon completion of this presentation, attendees will learn about the various regulatory and procedural mechanisms forensic and clinical laboratories use to gain accreditation, document their procedures, and provide Quality Assurance/Quality Control. Accreditation has become commonplace in laboratories over the last decade, especially with the advent of forensic DNA analysis. Nonetheless, there are competing standards, and indeed ASCLAD/LAB is weighing adoption of ISO Standards in the near future. Attendees will learn about these standards, the current debate about adopting ISO standards, how standards differ, and the implications of various standards for the users of laboratory services, including the courts. The definition of accreditation standards could be a pivotal issue, as forensic testing and the use of DNA databases potentially expand beyond national borders in the investigation of criminal matters, mass disasters, and terrorist incidents.

The trend towards using some method of accreditation to assess the level of a performance in clinical and forensic laboratories has continued over the last two decades. In the U.S., ASCLAD/LAB has been used widely to accredit forensic laboratories. Federal regulations bind clinical laboratories in the U.S. through the Clinical Laboratory Improvement Amendments of 1988 (CLIA). However, the accreditation process put forth by the International Organization for Standardization (ISO) has gained momentum beyond the borders of the U.S. and outside the pool of forensic laboratories. In part, this comes as a result of the need to standardize laboratory accreditation and the acceptance of test data throughout the world. The definition of accreditation standards could be a pivotal issue, as forensic testing and the use of DNA databases potentially expand beyond national borders in the investigation of criminal matters, mass disasters, and terrorist incidents.

While more than 232 laboratories are accredited by ASCLAD/LAB, the accreditation process and the standards employed are in a state of evolution. As recently noted in an ASCLAD/LAB communication, the: "ASCLD/LAB accreditation program must move forward, or in the future be viewed by the uninformed world as an inferior program which is recognized only by forensic scientists. *The outside world will point to the fact that U.S. citizens are only monitored by their own standards*." (Emphasis added) Whether critiques come from "the uninformed world," from courts, consumers or other end-users concerned about quality and transparency in laboratory work, the issue will still stand – forensic laboratories set their own standards by which they are judged.

This self-regulatory scheme is in contrast to the highly specific external regulatory structure the federal government has put in place for clinical laboratories, certified to perform testing on human specimens under the Clinical Laboratory Improvement Amendments of 1988 (CLIA). (57 FR 7139, § 493.1, Feb. 28, 1992.) In the past, the most controversial aspect of this distinction has been the CLIA requirement for blind proficiency testing, a requirement successfully avoided by forensic laboratories to this date.

However, over the last few years another potential yardstick has come to the fore, the standards promulgated by the International Organization for Standardization (ISO), specifically standard 17025, the "General Requirements for the Competence of Calibration and Testing Laboratories." ISO 17025 is specific to laboratory functions, and covers the technical competence of personnel, the ethics of staff, the use of well-defined test and calibration procedures, and participation in proficiency testing, including inter-laboratory comparisons. Independence of laboratory personnel, a topic of recent controversy, might be addressed through ISO 17025, as the standard requires arrangements to ensure that personnel are free from any commercial, financial, and *other pressures which might adversely affect the quality of their work*. ISO 17025 standard also demonstrates the laboratory's abilities to carry out specific tests. The accreditation certificate indicates the tests and equipment used, and significantly, *the degree of accuracies obtained.* The potential to estimate measurement uncertainties would be useful in assessing forensic work. This could be of crucial importance in, for example, in assessing the ability of a laboratory to resolve complex DNA mixtures, an area of expertise shown by recent studies to contain significant variation in proficiency. An additional reason for the growth of ISO standards has been the need to standardize laboratory accreditation and the acceptance of test data throughout the world. The definition of accreditation standards could be a pivotal issue, as forensic testing and the use of DNA databases potentially expand beyond national borders in the investigation of criminal matters, mass disasters, and terrorist incidents.

These issues have not gone unnoticed. Indeed, as far back as 1996, the Board of Directors of ASCLD/LAB voted to commit ASCLD/LAB to moving toward becoming an ISO accrediting organization. In December 2001, the members of the ASCLAD/LAB Delegate Assembly voted on a first phase toward revising the ASCLAD/LAB accreditation manual to move toward ISO standards. Ballots were mailed to the 236 Delegates. Although a year had passed since the Bush-Gore election debacle, 181 ballots were returned to ASCLD/LAB, but only 173 ballots were received or postmarked by the published deadline of February 4. (No indication is apparent if these were from Florida.) Of the 173 counted ballots, 112 Delegates (64.7%) favored ISO changes. Had the late ballots had been counted, the result would have been 66.3 % in favor of the ISO proposal, just two votes short of the two-thirds vote required to pass the proposed revisions.

In the wake of the close vote, ASCLAD/LAB's Board surveyed by phone the Delegate Assembly membership, which, the Board contends, expressed an interest in more information about ISO 17025 and the desire to review a draft of the final amplification document prior to any further review. According to the ASCLD/LAB NEWSLETTER, the Board intends to:

> "(1) identify and propose, to the Delegate Assembly, the incorporation into the ASCLD/LAB accreditation program certain elements consistent with other internationally recognized standards; (2) institute a process of providing on-going education to all Delegate Assembly members regarding the incorporation of ISO standards into the ASCLD/LAB accreditation program; (3) complete efforts to bring the ASCLD/LAB office and all of its operations into compliance with ISO 58 by January 2003; (4) make the official ISO 17025 standards document available to every Delegate Assembly member by January 2003; and (5) complete a final draft of an ISO 17025 forensic science amplification document by July 2003 for Delegate Assembly review."

While the ASCLA/LAB debate over ISO standards continues, the focus should not shift from fundamental legal principles when accreditation is involved in the judicial process. Regardless of the particular standards adopted, the frequent end-user of accreditation is the court system. If the accreditation process is used to gain the confidence of courts, it must be transparent, and conform to the requirements of the legal discovery process. This is critical in criminal practice, especially in cases involving scientific or other expert testimony and evidence, such as DNA. Full discovery of the accreditation process and laboratory evaluations is essential to evaluate evidence and to properly prepare for both the introduction of such evidence and for cross examination of an expert witness. Indeed, courts must have access to such material to fulfill their role of assuring that evidence introduced at trial is reliable. Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 589, 125 L. Ed. 2d 469, 113 S. Ct. 2786.

Accreditation, ASCLD/LAB, ISO Standards

E21 Trial Preparation: Evaluation of Digital and Paper Discovery in STR/DNA Cases

Brian Walsh, JD, and Ingrid Gill, BS, JD*, Cook County Public Defender's Office, 69 West Washington Street, 17th Floor, Chicago, IL*

Upon completion of this presentation, attendees will learn about the types of information available for review from forensic testing; the methods forensic laboratories use to record digital data in STR/DNA cases; the preservation and production of such evidence in the discovery process; how such evidence is used in case evaluation and litigation in review with the forensic expert who has performed the testing, independent review by consulting experts who may or may not be called to testify in court; and review and preparation needed by the litigation team.

Once the paper and digital data is obtained by counsel through discovery, the review and trial preparation begins. The data can be analyzed by an independent expert, or by members of the litigation team. The preparation of demonstrative exhibits and the need to consider use of all forms of data received in discovery will be discussed and demonstrated with case examples

STR/DNA, Digital Information, Discovery

E22 Expert Testimony in Medical Malpractice Cases - New Hazards

Linda B. Kenney, JD, The Galleria, Atrium Building 5, 2 Bridge Avenue, Red Bank, NJ; Andre A. Moenssens, JD, LLM, University of Missouri at Kansas City, Kansas City, KS; Haskell M. Pitluck, JD, 573 Lake Avenue, Crystal Lake, IL; Cyril H. Wecht, MD, JD, 542 Fourth Avenue, Pittsburgh, PA; and Joseph J. Maltese, JD, MJS, New York Supreme Court, 355 Front Street, Staten Island, NY*

Upon completion of this presentation, attendees will be informed about recent medical malpractice lawsuits in which medical experts were subjected to significant professional disciplinary actions subsequent to trial. Specific suggestions will be given as to how to avoid such serious consequences.

In July 2002, the North Carolina Medical Board revoked the license of Gary Lustgarten, MD, a Florida neurosurgeon who had testified for a plaintiff in a medical malpractice case in North Carolina. The Board ruled that Dr. L had engaged in "unprofessional conduct" by misstating facts about the case and the appropriate standard of care for a neurosurgeon in North Carolina.

The American Association of Neurological Surgeons (AANS) had previously suspended Dr. L's membership in that organization on two occasions following testimony he had given as an expert witness in other malpractice lawsuits.

In 2001, the AANS had suspended another neurosurgeon's membership following his testimony in a malpractice case in Illinois. The Seventh U.S. Circuit Court of Appeals upheld the AANS' right to discipline a member in a very strong and highly critical opinion written by Judge Richard Posner.

These actions might be considered simply as "blips" on the legal scene and casually ignored. However, in light of the growing fear, frustration, and intense resentment expressed by physicians and organized medical groups throughout the country vis-à-vis malpractice lawsuits, coupled with increasing efforts' at the state and federal levels to adopt new legislative measures for so-called "tort reform," it is highly likely that various medical societies, specialty organizations, and state medical boards may decide to become increasingly aggressive and undertake actions for a variety of reasons against physicians who testify as expert witnesses for plaintiffs in medical malpractice lawsuits.

Whatever the ultimate answer may prove to be regarding medical malpractice lawsuits and spiraling malpractice insurance costs, one thing is certain, namely, resolution of this problem cannot be justified by attempting to prevent physicians from testifying as experts for plaintiffs. This would be an egregious assault on the most basic and important features of the civil justice system in America.

These cases will be thoroughly analyzed and legally dissected in order to determine whether they are logical, fair, and just; or whether they are unacceptable intrusions into the justice system by overly anxious, embittered groups of physicians who would be willing to do anything they can to indirectly pressure their colleagues into refusing to serve as expert witnesses in malpractice cases.

Medical Malpractice, Medical Expert Testimony, Professional Disciplinary Actions

E23 Disclosing Information: Ethics for the Forensic Scientist

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This presentation will address the ethical obligations of scientific witnesses to "refrain from providing misrepresentation of data upon which an expert opinion or conclusion is based." Through the use of case examples of forensic reporting and testimony, including cases where questionable forensic reporting and testimony contributed to wrongful convictions, the presenters will address problems forensic scientists face when they attempt to comply with their ethical obligations.

The cases of Brady v. Maryland and Kyles v. Whitley establish a duty upon a prosecutor to disclose to the defense any evidence, which tends to negate the guilt of the accused. This means that the prosecutor has a duty to learn about favorable evidence known to others acting on the government's behalf in the case, including the police. The question thus becomes, what kind of burden does this place upon forensic scientists.

According to the AAFS Bylaws, the ethical obligations for forensic scientists are, by their nature, generally applicable statements of proper conduct: "[AAFS members] shall refrain from providing misrepresentation of data upon which an expert opinion or conclusion is based." (Article 2, Section 1(c)) Each time a scientist authors a report or testifies, questions arise concerning how much information a scientist must volunteer in order to comply with this ethical obligation.

A series of case examples will illustrate that forensic scientists at times fail to report weaknesses, shortcomings, and/or alternative explanations of the data. In some of these cases, the failure of the forensic scientist to disclose faulty forensic data has contributed to wrongful convictions.

Some scientists and commentators see it as the lawyers' problem to deal with: the adversarial process presumes that well-informed attorneys with equal access to resources will sift through the forensic evidence and present a fair and accurate view of the scientific evidence. This view is exemplified by the comment, "If the attorney had asked me the right questions, I would have divulged the information." This proposition ignores the fundamental reality that most lawyers do not understand forensic science. They rely heavily upon the government forensic scientists to explain and interpret it for them. Budgetary constraints mean that defense counsel will not have access to an expert to help them interpret scientific evidence in every case, and must be selective in the use of their resources.

As forensic evidence, in particular DNA, becomes more prevalent in the courtroom, this reality will become a more common phenomenon. A lawyer who cannot effectively question a lab analyst has and will continue to lead to innocent men being convicted. Consequently, the forensic scientist often acts as gatekeeper to knowledge for both the prosecution and the defense. This makes them unique among witnesses, and forces them into a tough position in the adversarial system.

Moreover, as expert witnesses, the courts give them more leeway, allowing their testimony to include hearsay, opinions, and other ordinarily inadmissible forms of evidence. Thus, they are treated differently than an ordinary witness. This is why they have a Code of Conduct that lay witnesses do not have.

Questions addressed in this presentation are, How much candor are government forensic scientists ethically bound to show? Do they have to point out all of the weaknesses and shortcomings in the lab-work, and in the science itself? Are they to reveal all possible interpretations of the data?

Presumably the ethical duties of a forensic scientist spring from the ASCLD-Lab Code of Ethics, and the AAFS Code of Ethics and Conduct, and the Codes of ethics of the respective regional organizations. Reading these only gives one a general outline of what should be required. There is no set body of law on how this duty is interpreted. Looking to the case law of the Attorney Model Code of Ethics may give guidance to what the scope of this duty should be, notwithstanding the obvious differences of their respective roles.

An ethical duty of candor to all sides should arise from the moment that the lab work has been performed. Any ambiguities or quirks in any of the testing should be noted in detail in the initial report. Too often the report would not indicate that these types of problems are deeply buried in highly technical lab notes that require an expert to decipher.

This duty should continue into the trial itself. The witness should not view themselves as a witness for either side, because when they do that, the forensic evidence can get shaded, and the truth can be lost. Only through fully transparent conduct by these important witnesses can it be certain the truth comes out.

Expert Witness, Ethics, Disclosure

E24 Innocent People Convicted of Child Sexual Abuse and Imprisoned as a National Problem

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The goal of this presentation is to show there is a problem of innocent people being convicted of sexual abuse and society not acknowledging it.

The problem of innocent people convicted of child sexual abuse and languishing in prison is a national disgrace that has not been publicly acknowledged by the politicians, bureaucrats, so-called child advocates, and the general public. While DNA testing has focused attention on and provided exoneration for a significant number of innocent people on death-row, most cases involving child sexual abuse incarcerations do not contain any DNA evidence. Over 100 exonerations of death row inmates have occurred based on DNA testing amidst the multitude of cases in which DNA was not available or preserved. Considering a known error rate of 37% of primary suspects being excluded in cases where DNA is available for testing, (1) the corresponding percentage of innocent persons convicted of child sexual abuse could be even higher when one looks at how those convictions came about.

Most criminal convictions of child sexual abuse are based upon verbal testimony of the alleged victim without independent corroboration. Generally, there are no conclusive medical findings specific to sexual assault. Often, physical findings are deemed "normal, but consistent with abuse *based upon the history given*." (*emphasis added)* The "history given" is generally statements made by the alleged victim if older or, more often, by a third-party person who has suspicions of abuse being perpetrated on the alleged victim. Alleged victims initiated reports in only 0.9% of all cases of alleged abuse.(2) Persons taking a medical history are trained to assume that the information being relayed to them is true. They do not challenge the statements nor do they investigate any possible motivations or mistake by the person reporting the abuse.

A child's statements of alleged abuse can be subject to significant influences during the course of a prosecution. Those influences can distort the truth and result in the creation of incidents that never happened. The interviewing process is crucial in determining whether the child's statements are reliable or not. Yet, most government agencies do not follow the recommendations of leading researchers and experts. (3)

Many children are led into making statements that confirms what the interviewer already believes happened.(4) Many leading researchers have shown that children can be led to believe that something happened to them when it did not. (5)

Numerous criminal cases over the past few years has illustrated the problem of innocent people being imprisoned primarily through the testimony of children who sounded credible, yet whose stories were unreliable and tainted during the investigative process. While a few innocent people have had their convictions for sexual abuse overturned because the truth and the techniques used were exposed (6), thousands of others convicted under similar circumstances are still in prison.

To overturn a conviction is extremely difficult. Appellate Courts are to determine whether the convicted person got a "fair trial." Courts have stated that their job is not to determine guilt or innocence. "Actual innocence" is not grounds for further appeal. DNA test results are an exception because DNA technology was not available at the time those cases were heard. The system is not conducive to uncovering an unjust verdict made by a well-meaning jury. The more errors in verdicts that are exposed add to the undermining of faith that the public has in the judicial/legal system. That is not a desired public policy.

Critics frequently spout three arguments to the issue of innocent people being falsely convicted for child sexual abuse.

First, critics say, "If a few innocent people are convicted, this is the price that we, as a society, have to pay in order to get the guilty people off the streets. All stops must be pulled in order to protect children." Evidently, those who say this have not been falsely convicted or incarcerated. Nor has a family member or close friend. No system is perfect. The more vital question is at what number or percentage does the problem become intolerable? Is a 1% error rate tolerable? What about a 10% error rate? There are approximately 3 million people incarcerated in U.S. prisons. One percent equals 30,000 innocent people. Ten percent equals 300,000 innocent people. A more practical approach would be, "What can be done to help release innocent people and, at the same time, prevent more innocent people from being put in prison?" However, the problem has to be acknowledged as being significant before it can be corrected.

The second argument critics like to make is that the examples of people who were vindicated prove that the system "works." Yes, it worked for a few affected people. The problem lies with the untold number of innocent people who are still incarcerated, many never to see freedom again. If a ship wrecked at sea, should satisfaction be had with the knowledge that 500 out of 30,000 are rescued while the remaining are ignored? Should the rescuers be congratulated that the rescue system "works?" Do people refuse to acknowledge that a significant problem exists when the vast number of people perished? Do people turn a blind-eye to finding a better solution?

The third argument critics make is that in many of the child sexual abuse convictions, some type of expert testified for the Prosecution. The reality is that most expert testimony for the Prosecution is for the purposes of bolstering the credibility of the alleged victim. Medical doctors rarely testify to specific physical findings of abuse. Psychologists, social workers, and therapists will repeat the alleged statements of the alleged victim. They will sometimes testify to "behavioral indicators" which have no scientific reliability or validity. (7) The underlying message sent to the jury is that these "experts" believe the child was abused. "Experts" do not possess a special ability to determine the truthfulness of what someone tells them. They are not sooth-sayers or crystal ball readers, even though many of them try to be.

There are numerous "Innocence Projects," using DNA testing, that has helped bring attention to the plight of a limited number of innocent people who are incarcerated. The problem is not solved for the vast majority of innocent people who were convicted of child sexual abuse in which there wasn't specific physical findings, corroboration, or DNA evidence. "Innocence Projects" are limited in what they can achieve and the number of people it can help. They are reactive, rather than proactive. The time has come for a public acknowledgement of the problem of innocent people in prison and the search for a proactive solution.

1. A June, 1996 U.S. Department of Justice Report, showed that over 25% of the DNA tests conducted by the FBI of primary suspects in sexual assault cases from 1989-1995 resulted in the suspect being excluded. When the inconclusive results were factored in on a corresponding percentage, the rate was 37% as being innocent (excluded).
2 Child Maltreatment 1999, U.S. Department of Health & Human Services, p2, figure 1-1, "Reports by Source."
3. See: Investigative Interviews of Children, written by Dr. Michael Lamb, National Institute of Health, and Dr. Debra Poole, Central Michigan University. Published by the American Psychological Association.
4. Confirmatory Bias (see articles)
5. Dr. Elizabeth Loftus, Dr. Stephen Ceci, Dr. Maggie Bruck, et. al.
6. *State v. Michaels, State v. Snowden, State v. Kelly, State v. Wilcox, State v. Aldridge.*
7. See articles.

Sexual Abuse, DNA Testing, Criminal Convictions

F1 Skeletal and Dental Image to Photo Superimposition: Two Reliable Methods of Forensic Identification

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The learning objectives of this presentation are to demonstrate the usefulness of the techniques of skull image and dentition image to photograph superimposition for forensic identification of human remains when there is an absence of clinical antemortem records.

Many forensic scientists have used superimposition of craniofacial structure images over facial photographs of missing individuals to identify unknown human remains. Even though the scientific knowledge extracted from various research papers has found inaccuracies of the results due to several known factors, standards have been established to evaluate the result of this technique.

Two criminal cases under the investigation by Mexican police authorities from the states of Nuevo León and Chihuahua, México will be presented.

Case No. 1: On November 17, 1998, a dead body wrapped in plastic bags and fastened with duct tape was found on the side of interstate highway 44 at the border line (Nuevo León side) between the states of Nuevo León and Coahuila, México. After the package was unwrapped, the medical examiner found the decomposed body of a female with multiple perforating cuts on the soft tissue of the face probably to prevent visual identification. Hand wrist X-Rays revealed a skeletal estimate between 15 and 17 years of age. Police investigators immediately started gathering information about female missing persons between the ages of 15 and 20 years. Three photographs of a 17-year-old girl missing since the end of October 1998 from the town of Saltillo, Coahuila were collected from police officers in charge of the case. Two photographs were taken in June 1995, and the other one during the year of 1997. After requesting the medical history on the missing girl, as well as clinical records taken at hospitals and medical or dental offices, the police investigators confirmed that no records or medical history on the missing girl were found.

The three photographs from the missing girl were transferred to a computer by a digital scanning method, and prepared for the photo superimposition study. In order to preserve the integrity of the soft tissues of the head and face due to the nature of the criminal investigation, it was decided that instead of using the victim's skull image for the superimposition study, that an X-Ray image would be taken of the victim's head duplicating the same position shown on the comparison photographs of the missing girl. A frontal (Posteroanterior) X-Ray image from the unknown body's head was taken with a portable X-Ray unit, from a distance of 93 centimeters, due to space limitations within the autopsy room facility. After development of the X-Ray film, the skull image was transferred to the computer by a digital scanning method. In order to know the magnification values for the X-Ray image, a new X-Ray was taken under the same circumstances, utilizing instead of the body's head, a plastic natural size skull fitted with several metal markers, located at the principal anatomical landmarks of the skull and mandible. The X-Ray image with the metal markers was measured and compared to the measurements of the original markers located on the plastic specimen in order to describe the magnification values at each landmark location.

The X-Ray image of the victim's head was compared with the most recent photograph of the missing girl, by means of a digital process done by computer graphics. The face on the missing person photograph was prepared by drawing eight reference lines, five horizontal and three vertical; the lines indicated specific anthropometric landmarks for the superimposition study. The X-Ray image of the skull was prepared by drawing fourteen reference marks; these marks represented the specific anthropometric skull and mandible landmarks for the comparative study. The results are presented graphically, and the X-Ray image magnification percentages are presented in a tabular form.

Case No. 2: On September 18, 2000, a cardboard box containing one human skull, one human mandible, two color photographs and one ID card from a missing male person, was sent to the Department of Legal Medicine by the Attorney General's office from the state of Chihuahua, in order to know if the bones were related to the person shown on the photographs. The partial remains belong to an unidentified body found death outside the city of Hidalgo del Parral, approximately two years before. The ID card and the photographs belonged to a male individual 30 years of age from a suburban town nearby the city of Monterrey, reported last seen in the city of Chihuahua, several days before the date the death body was found in Hidalgo del Parral.

After receiving the package the local police collected five additional color photographs of the missing person. All the photographs depicted the missing individual smiling and showing his anterior dentition. The investigators located two dentists who attended the missing man few years ago, but no dental records were obtained from their offices.

The degree of obliteration on the cranial sutures of the victim's skull gave a compound estimate of twenty-five to forty-four years, with a mean of 34 years of age, at the time of death. The external morphological characteristics of the skull and mandible gave an estimate of ambiguous sex, with a tendency to a male subject. Discriminant function analysis and the cranial index, reported a white dolichocranial female individual.

The mandible was attached to the cranium by gluing the upper and lower teeth together in full occlusion utilizing a standard procedure, prior to mounting the skull on an articulating vertical stand fixed over a turntable. This setup was used to photograph the remains in all the different positions, duplicating the head positions shown on the collected photographs. Standard medium telephoto portrait images of the skull were acquired from a fixed distance, with a digitally equipped camera in six different positions, following standard procedures. The resulting digital images were transferred to a computer and prepared for their analysis.

The missing person photographs and ID card were transferred to a computer by a digital scanning method and were prepared for the image comparison studies. The frontal photograph on the ID card of the missing person was fitted with the reference facial lines, and the position related skull image was also fitted with the corresponding skull landmarks. The two images were compared digitally on a computer, and the results of the study are presented graphically.

The remaining photographs were compared with their skull image counterparts, directing the superimposition analysis to the dental structures. The results of these comparisons are presented graphically for their forensic evaluation.

Conclusion: Even though the image superimposition methodologies used on the two cases presented could not derive a positive identification of either human remains, the results were very conclusive on the high similarities found, which confirmed the usefulness of the technique on forensic cases were no antemortem records exist.

Forensic Identification, Computer Aided Image Superimposition, Forensic Odontology

F2 Facilitating the Search for Antemortem Dental Records

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The forensic community will be presented with an aid in acquiring antemortem dental information. The goal of this project is to share a technique with the forensic community, including law enforcement and medical examiners that may help in identifying sources of antemortem dental information for the process of dental comparison in dental identification.

This poster exhibit will present a guide for the forensic odontologist, medical examiner/coroner, and criminal investigator for the interview process when attempting to secure antemortem dental information. The document is the *Antemortem Dental Data Collection Search Record.* This information-gathering tool has been developed over several years by the author, with the generous assistance of many professional colleagues, with the intent of sharing this information-gathering tool with other investigators. The document has been used successfully as an aid to investigators in collecting and documenting avenues for securing antemortem dental information as well as the records themselves. It is a standardized method of collecting information from the family and/or friends of a victim that may enhance the investigator's ability to secure antemortem dental treatment records from one or more sources. Additionally, this tool considers the collection of non-traditional information that may help in securing antemortem dental treatment records, radiographs, orthodontic or prosthodontic models or high quality facial photographs. The form suggests a variety of available sources for the necessary dental information that may not be immediately considered by a distraught next of kin or inexperienced interviewer, and a uniform concise method to document these potential sources of information. The document can be a valuable asset in assisting the investigator and the family of the victim to consider a variety of available sources for antemortem dental information and a concise method of documenting the potential sources of information.

It is suggested that the interview process associated with the use of the *Antemortem Dental Data Collection Search Record* be conducted in as relaxed manner as possible. It is best accomplished by a trained interviewer who is familiar with the importance of securing antemortem dental information in a concise, accurate, and compassionate manner. The *Antemortem Dental Data Collection Search Record* is a work in progress that has evolved over several years. The document is open for additions, corrections, and modifications. All comments and suggestions are appreciated. It is available to all interested individuals in a paper form as well as on diskette in MS EXCEL format. The document can be converted to MS WORD format. It can be easily duplicated.

The *Antemortem Dental Data Collection Search Record* can be an effective tool in helping Medical Examiners or Coroners and law enforcement personnel in identifying sources for current antemortem dental records. The identification process may be slowed considerably or halted completely if antemortem dental records are not available to the investigators. A postmortem dental examination may reveal significant dental information but the dental comparison can be stymied if the investigator receives a blank stare when the family is confronted with the single question "Who is the victim's dentist?" It is incumbent on the Forensic Odontologist to help guide law enforcement to the areas of investigation that may result in locating valuable antemortem dental records.

A tool is presented that may assist investigators in developing sources for the collection of antemortem dental information to aid in the comparison process for identification of an unknown human remains. It allows for gathering and documentation of multiple potential sources for antemortem dental records and other ancillary dental artifacts in a clear and concise manner, opening avenues for investigation.

The author would like to see the use of the *Antemortem Dental Data Collection Search Record* in more widespread use to assist and guide forensic dental investigators, law enforcement, and medical examiners in identifying sources for antemortem dental information.

Antemortem, Dental Records, Forensic Odontology

F3 Forms of Identification

Bernard J. Wujcik, MS, DDS, 4318 Lincoln Highway, York, PA; and Linda K. Himmelberger, DMD, 227 Lancaster Avenue, Devon, PA*

After attending this presentation, the participant will be familiar with various forensic odontologic forms that can be used in an individual or multiple victim identification, with or without fragmentation.

This presentation will review the forms of the Pennsylvania Dental identification Team (PADIT). These forms have been utilized in mass disasters (44 victims and 133 victims), multiple victims (11 and 19 victims), and for individual fatalities. The set of forms include the following: Records Acquisition Form, Antemortem Record, Search and Recovery Form, Postmortem Record, Comparison Record, and Logs (Antemortem/Postmortem). The Antemortem and Postmortem Record Forms can record the characteristics of each tooth in three different ways: by odontogram, by WinlD descriptor, and by a narrative. While no form is foolproof, these dynamic forms have proved to be easy to understand and to complete, even by relatively inexperienced forensic odontologists. The forms are reviewed and updated annually and after each use in mass/multiple victim activation.

Odontology, Identification, Fragmentation

F4 Homicide in Van Buren County, MEC 02-1272

J. Michael Cisneros, DDS, Assistant Chief Forensic Odontologist, 4660 Trousdale Drive, Nashville, TN; Michael P. Tabor, DDS, Chief Forensic Odontologist, 107 Maple Row Boulevard, Hendersonville, TN; and Bruce P. Levy, MD, State Medical Examiner, Sherry Saint, Investigator, and Linda Scavone, Forensic Photographer, 850 R.S. Gass Boulevard, Nashville, TN*

The attendee will review overlay and digital analysis of a bite mark and will determine which is the most subjective.

The decedent, Donald Lawson, was reportedly found unresponsive at his residence in Spencer, TN, and was transported to White County Hospital in Sparta. The decedent reportedly sustained blunt force injuries from an unknown assailant and unknown instrument (possibly a walker). The decedent was transported to the Office of the State Medical Examiner Center for Forensic Science, 850 R.S. Gass Boulevard, Nashville, TN, for further investigation.

Dr. Bruce P. Levy performed an autopsy on May 21, 2002 with the following report.

Pathologic Diagnoses

1. Blunt force injuries of head and neck:
   1) Multiple lacerations, abrasions and contusions of face and scalp.
   2) Multiple facial fractures.
   3) Hemorrhages of neck.

2. Blunt force injuries of torso and extremities:
    1) Bite marks of abdomen and right upper extremity.
    2) Abrasions, contusions and lacerations of chest, abdomen and back.
    3) Abrasions, contusions and lacerations of both arms.
3. Atherosclerotic and hypertensive cardiovascular disease:
    1) Cardiac hypertrophy (780 grams).
    2) Arteriolar nephrosclerosis.
    3) Aortic atherosclerosis, marked.
    4) Cerebral artery atherosclerosis, moderate.
    5) Coronary artery atherosclerosis, marked:
        1) Status-post coronary artery bypass grafts (2) and pacemaker placement:
            1) Bypass grafts patent.
            2) Pericardial fibrous adhesions.
4. Pulmonary vascular congestion and anthracosis.
5. Benign prosthetic hyperplasia.
6. Pleural fibrous adhesions, bilateral.
7. Status-post laparoscopic cholecystectomy, remote:
    1) Peritoneal fibrous adhesions, focal.

Cause of Death: Multiple blunt force injuries of head.
Manner of Death: Homicide
Circumstances of Death: Assaulted by other person(s).

On May 21, 2002, Dr. Mike Tabor and Dr. Michael Cisneros were called to the Forensic Science Center in Nashville, TN, to evaluate bite marks on the decedent, Donald Lawson. There were bite marks on the decedent's abdomen and right upper extremities. Linda Scavone, Forensic Photographer, took digital photographs using an ABFO #2 ruler. The bite mark on the right side of the abdomen was excised using an acrylic ring cyanoacrylate and suture technique for examination.

On May 28, 2002, Dr. Mike Tabor and Dr. Michael Cisneros were asked to evaluate accused Robert L. Christian's dentition to the bite mark pattern on Donald Lawson. Impressions and wax bites of Robert L. Christian were taken at the Metro Police Department on James Robertson Parkway in Nashville, TN.

After studying the excised bite mark and digital photograph of the decedent using overlays and digital analysis, the dentition of Robert L. Christian was found consistent with the bite mark left on Donald Lawson.

Bite Mark, Overlay, Digital Analysis

F5 Forensic Odontological Analysis of Professional Incompetence in Relation to a Case of Bilateral Harelip and Cleft Palate

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The goals of this presentation are to demonstrate how inadequate professional judgment negatively affected the outcome of treatment.

The patient was effectively treated until age twenty in foreign institutes according to the protocol for bilateral lip and palatal clefts. Despite completion of orthodontic treatment, the patient believed that the aesthetic quality of his anterior teeth could be improved. To this means he turned to his local dentist who thence undertook prosthodontic therapy.

Following what the patient felt was unsatisfactory treatment, the patient visited the Institute of Forensic Medicine. His complaints were the following: during mastication food would fall out of his mouth, as would saliva. While speaking his consonants would "whistle." The appearance of the anterior region was not acceptable. It was necessary to involve a specialist to reach a professional opinion.

The analysis revealed that the patient's dentist had neither noticed nor realized the stability of the first incisors bordering the premaxillary cleft. During treatment, in the interest of replacing the bilaterally missing second incisors space expansion (unilateral) therapy was initiated. Furthermore, the attending dentist attempted to solve the slight open bite problem by first incisor extrusion. During treatment, the stability of the anterior teeth (first incisors and opposing canines) ceased, so much so that movement of these could only be remedied by circular prosthodontic "bracing" in the form of bridgework spanning from 15-25 (FDI).

The unilateral space-expansion and bridge controlled and closed the anterior gaps; however, the incisal midline shifted distally. Frontal aesthetics therefore worsened. The axis of the first incisors became protrusive, the phonation worsened (in the speech therapist opinion: "whistly"). In the interest of solving the asymmetry, aesthetic "tuning" by grinding/polishing was performed. In order to correct the first incisors axial protrusion over-preparation with root canal therapy (extirpation, obturation) was carried out. The possibility of extrusion root resorption, and as a result of incomplete root canal obturation the prognosis for loss of anterior teeth seems high. The new ten-piece bridge had not solved the problem of midline distolocation, and remnants of the premaxilla began proliferation which will resulted in osseo-resorption of that area.

The patient received psychiatric counseling. As the result of parental pressure (understandably, they supported treatment abroad over the course of twenty years), forensic odontological analysis was initiated. Within this framework it was concluded that incompetent and inadequate dental treatment and therapy was performed. This was directly injurious to the patient. The patient has filed claim for damages incurred. The case will be illustrated with excellent photos.

BCLP, Twenty Year Complex Therapy, Forensic Odontological Assessment

F6 Overview of World Trade Center Disaster

Jeffrey R. Burkes, DDS, 520 First Avenue, New York, NY

No abstract provided.

F7 OCME/DMORT Recovery Operations of 9/11 at the World Trade Center and Staten Island Landfill

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The attendee will receive an overview of the recovery operation of human remains at Ground Zero and the Staten Island Landfill following the attack on the World Trade Center.

The terrorist attack on the World Trade Center was unique in a variety of ways. Never before had the country sustained such a violent strike that resulted in so large a number of civilian deaths and casualties in the homeland. A recent death toll of 2,795 was more than those who died at Pearl Harbor, an attack on a military base in a U.S. territory. Preparation for this type of surprise assault was impossible. Response to

this type of attack had never been truly played out. Therefore, when it did occur in such a huge magnitude, rescue and recovery teams were overwhelmed. Considering the number of people (approximately 45,000+) working in the Trade Center, the death toll could have been substantially worse.

Although rescue efforts continued in hopes that survivors would be found in the numerous pockets of the ruble and debris, it was soon obvious that the destruction was so severe that it was unlikely that intact bodies would be recovered. Once authorities decided to re-open the Staten Island Landfill (closed the previous March), for a repository for all the ruble, it was further determined that all debris brought there would be searched for human remains, personal effects, and anything that could be considered evidence from a crime scene. It was estimated that the collapse of the Trade Center buildings produced over 1.7 million tons of debris, a sizable amount to deal with and cart away. It's unlikely that any other community has ever been faced with such a challenge in removing such an extraordinary and horrific amount of debris filled with so touching and emotional amount of human remains.

The debris and rubble from the attack site were transported to the Fresh Kills Landfill (the name means waterway in Dutch), on Staten Island by barges that were filled from a loading site on the Hudson River. After arriving at the base of the landfill everything was offloaded to large Volvo trucks and carried up to the top where it was spread out by pay loaders on a three acre raking site to be thoroughly and painstakingly searched by New York Police Department (NYPD) personnel and, in the beginning, by cadaver dogs. However, the commingling of human and non-human remains and the residue from the previously closed landfill produced confusion for many of the dogs and their involvement in the operation was terminated after a few weeks.

In order to identify human remains from within the large amount of animal residue from all the restaurants in the Trade Towers, the New York City Office of the Chief Medical Examiner sent the federal government's DMORT (Disaster Mortuary Operational Response Team) team's forensic dentists and forensic anthropologists to the landfill site on a 24/7 basis. Each team consisted of one dentist and three anthropologists. While DMORT team members actually worked the raking site from time to time, their mission was to identify what the NYPD personnel brought to them.

Working under the supervision of the NYPD Crime Scene Unit, the forensic teams were able to sort out and identify the human remains brought to them for triage. Each human specimen was photographed, tagged, placed in an evidence bag, and held in a reefer truck until picked up by the medical examiner's office for completion of postmortem records and DNA analysis. In spite of the mass carnage and extreme trauma to the remains, much of which was unusual and rarely seen, every effort was made to recover and identify body parts from the seemingly endless tons of debris. Nothing was left unexamined. When in doubt about a specimen, it was considered human until the final decision was rendered by the medical examiner.

Human remains recovered from the World Trade Center (WTC) site were delivered to the medical examiner's office where they were anatomically identified, matched to dental records and/or fingerprints, and sampled for DNA. Under the direction of the OCME NYC, combined efforts of the NYPD Crime Scene Unit, DMORT, and many other support agencies, over 19,900 body parts were recovered. This resulted in 1,435 positive identifications. The major modalities of identification were DNA, dental, and fingerprints. There were over 700 DNA, over 500 dental and over 200 fingerprint identifications. Photos, remains viewed, body X-Rays, tattoos, and personal effects were the other means of identification utilized for this disaster. Of the victims identified by multiple modalities, 83% were by DNA, 78% by dental, and 40% by fingerprints. Due to the severe trauma that these victims received, positive identification required tremendous effort by all of the agencies working together.

DMORT, Staten Island Landfill, WTC

F8 American Airlines Flight 587

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The attendee will learn how forensic dentists were able to organize and handle two concurrent mass disasters: Flight 587 and the World Trade Center.

On November 12, 2001, American Airlines Flight 587 took off from John F. Kennedy International Airport and crashed into Belle Harbor, NY (in the borough of Queens) shocking once again the city of New York already reeling from the attacks of September 11th. All 260 people on the flight along with 5 people on the ground perished. The airspace over New York was closed, with the assumption that this was another terrorist attack.

The Office of the Chief Medical Examiner City of New York, its forensic dentists, and the members of the New York Society of Forensic Dentistry's Dental Identification Team faced the unprecedented task of running two mass disaster identification efforts at the same time.

Since the Manhattan office of the Chief Medical Examiner of the City of New York was already set up for the processing and identification of the World Trade Center victims, it was decided to bring the victims of Flight 587 to Manhattan some 20 odd miles away, rather than setting up a new recovery site at the Medical Examiner's Queens office.

In the Manhattan office, new protocols were set up to differentiate the victims of Flight 587 from the victims of the World Trade Center. New computer databases, new identification numbers, and different visual cues, i.e., the colors of paper, folders, etc., were implemented.

The teams of pathologists, medical legal investigators, FBI investigators, the NYPD, and other agencies as well as the forensic dental teams were in place and began processing the victims. NYPD detectives processed property, including wallets, jewelry, and other personal effects on the victims, which helped give clues in the identification process. After the pathologists performed the autopsies, the postmortem dental teams examined the full body radiographs to confirm presence of dental remains. The jaws were dissected as necessary and radiographs and chartings were done. This information was then entered into computers using the WIN-ID program.

The antemortem dental team began the task of gathering dental records. Flight 587 was bound for Santo Domingo in the Dominican Republic, an island in the Caribbean. Many of the victims were from the Dominican Republic and the task of getting dental records was made more difficult not only because of the language barrier but the possibility of no existing dental records whatsoever.

After 2 weeks, all the postmortems were completed. All postmortem chartings were entered into the computers with incident numbers differentiating Flight 587 from the World Trade Center. After about 4 weeks, all dental records that were available were received and processed into the computer databases. Postmortem and antemortem comparisons using WIN-ID were done and completed. The victims of Flight 587 that could be identified by forensic dentistry were completed after 4 weeks. Other means of identification including DNA were utilized to identify those whom no antemortem dental records were available.

Forensic Dentistry, WIN-ID, DNA

F9 Just Another Routine Day in the Office

Frank J. Pappas, DDS, and Konstantinos Cherpelis, DDS*, 33-03 Bell Boulevard, Bayside, NY*

The attendee will learn how juggling a general dentistry practice and performing forensic odontology can be anything but "routine." The purpose of this lecture is to demonstrate how daily office routine can be interrupted by having to perform an "emergency" comparison.

It is well known that things can occur at the most inconvenient times and sometimes extreme measures to solve a case are necessary. In this case of skeletal remains, a skull from a missing person of three years was brought over to the dental office for comparison. If the detective's investigation was correct the missing person was murdered and the suspect who had known dealings with the deceased was under surveillance. The arrest warrant was pending the positive identification of the remains. Thus, time was of the essence in order to obtain a warrant and arrest the suspect prior to him fleeing.

The case had been pending for over three years. The police were very anxious to solve the case due to the fact that the victim was a minor who was brutally beaten via blunt impact injuries to the head and part of the body was charred. During an interrogation of a burglary investigation, new leads were obtained which led the detectives to the suspect who had sexual relations with the minor. Upon obtaining the name of the minor all the pieces of the three-year-old puzzle fell into place. All the while, steps were taken by missing person's detectives to identify the skeletal remains of this minor. The skull was sent to the FBI lab in Washington, DC, for fabrication of a computer generated photo based on specific facial points on the skull. However, this was to no avail and the case was still open. This new lead could possibly solve the missing person's case as well as the homicide.

The detectives were anxious for the results of the dental identification. The examination and radiography of the skull where performed in the dental office in between patients with the detectives waiting. To complicate the issue of time constraints, this was not a routine identification. There were issues with the antemortem records, e.g., discrepancies between charting and radiographs. Possible insurance fraud committed by the treating dentist or some type of charting error had to be considered.

What conclusions can be met with a match on radiographs but very specific charting with contradicting information? Is this enough evidence to make a positive identification to subsequently obtain a search warrant? What about the patient in the next operatory mid root canal procedure? Is a treating dentist contacted? Will that dentist sign an affidavit stating he committed Medicaid fraud? What is to be done?!?!

This case study will highlight some of the difficulties a forensic odontologist may encounter. It will exemplify how things are never as easy as they seem, how routine identifications aren't always routine, how nuts and bolts always get thrown in to the system and how the forensic community needs to adapt and modify.

Dentistry, Comparison, Skeletal Remains

F10 Three Cases of Single Radiograph Victim Identification

Henry J. Dondero, DDS, and Jennifer G. Dondero, 2 Emerald Drive, Glen Cove, NY*

The forensic dentist must develop the ability to think past the initial disappointments in victim identification search patterns and utilize as much investigative information in creating secondary searches.

This paper will present three cases of identification of human remains from the World Trade Center Disaster. The enormous numbers of victims from this tragedy has re-defined the term "Mass Disaster." The WinID search software was originally developed to accommodate a two to three hundred fatality incident. This program has been updated numerous times since "9-11" and has performed admirably. It is clear that the forensic dentist must be accomplished in computer search techniques as well as conventional intuitive thought processes. Patience in the tedious task of selecting and formulating search criteria was the principle factor responsible for the success achieved below. Each of the cases presented was identified by a comparison of postmortem radiographs and clinical examinations with the antemortem dental charts and radiographs obtained from the respective family dentists. In each case, the successful identification of these victims was elicited from the information contained in a single radiograph.

Case Number 1 presented the recovery of a victim with nearly a full dentition. The initial search on WinID produced well over 100 possible matches, which was due to the inordinately large number of victims of this tragedy who presented with either all-virgin teeth or with minimal restorations. The dental remains exhibited one tooth that had an amalgam restoration while the remainder of the teeth were un-restored. Identification based on the anatomy of the restoration or any of the usual parameters were unsuccessful. It was noted during the postmortem examination that all the teeth showed the classic "pink tooth" look with the exception of teeth numbers eight and nine. Radiographically these teeth showed marked root resorption. It was determined that the decedent had suffered a trauma to several teeth accompanied by the resultant resorption of root structure. This single defining factor offered the unique characteristic needed for identification. Subsequent filtering of the WinID database was successful.

Case Number 2 offered a different obstacle to successful WinID searching. While several teeth were missing or restored, the closest WinID possibilities were not at all feasible. After the initial search, the investigators discussed several different possible search options. During the dental postmortem examination of the victim, it was noted that one of the teeth that was missing seemed to have been either extracted recently or avulsed due to the blunt trauma associated with the tragedy. It was decided to "replace" the missing tooth for search purposes. This decision resulted in the retrieval of one radiograph containing a recent extraction, a chipped tooth, and a restoration thus affording a positive identification.

Case Number 3 dealt with the fragmented remains of the left mandibular arch. The two premolar teeth were un-restored, the first molar had a metallic restoration, the second molar had a nearly complete coronal fracture and the third molar was missing antemortem. The initial WinID search offered ninety-one possible matches. Tedious comparisons of ante- and postmortem radiographs successfully elicited an identification of the decedent based solely on the single X-Ray film of the area involved. The unique shape of the pulpal amalgam and the identical root morphology established the resultant identification.

The identification of these three victims was accomplished by utilizing the search parameter filtering characteristics of the WinID software program and by the creativity of the investigators to rethink the parameters of search to fit the individual case.

Single X-Ray Identification, Forensic Odontology, Victim Identification

F11 A Multidisciplinary Approach to a Mass Disaster Victim Identification

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The forensic dentist must be capable and willing to exhaust all investigative avenues and to accept that under certain circumstances a dental identification cannot be ascertained but will, by nature of its statistical narrowing effect, facilitate identification by other means.

The case presented is of one victim of the World Trade Center Disaster. The decedent was recovered from the disaster site on September 12, 2001, one day after the tragedy. The partially decapitated female body was generally intact; however, the only dental remains that were recovered was a fragment of the left mandible, extending from tooth number seventeen to tooth number twenty-seven. The clinical and radiographic examination revealed amalgam and composite restorations on teeth numbers seventeen, eighteen, and nineteen. One of the premolars had been extracted, presumably for orthodontics. The anatomy of the remaining premolar led the investigators to believe that tooth that was removed was number twenty. The space created seemed to have been successfully closed. Teeth numbers twenty-one through twenty-five and tooth number twenty-seven were virgin. Tooth number twenty-six had apparently been traumatically avulsed postmortem.

The initial search through the WinID database presented more than one hundred-fifty possible matches. After eliminating all males from the search, approximately sixty possible matches remained. The painstaking task of comparing each victim's antemortem X-Rays with the decedent's narrowed the search to one highly likely individual. It was determined that more radiographic evidence was needed and the family dentist was contacted to send the original X-Rays, not copies. Also, new X-Rays of the fragment were taken at different angulations. After the gathering of this new radiographic evidence and clearer family films, it was determined that this victim was now excluded from the list of possible matches.

For several months routine searches did not reveal any new possible matches, despite the addition of hundreds of new family records to the database. In early March 2002, family records from foreign countries started arriving on a daily basis. At this time a possible match appeared evident. The WinID comparison odontogram showed a missing tooth number twenty-one instead of number twenty. This was not deemed to be exclusionary. While both diagrams showed identical materials for the restorations, the family records failed to note the surfaces involved. There were no X-Rays at all to refer to. These records came from a foreign country and were difficult to understand. At this juncture the Police were notified to determine if the victim's roommate could lead the investigators to a possible American Dentist. No further information about an American practitioner could be found, however, the police did obtain a comb, hairbrush, and toothbrush for DNA analysis.

The investigators obtained the assistance of a bi-lingual Dental Hygienist who was able to translate the dental records received from the language of the country involved. A representative from the victim's place of employment who was to implement the gathering of family records for the Medical Examiners Office was contacted and obtained new dental charting. No X-Rays were sent and again the new records stated the restorative materials but not the surfaces involved. Contact was then made with the consulate from that country in New York City and the situation was explained asking if their State Department could track down any available radiographs. After several more weeks of waiting for records it was disappointing to learn that no X-Rays or additional information would be forthcoming.

Recognizing that a dental identification based on such sparse information would be impossible, the investigators notified the Medical Examiner's Office of a "Probable Match" and requested that a DNA analysis be conducted. After several weeks the Dental Unit was notified of an identification based on DNA.

Multidisciplinary Victim Identification, Forensic Odontology, Mass Disaster

F12 A Consistent and Accurate Method of Interpretation of Duplicate Dental Films in Mass Fatality Incidents

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After participating in this session, the attendee will be able to properly determine the correct orientation of duplicated dental radiographs based solely on the orientation of identifying landmarks placed by the manufacturer in commonly used radiographic and duplicating films.

Objective: To prove through example that an easy, accurate and verifiable method exists to determine the correct orientation of a duplicated dental radiograph based solely on the position of the dimple, irrespective of orientation of either the source or duplicating film during the replicating process.

The World Trade Center disaster on September 11, 2001, was the worst terrorist act in the history of the U.S. and caused the loss of more than 2,800 lives. It also created a huge task for the New York City Office of the Chief Medical Examiner (OCME) in Manhattan. Even before the search and rescue effort was ended, the recovery and identification of the bodies began. Thousands of dentists from around the world were invaluable in supplying the antemortem dental records of the victims that was essential for the identification process to begin. This information was provided to the OCME, which had assembled one of the largest dental forensic teams in history. By the summer of 2002 the OCME had reported 1,229 victims (44%) of the victims have been identified from over 19,000 fragments recovered. Over 700 identifications had been done using standard technologies such as fingerprints, personal belongings, and, of course, dental identification. The primary tool used for dental identification was visual comparison of antemortem and postmortem radiographs. This process was greatly aided by the use of a computer program called WINID, which had been developed by Dr. James McGivney.

Due to the large number of radiographs coming from a diverse dental community worldwide, a number of problems arose with regard to the information contained in the antemortem dental records. Although the original radiographs were requested from all dentists, the OCME dental identification team received a large number of duplicate radiographs. Unfortunately, many lacked any type of reference markings making it impossible to determine the proper orientation of right and left. In some cases, the markings of the duplicate radiographs were thought to be inaccurate. Additional problems arose with regard to the several different types of dental film, as well as different types of duplicating film, used.

Without accurate antemortem records, the ability to obtain matches in a mass fatality incident is greatly complicated, if not impossible. The simplest solution was to contact the dentist or determine orientation from the most recent dental charting. Should that fail, another solution to the "orientation problem" was to create a mirrored duplicate entry of the same individual by creating a "mirror image" of the odontogram and "flipping" the companion scanned radiographs. This process was simplified by a feature built into WINID.

Contacting the dentist or verifying by the dental chart proved both cumbersome and time consuming. The creation of the mirror image, although easier, greatly increased the number of antemortem records and therefore the number of possible matches that WINID generated. This was especially problematic in cases where the victims had only a few restorations, which is common in younger individuals. This greatly slowed the identification process.

The easiest solution seemed to be to find a way to ascertain right and left on the actual duplicate. The method most frequently used by members of the dental identification team was the position of the image

of the dimple from the original radiograph. The correct position of the dimple on a #2 periapical dental film of the posterior region is on the TOP LEFT of the RADIOGRAPH (TLR) or BOTTOM RIGHT of the RADIOGRAPH (BRR). In this position you are viewing the radiograph as if the dimple is out towards you. Although this seemed to be common knowledge among a number of dentists on the team, no one seemed to have a clear idea where this knowledge originated. In a process where accuracy was paramount, it was essential that this supposition could be proven beyond any doubt.

In achieving the author's objective, common knowledge will be examined to determine if it is correct. In addition, the different types of film available will be discussed as to whether they can be treated in the above manner in determining right or left.

Duplicating film, Dimple, Orientation

F13 Self Contained Forensic Odontology Training Program Using WinId3

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Upon completion of this presentation, attendees should be able to train themselves for a mass disaster using WinId3.

Preparation for a Mass Casualty Incident is very time consuming. Organizing groups of people at one time can be difficult. Scheduling conflicts can create additional problems. Trainees may not live in close proximity to a forensic group and may need to travel to attend a seminar or multi-day program. People will volunteer to give up time to be trained, but motivating people to maintain their level of training can be more difficult. Many professionals sometimes feel that if they saw it once, they are experts and do not need to train again. Using these professionals in a real disaster can become a disaster if they make a mistake. With the recent events that have occurred such as the World Trade Center terrorist attack followed by the American Airlines #587 accident many people have received onsite forensic training. This is not an ideal way to learn because mistakes will occur.In Forensic Odontology, one mistake generally means two mistakes. The psychological trauma to the families of the deceased is unacceptable. Therefore, forensic specialists must be able to train and more importantly maintain proficiency on an ongoing basis.

There are several computer programs available to use for comparisons of antemortem and postmortem records. The Suffolk County Medical Examiners Office and organizations such as DMORT (Disaster Mortuary Operational Response Team) have decided to utilize WinId3 as the computer program of choice for any mass casualty event. WinId3 was written by Dr. James McGivney and is always being upgraded. The program itself is not difficult to learn. To use WinId3 to its fullest potential means additional training time. When a dental examiner is reading the X-Rays without a chart, there is room for interpretation. As the computer programs are getting more sophisticated, there can be room for interpretation. However for training purposes, everyone should be trained at the same level if possible. Consistency is also extremely important.

This presentation is designed to create discussion on training for comparing antemortem and postmortem records. The result of this presentation will provide forensic odontologists with the ability to train themselves. The WinId3 has been utilized as the basis for the author's training program. Everything necessary to train with a group or alone will be available on a compact disk. Anyone using this training program has to have at least the basic knowledge and understanding of computer usage.

A version of WinID3 is on the compact disk for those who may not have Internet capability. More up to date versions are available on the Internet as freeware thanks to Dr. McGivney. A database consisting of antemortem and postmortem records is provided to place into WinId3. An antemortem records database with a blank postmortem database is included for the training exercise. This allows for the creation of post-mortem records to compare. Charts and X-Rays of all the antemortem records and postmortem X-Rays are included in the program. An answer key and instruction manual in cookbook style is also provided. Everything is in a separate folder for easy access. Commonly used identification forms are also included to aid in creating records and comparisons.

WinId3 comes with an antemortem and postmortem database for practice. The authors go several steps further. By including Charts and X-Rays, the trainee can create his/her own charting for the antemortem record, enter those records, and run comparisons. Postmortem X-Rays can be obtained also outside the main database and used to construct a postmortem record. These records can then be entered into a database that contains only antemortem records. Comparisons can be run. The trainee can check for mistakes using the main database or the answer key. Since WinId3 is also networkable, a group can practice together simulating a mass fatality incident.

The authors provided a compact disk to several members of a study group, The Suffolk Society of Forensic Dentistry, to try. With very little help everyone was able pull up charts, X-Rays, and forms. It was suggested that forms and charts be printed and that X-Rays can be viewed on screen. Participants then created the ante or postmortem records, accessed the appropriate database, and entered the records. Comparisons were run, and mistakes were reviewed and corrected.

With this computer-training program and advances in computer technology, it is possible for anyone wishing to train and maintain his/her forensic skills to do so anywhere anytime.

Forensic Odontology, Mass Disaster Training, WinId3 Training Program

F14 Dental Task Force Revisited

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After attending this presentation, the odontologist will know the importance of uniformity in preparing antemortem dental records to minimize errors, have examples of common chart interpretation challenges and how to manage them, have examples of WIN-ID code use and how to standardize them, and understand the need for adequate training and preparation of examiners and team leaders to minimize identification delays.

In 1988, Dr. Curtis Dailey presented guidelines for a dental task force. The recommendations are even more valid today with larger incidents and multiple responders. The dental task force saw its largest expression in the dental response to the WTC disaster. During the processing, the use of the WIN-ID program was key to the identification process. With a large number of people of varied experience processing records, the need for standardization of interpretation and coding of the antemortem dental data was very clear. The following ideas and examples will aid teams in minimizing errors that will affect the identification process.

Errors have been analyzed by various authors and can be simplified into two general classifications, those that will affect WIN-ID ranking and those that will not. Errors using primary codes are likely to produce a "mismatch" error that will alter a records ranking. Errors in secondary code characteristics will not affect the computer ranking by can delay identification efforts. Understanding these errors and their effects will aid the WIN-ID user during comparisons.

Developing guidelines for interpretation and coding of any dental characteristic likely to be encountered in antemortem record analysis can reduce errors. Interpretation of such characteristics as third molar status, interpretation of post extraction drift of teeth, antemortem X-Ray charting, and notation of caries should be decided before antemortem record analysis starts. Guidelines will include form preparation, notations used, chartings, and coding of any given dental characteristic.

Another area for pre-determination is the use of the WIN-ID "Comments" section. Such conditions as implants, sealants, orthodontic appliances, etc., can be noted and used as discriminators in the "FILTER" mode. To be of value, the comments should be standard. The most current WIN-ID version has a default menu for many of these characteristics.

Training modules should be developed to standardize examiners. The module offers the examiner an opportunity to use the guidelines and the team leader to promote compliance. Ideally the module will be completed before mobilization to an incident, but can also be used to integrate examiners on-site.

Examples have been provided in the presentation of ways to provide guidelines to ensure standardization in composite antemortem record preparation. Use of multiple examiners, sometimes from different teams and training backgrounds, requires standardization of record preparation. Printed guidelines for record interpretation and coding, linked to training modules, will provide a basis for uniformity of data that will maximize the potential of computer assisted comparison.

Mass Disaster, Computer, Antemortem Records

F15 Interpol's Role in Promoting Reliability, Validity, and Standardization of Disaster Victim Identification Procedures Worldwide

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At the completion of this presentation the attendee will understand the role of Interpol in: 1) globally enhancing and facilitating cross-border criminal police co-operation to solve serious transnational crime; and 2) promoting and implementing the policies and standards of disaster victim identification to its 179 member countries.

Interpol's mission is to promote international police co-operation, i.e., to help officers from different police forces, countries, languages, and cultures to cooperate with one another and work together to solve international crime.

Interpol, with its headquarters in Lyon, France, works around the clock in four languages (English, French, Spanish and Arabic). It receives, stores, analyses and circulates intelligence with its 179 member countries. Interpol plays a key role in information exchange by:

- Encouraging member countries to use the Automated Search Facility (AFS), which allows 24-hour remote interrogation of the information collected from around the globe and stored in its central databases;
- Issuing international 'wanted' notices for fugitives or other notices for missing persons or unidentified bodies;
- Distributing international bulletins, publications and circulars such as weekly intelligence messages on drugs and regular updates on new specimen or fraudulent banknotes in circulation;
- Convening international conferences and symposia which bring police chiefs and experts together to develop and exchange practices for better cooperation; and
- Offering forensic services (fingerprints, DNA, disaster victim identification, counterfeit currency and travel documents).

This presentation is mainly focused on the forensic services offered, especially the services related to disaster victim identification (DVI). The author served as an intern in Interpol's Headquarters and carried out a research project concerning Interpol's role in implementing DVI policies and standards to its member countries and consequently, ensuring the reliability and validity of DVI procedures worldwide. This research project consisted of a review of Interpol DVI related services as well as a questionnaire prepared for the 179 Interpol's member countries. The specific goals of this ongoing research project are:

1. To collect information on DVI activities in Interpol member countries;
2. To inform the member countries of the INTERPOL DVI related services, such as standard INTERPOL DVI form and guide, etc.;
3. To specify member countries awareness, usage and satisfaction to the INTERPOL DVI related services;
4. To analyze the reliability and validity of the DVI procedures among the member countries worldwide.

The questionnaire has been completed and disseminated to the member countries and responses are expected in fall 2002. Then these responses will be analyzed to determine the profile of DVI services across Interpol member countries. The resulting analysis will allow member countries to better collaborate using standardized Interpol forms, methods, and databases.

Interpol plays a unique role in assisting its member countries to effectively cooperate in DVI matters using reliable, valid and standardized techniques. Collaboration using standard methods will greatly assist in disasters involving multinational victims. Such disasters, particularly terrorism-related, are now occurring almost daily. Thus the current research is particularly timely as the need for global cooperation among police and forensic experts has never been more acute.

The author would like to kindly acknowledge the generous assistance and contributions of Dr. Zhijin Zou MD, PhD, who is a Specialized Officer in the Identification Branch of the Interpol General Secretariat. The author would also like to thank Mr. Lenno Reimand of the National Central Bureau of Interpol in Tallinn, Estonia for sponsoring the internship.

Interpol's Standards, International Collaboration, Disaster Victim Identification

F16 The Gander Disaster: Dental Identification in a Military Tragedy

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The objective of this abstract is to chronicle the contribution of dentistry to the victim identification efforts in one of the most significant disasters in aviation and U.S. military history—the December 1985 crash of a charter airliner near Gander, Newfoundland, Canada, which resulted in 256 fatalities.

On December 12, 1985, a contract airliner (Arrow Airways flight 950) carrying 248 U.S. Army personnel from the 101st Airborne Division, who were returning home from a 6-month peacekeeping mission in the Sinai, and eight civilian flight-crew members crashed on takeoff from Gander International Airport in Newfoundland, Canada. No one survived. At the time, it was reported to be the worst aircraft accident in U.S. military history, the largest air disaster on record in Canada, and the fifth-worst disaster in aviation history.

The role of dentistry from the dentists' perspective has never been reported. Therefore, this presentation will discuss the valuable role that

dentistry played in the investigation and identification process and will record its historical significance. The dental team's organization, methodology, obstacles, and significant contributions will be reviewed.

Dental comparison was the principal means of identification because of incineration and/or dismemberment of the majority of the remains. Identification efforts were further hampered because the military members were carrying their dental and medical records, which were either destroyed or only gradually recovered during the ensuing two months due to inclement weather. The Armed Forces Institute of Pathology Department of Oral Pathology was responsible for providing forensic-dentistry support and leadership for this endeavor. The assembled U.S. dental-identification team was composed of 23 dental officers of the Air Force, Army, and Navy and 16 dental technicians and 2 computer specialists.

Of the remains returned to the U.S., approximately one third were intact, one third were partially intact, and the remainder consisted of several hundred isolated body parts including teeth, fragments of jawbones, and portions of the craniofacial complex. All 256 passengers were identified. Dental means positively identified 180 (70%) of the 256 victims. Dental comparison alone or in combination with other modalities other than fingerprints was the means of positive identification for 113 (44%). Dental plus fingerprint comparison accounted for 67 (26%). One or more of the following modalities identified 68 (27%) victims: fingerprints, medical radiographs, medical/surgical history, anthropology, visual recognition, and personal effects. Dental findings were supportive in 16 of the aforementioned 68. The exclusion matrix method, which included dental data among the criteria studied, identified the remaining eight victims or 3%. Dental evidence supported the exclusion of seven victims for identification in the matrix.

Outcomes included the establishment of the CAPMI forensic dentistry computer system as a viable system for mass-disaster dental identification and the establishment of a military central repository for the storage of duplicate panoramic radiographs.

Dental Identification, Mass Disasters, Gander

F17 Insurance Fraud or Sloppy Charting?

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The educational goal of this presentation is to identify a human skull using antemortem and postmortem dental radiographs and charting that oppose each other.

This abstract will discuss how one error or exaggeration on the deceased's antemortem chart almost made it impossible to make a positive identification using dental radiographs and charting.

The Coroners office brought a human skull, along with antemortem records, to a dental office for identification. The teeth and restorations of the deceased were recorded, and periapical films were taken of the teeth and jaw that were available.

A human skull was radiographed using dental periapical films. The coroner thought the remains might have been from a 19-year-old male that had been missing for nine months. The maxilla was attached. There were no other bones present. The skull contained teeth #'s 1, 2, 3, 5, 14, 15, and 16. The remaining maxillary teeth were lost postmortem. Two different sets of antemortem radiographs were available, along with charting. All of the teeth that were supposed to be present, if this were the deceased in question, were present. The antemortem radiographs were done before restoration. The restorations that were present in the deceased were slightly different from what had been treatment planned by both previous dentists.

The original dentist had the following treatment plan for the above-mentioned teeth (#'s 1, 2, 3, 5, 14, 15, 16). Tooth #1 extract, #2 occlusal decay, #3 mesial occlusal decay, #5 distal occlusal decay, #14 occlusal decay, #15 occlusal decay, and #16 extract.

The second dentist treatment planned and restored the teeth as follows. Tooth #1 consultation, #2 occlusal lingual amalgam, #3 mesial occlusal lingual buccal amalgam, #5 mesial occlusal distal amalgam, #14 occlusal lingual amalgam, #15 occlusal lingual amalgam, and #16 consultation.

The deceased's skull had the following dental restorations. Tooth #1 impacted, #2 occlusal lingual amalgam, #3 mesial occlusal amalgam, #5 mesial occlusal distal amalgam, #14 occlusal lingual amalgam, #15 occlusal lingual amalgam, and #16 impacted.

The differences between the teeth that had occlusal lingual amalgams could be easily explained. The restoring dentist found it necessary to extend the filling into the lingual groove. The original dentist diagnosed tooth #5 as needing a distal occlusal filling. The restoring dentist must have felt the need to include the mesial. The discrepancy comes with tooth #3. The original dentist treatment planned #3 for a mesial occlusal filling. The restoring dentist billed the restoration for this tooth as a mesial occlusal lingual buccal. The restoration was also charted this way. The deceased had an average sized mesial occlusal amalgam on tooth #3. It did not extend onto the buccal or lingual surfaces.

Given that there were only seven teeth to evaluate postmortem, it was crucial that all factors studied, including bony trabeculation, sinus variations, root morphology, teeth present or absent, as well as restorations, be congruent.

The restoring dentist was called numerous times to clarify if this was a "charting error." The calls were not returned promptly. Eventually the deceased's teeth were shown to the restoring dentist. The dentist explained that he routinely charted and billed for extra surfaces if the restorations extended a little to the buccal or the lingual.

The deceased was identified using the antemortem and postmortem records, and radiographs. The forensic odontologists relied on the comparisons of the postmortem and antemortem radiographs to give a positive identification of the deceased.

It is imperative that forensic dentists be cognizant that restoring dentists do not always accurately chart the decay or the restorations present or needed. Whether the restoring dentist is sloppy at restoration charting or fraudulent does not concern anyone, except the insurance companies and the patient. Forensic odontologists should study all of the evidence, but base their decisions on scientific fact.

Dental Radiographs, Forensic Science, Inaccurate Charting

F18 Problems in an Identification

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The goals of this presentation are to provide the forensic community an opportunity to view a case with problems with age identification.

The decapitated body of a small African-American girl was found in a wooded area of Kansas City, MO, in April 2001. A few days later a volunteer helping the police found the decomposed head in a trash bag nearby in the woods. This began an exhaustive search and investigation by the Kansas City Missouri Police Department, the Federal Bureau of Investigation, and forensic experts in several fields to identify the child who came to be known as Precious Doe. The case has been covered extensively in the press, both locally and nationally. The case has been aired on "America's Most Wanted" and in the U.S. news. Public watches and memorials were held. A memorial site was set up, and hundreds of stuffed animals and flowers were placed there in remembrance. The Kansas City community was and still is upset over the fact

someone could do such a monstrous thing to a child, and that no one has come forward to identify or claim the body. Despite an excellent response and over 600 solid leads called in and investigated, the identity of Precious Doe remains a mystery.

The girl is described as about three feet tall and 41 pounds with a small, brown crescent-shaped birthmark on her left shoulder.

A reconstruction of the head was done which characterized Precious Doe as a cherubic little girl four to six years of age with mahogany skin, short neat cornrows and bright brown eyes.

A standard dental evaluation was done. This showed a complete primary dentition. There were no caries or restorations. The mandibular left primary central incisor was missing and the socket healed. The permanent first molars and incisors were formed, and the crowns partially calcified. The premolars showed only noncalcified tooth formation. The dental age was estimated at three, plus or minus six months.

As already noted this case received nationwide attention. A claim from a Florida woman was made that Precious Doe was her daughter. This woman's daughter had disappeared when she was five years of age. The woman identified the birthmark on Precious Doe as similar to one on her daughter. The Florida child had been missing for about a year, and the time frame fit that of Precious Doe; however, DNA testing proved this identity was not possible. However, as a fall out of this publicity the Florida foster childcare system is being investigated.

The poster presenting this case will include pertinent newspaper articles, photographs, radiographs and explanations of the age determinations.

There are several theories as to why Precious Doe has not been claimed or identified: the parents may be involved in her murder; the child's mother may also have been murdered; or she and her family may be from another state.

If anyone has a missing person in your files that fits this description, please contact Sgt. David Bernard of the Kansas City Missouri Police Department.

Identification, Dental, Precious Doe

F19 Researching a World War I Battle Death: Forensics and Genealogy Come Together

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The educational goals of this presentation are to illustrate the vital supporting role forensic sciences can play in researching a World War I military death and confirming identification of a World War I casualty.

Two years ago, a dental patient approached an Academy member to evaluate some dental charts dated 1921. The purpose of this presentation is to describe the route the patient took to obtain those dental charts and the role the Academy member played in helping him understand the forensic dental process in his genealogical research is the purpose of this presentation.

Two years prior to that time, the patient had begun researching the life of his grandfather, 1Lt. Louis Carmel Brown. 1Lt. Brown, a platoon commander in Company D, the 7th (combat) Engineer regiment, 5th Division, American Expeditionary Force (AEF), was killed in the Meuse-Argonne Offensive of the U.S. Army against German troops in October 1918. There are no living military veterans of his unit or relatives/friends who knew his grandfather, so the patient began following traditional genealogy search methods: military service records, unit histories, etc.

His first step was to submit a request (Form 180) to the National Personnel Record Center in St. Louis for a copy of his grandfather's military service record. He was informed by the National Personnel Record Center that in all likelihood his grandfather's military service record was destroyed in a major fire at the facility in the 1973. He was advised to research as much as he could into specific areas of his grandfather's life and re-submit his request. With the information then supplied, the National Personnel Record Center could "re-create" some of the service record.

The focus of this presentation is the use of forensic tools in researching World War I military service, medical treatment, and burial procedures.

Military Service: The research began at the "beginning" of Mr. Brown's World War I service. In 1917, Mr. Brown was the water department engineer for the city of Toledo, OH. Late in that year he was recalled or volunteered for active duty. This research included: Ohio military draft records, Toledo Blade articles, and discussions with the historian of the Army Corps of Engineers. The following sequence was discovered: training in the Engineering Reserve Officers Training Corps (EROTC) at Ft. Lee, VA; transfer to the 1st Battalion, 601st Engineers (Sappers) at Fort Laurel, MD; transportation of unit to France in June 1918. On August 27, 1918, 1LT. Brown reported to Company D, 7th Engineers, 5th Division, an active front unit.

The next research steps included: contacting the 5th Division Society (a veterans organization), the 7th Engineers Veterans Association, and back to the historian of the Army Corps of Engineers. These discussions produced the fact that both the 5th Division and the 7th Engineers wrote unit history books after the war. Copies of these rare books were found and purchased through Internet searches. These books gave much information on the actions of the units and the battle conditions in those actions. They also revealed the day, time, and action when 1Lt. Brown was wounded. Further research was made into the units' records in the National Archives and it revealed more detail of the day's actions, of 1Lt. Brown's wound(s), and unit burial policies.

In 1986, during a trip to France, a family member found 1Lt. Brown's grave in the Meuse-Argonne Cemetery (maintained by the American Battle Monuments Commission or ABMC) outside Montfaucon, France. A search of ABMC archived records found an eyewitness report to 1Lt. Brown's wounding, condition of wound, type of wound, and his subsequent journey through the medical process: Field Hospital 17 and Mobile Hospital 1, where he died four days later. The search also provided details of the body's disinterment in 1921 from the hospital's gravesite to the Meuse-Argonne Cemetery. These details include: condition of remains, uniform markings, and dental charts (including pre-mortem and postmortem dental attributes) for identification.

Forensic analysis: The unit casualty reports of 1Lt. Brown's wound(s) do not match the eyewitness account or the subsequent condition of 1Lt. Brown as he was dying. A military forensic pathologist was asked to evaluate the details. In addition, forensic odontology analysis of the disinterment dental charts appears to buttress one of the wound scenarios.

The presentation ends with a brief discussion of how today's battlefield casualty identification and disposition of remains processes are different.

Conclusion: What started out as a genealogy project turned into a study of U.S. Army military procedures for battlefield casualties in World War I and the role of the forensic odontology charting system.

Combat Engineers, Disinterment, Meuse-Argonne

F20 Image Analysis of Radiographs of Twins for Objective Identification and Individuality

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The objective of this presentation is to examine whether a computer automated method developed to discriminate differences in radiographs of separate individuals for identification is capable of discriminating between inherently similar individuals (monozygotic twins).

Dental identification is often accomplished by comparing dental radiographs of an individual that were generated at different times. Identical twins should be the most difficult sources of similar data to differentiate and therefore identify. The UT-ID computer program objectively compares radiographs to identify the individual and provide a threshold for that identification. This software program provides an objective estimate by first registering the digitized radiographs of the individuals and subsequently performing a cross covariance correlation (CCC) between the registered images. Registration is used to correct for the projection geometry of the radiographs. This computer software eliminates subjectivity in the comparison of radiographs and provides a threshold value that is used to indicate that the images are from the same individual. The computer analysis is objective and can be used as a tool to further substantiate a subjective identification.

This computer-based image analysis system, UTHSCSA Image Tool Software and its plug-in UT-ID (Version 3) developed by S. Brent Dove, DDS, MS, Dental Diagnostic Science, UTHSCSA, San Antonio, TX, were used to objectively compare the radiographic images of identical twins to determine individuality. Fraternal twins were used as a control group. Fraternal twins would be expected to be less similar but still more alike than random individuals of the general population. UT-ID provides the cross covariance correlation (CCC) range to define the threshold for determining objective identification for these subjects.

In two previous studies presented at AAFS meetings, UTHSCSA Image Tool software provided perfect and near perfect discrimination between radiographic images in a laboratory and clinical setting respectively. Registering the images and performing cross covariance correlation (CCC) between the registered images produced a threshold indicative of positive identification. As more data are analyzed, the cross covariance correlation threshold can be further refined.

Radiographs were utilized consisting of selected areas of full mouth series, single periapical radiographs, bitewing radiographs and areas of panoramic radiographs. Each twin had the same area analyzed that was supplied by the dentist of record. Time frame and age were as closely matched as the records permitted. Restorative treatments that would differentiate the twins were not utilized. Only common anatomical areas that could be compared were selected to be studied. These areas of the radiographs were then digitized on a flatbed scanner with transparency adapter at 400 dpi. These digitally scanned images, from the same anatomical area are then registered for each subject identical and fraternal twin. These images were compared to the corresponding images of control identical and fraternal twins and differences and similarities noted. The cross covariance correlation is determined by the program for the compared films and compared to a threshold value that is used to indicate identification.

UT-ID and the objective data it generates can be used to identify individuals from similar radiographic studies. Results indicated that the identical twins while more similar could still be differentiated from each other without reliance on restorative treatments. Fraternal twins were more easily differentiated from each other. Identity is not an issue that can be determined by statistics, probabilities or computer programs alone. In this study population, no two people were identical and the radiographs from each of these subjects were unique (like no other). Radiographic information is important, but may differ in the amount of information present. It is therefore the scientist who must make the identification. UT-ID provides an objective tool for scientists to facilitate identifications using radiographic information.

Dental Identification, Monozygotic Twins, Computer Identification

F21 The Use of Photographs in Dental Comparisons for the Identification of Human Remains

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This presentation will demonstrate the development of initial statistics and therefore, preliminary scientific basis for the identification of human remains through direct visual comparison of photographs exhibiting some anterior dentition to the dentition present on found human remains.

A lack of dental information reported in missing person files, the prolonged efforts of identification staff to obtain antemortem comparison materials and the absence or inaccuracy of antemortem dental records reported in a large number of identification cases make the need for alternate dental comparison techniques clear. The comparison of photographic media is widely accepted and integral to the field of forensic odontology. Yet one of the simplest and most accessible of images, a smiling snapshot, receives little attention in the research forum.

The technique of direct visual comparison is explored for its ability to narrow a pool of potential candidates for identification. Additionally, video superimposition of photographs is employed to further evaluate the accuracy of the direct visualization technique and to reduce the number of false inclusions and indeterminations. Initial figures show that potential matches can be reduced by 80 percent when the direct visual comparison technique is used. Application of video superimposition to the same photographs further reduces the potential match rate by 98 percent.

It is envisioned that confirmation of the technique by further research and its subsequent application to human identifications, both singular and en mass, can free up staff hours and finances dedicated to the preliminary stages of investigation and result in increased numbers of confirmed identifications.

Human Identification, Forensic Odontology, Direct Visual Comparison

F22 Additional Postmortem Dental Findings

Rachel C. Hall, BDS, PhD, and Iain A. Pretty, BDS, MSc, Department of Clinical Dental Sciences, The University of Liverpool, The Edwards Building, Daulby Street, Liverpool, England*

Following this presentation attendees will: (a) understand the importance of postmortem dental profiles in the identification of found human remains, (b) understand the importance, prevalence, incidence and presentation of features of the dental hard tissues likely to assist in profiling the individual, and (c) be aware of that such findings are indicators and should be combined with other features to develop a full profile.

The use of the unique features of the human dentition to aid in personal identification is well accepted within the forensic field. Indeed, despite advances in DNA and other identification methodologies, comparative dental identifications still play a major role in identifying the victims of violence, disaster or other misfortune. The classic comparative dental identification employs the use of postmortem and antemortem dental records (principally written notes and radiographs) to determine similarities and exclude discrepancies. In many cases the tentative identification of the individual is unknown and therefore antemortem records cannot be located. In such a situation a dental profile of the individual is developed to aid the search for the individual's identity. With such a profile a forensic odontologist can identify and report indicators for age at time of death, race (within the four major ethnic groups) and sex. In addition to these parameters the forensic dentist may be able to give more insight into the individual. This presentation outlines some of the additional personal information that can be derived from the teeth of the deceased, and which may assist in their ultimate identification. With extensive illustrative examples, a review of the recent literature provides many additional findings beyond those usually considered by forensic dentists.

The purpose of the postmortem profile is to provide information to investigators that will restrict the search to a smaller population of individuals. For example, by profiling the sex of the individual 50% of the possible population can be excluded. Forensic odontologists can usually determine the sex, race (within the four major races), and age (at time of death) from careful study of the teeth, their anatomical arrangement and the skull's osteological features. In addition to the parameters described above, odontologists may be able to provide information on the individual's habits, occupation, and likely place of residence, medical history and socio-economic status. The presentation illustrates these 'additional dental findings', explaining the various aspects of the dentition that may assist in a postmortem profile. It is important to note that additional dental findings are merely indicators. Few of them offer definitive proof. However, faced with an unidentified individual, any information that may help in the search for their identity is likely to be useful. The presentation concentrates on those features visible on the hard dental tissues only – it is unlikely that diagnosis of soft tissue conditions would be possible with the body types typically requiring postmortem profiles.

Using a MedLine search, the following areas were reviewed for possible dental indicators: a) occupational diseases of the teeth, b) medical conditions and drugs, c) habits, pastimes and lifestyles, and d) abnormalities of tooth form and structure. Over 100 articles were examined and an image database consulted in order to provide clinical examples. These will be presented to attendees along with details of incidence, prevalence and associated forensic significance.

With the increase in international travel, immigration and refugees there is a potential for a rise in the number of postmortem dental profiles which odontologists will be asked to perform. The assessment of the dental tissues for indicators likely to reduce the pool of possible antemortem records is of use in both individual and multiple fatalities. While recognized that none of these features will identify an individual alone, they represent an important part of the odontologist's armamentarium. The presentation will also be of value to odontologists, pathologists, and anthropologists.

Odontology, Postmortem Profiles, Identification

F23 Removable Prostheses – How Can We Label With Patient Acceptance?

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Following this presentation the attendee will be familiar with: a) the incidence and prevalence of individuals wearing full dentures in the U.S. and U.K., b) problems with current denture marking systems, c) previous research in this area, and d) possible new techniques for marking dentures with increased patient acceptance.

The decrease in caries experience and the commensurate increase in oral hygiene standards in the Western World have led many to believe that the provision of complete dentures was soon to become of historical interest only. However, the true picture is different; in the U.K. alone, 650,000 patients per year get their first dentures. Dental identifications are requested for found human remains where visual identification is no longer possible or desirable. Many elderly people (a large cohort of those persons wearing full dentures) die alone in their own homes and are not discovered for some time. In such cases, the Coroner will request the services of the forensic dentist to identify the individual based upon a tentative lead. In cases where dentures are not marked and no other method for identification is possible, i.e., fingerprints, serial number on pacemaker, other prostheses, etc., identification may prove very problematic.

A series of cases will be presented illustrating the difficulties of identification in non-marked, full denture wearers. Within the U.K. there is no legal obligation to have dentures marked, although a fee item does exist on the NHS payment scale. Patients are often unwilling to have their dentures marked due to: a) cost, b) aesthetics, and c) lack of understanding of the benefits. Within a general practice setting, denture wearers gave aesthetics as the most common reason for refusing to have their dentures marked. Common methods of denture marking will be illustrated.

Research was conducted to determine methods of uniquely marking dentures that would comply with the following prerequisites:

a) Were aesthetically pleasing to the patient, or un-detectable
b) Were cost effective
c) Were resilient to postmortem changes
d) Were resilient to denture cleansers
e) Did not effect the fit, comfort or strength of the denture

Several techniques were employed a) restoring one or two posterior teeth with composite resin in a unique cavity design visible radiographically, b) placement of an 'invisible marker' detectable only under certain lighting conditions, c) placement of gold leaf under denture teeth in a unique configuration, visible radiographically, and d) placement of paper roll under denture teeth visible radiographically.

Each of these techniques was tested on mandibular and maxillary full dentures and then subjected to a range of challenges including: a) cleansing overnight with proprietary denture cleansers, b) exposure to heat, c) exposure to saliva, and d) exposure to maxillary forces. Each of the methods worked well, and examples of each will be illustrated. The simplest and cheapest method was the use of a specially designed marker pen, currently used for marking property. The drawback to this solution is the requirement for a UV light source and that there is no means of indicating which dentures have been marked. The radiographic techniques suffered from the effect s of angulation, although all were uniquely marked. It was difficult to include name and date of birth; instead a reference number could be used, such as an individual's social security number. The restoration method was simple and highly aesthetic but would require an antemortem record to enable a comparison.

While full dentures continue to be a treatment option, it must be ensured that they carry a feature unique to that patient, which would

most usefully be their name and date of birth. Encouraging patients to have their dentures marked, and encouraging dentists to offer such a service economically, is an important role for odontologists.

Odontology, Identification, Dentures

F24 Do Insect Artifacts Affect the Quality of Forensic Dental Radiographs?

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The participant will learn about the potential for insect artifacts to affect the forensic quality of postmortem dental radiographs.

This abstract and slide presentation will give the details on the methods and conclusions of a study designed and performed to determine whether or not insects in the oral cavities of decomposing deceased individuals can be evident on dental radiographs taken during forensic dental evaluations. Such artifacts could interfere with the forensic quality of the dental radiographs.

In the hot and humid state of Texas, it is frequently necessary to perform forensic dental evaluations and comparisons of human remains in various stages of decomposition. Quite often, the oral cavities of these deceased individuals are filled with insects of various types. Prior to performing the intra oral examination or taking any radiographs, it has been routine to clear away any insects present.

This study was designed to determine if insect artifacts appear on postmortem dental radiographs, and if they do, then at what exposure levels they would be most evident. The decomposing human remains chosen for this study were those of an unidentified white male, approximately 17 to 32 years of age, found floating in a shallow creek by a passing motorist. The time of year was late spring, and the local temperature during the previous days had been in the high 80s Fahrenheit. The decedent was floating face down in approximately six inches of water. There was an apparent gunshot wound to the chest. The oral cavity was filled with a multitude of larvae, also known as maggots.

A single larva, representative of the majority of the maggots present in the oral cavity, was chosen for this study. The larva was very chilled from having been in the morgue cooler quite some time; therefore, it behaved very well and did not move during the taking of the radiographs. It measured 7/16 inch in length and 2/16 in width. The maggot appears to be one of the blow fly types, most likely a hairy maggot blowfly. They possess a high level of chitin in their tissues and have very distinctive protective spines that act as protective armor on their bodies. This species is of particular forensic importance in the southeastern, central, and southwestern portion of the U.S. as the adults are often among the first insects to arrive at a recently deceased person in these areas.

Single-film packets of dental radiographic film (KODAK brand, Ultra-speed D, safety film) were labeled with the exposure setting to be used for each film. A KVP of 70 was used for all exposures. The exposure settings to be used were the standard ones on the radiographic unit: 0.01, 0.02, 0.04, 0.05, 0.06, 0.08, 0.10, 0.12, 0.16, 0.20, 0.25, 0.32, 0.40, and 0.50. Each film was placed under the representative maggot and was exposed according to the label on the film pack. Each film was exposed at a precise distance of two inches from the radiographic cone head. The cone head was never moved; instead, the film and maggot were located on a movable cart to allow consistent distance from the radiographic cone head for each of the films taken.

After carefully viewing the series of radiographs, the maggot was quite visible in the 0.04 exposure to the 0.16 exposure range. In general, dental radiographs are taken in the 0.16 to the 0.25 exposure range, so it is possible that maggots, in sufficient numbers, could adversely affect the quality of the postmortem dental radiographs. Previous experiences have also demonstrated that maggots embedded in unhealed sockets of postmortemly avulsed or missing teeth have necessitated the remake of radiographs after their removal from the deeper portions of the sockets.

In conclusion, it is advisable for the forensic dentist to remove all maggots prior to taking the postmortem dental radiographs. During the slide presentation, photographs documenting the study will be presented and elaborated upon.

Forensic Sciences, Forensic Dentistry, Forensic Entomology

F25 Age of Majority vs. Third Molars

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The educational objective of this presentation is to reconstruct chronological age based on third molar development with an expected outcome of regression formulas for calculation of majority.

Materials and methods: Assembled from patient files of the School of Dentistry, Oral Pathology and Maxillo-Facial Surgery of the Katholieke Universiteit Leuven, Belgium were 2,515 orthopantomograms were. Selection criteria were: no medical history, no pathology present on the radiological image, at least one third molar present, Caucasian origin (Belgian Whites), orthopantomogram taken at an age between 16 and 22 years of age. A distinction was made between males (n = 1056) and females (n= 1459). Two observers attributed scores for each third molar present based on its dental development: Scores from 1 to 10 were used according to the ten developmental stages as reported by Gleiser and Hunt (1955).

Statistical analysis: The SAS statistical analysis software package was used (SAS Institute, Cary, NC, USA). Kappa statistics were used to determine inter- and intraobserver effects. Multiple regression analyses were performed and probabilities were calculated.

Results: No intra- or interobserver effects were found. Statistical analysis resulted in multiple regression formulas for both males and females with the dental developmental stage of the third molars as variables. It seems that the third molars may account for 45% and 42% respectively of the variation in chronological age for males and females (r^2). Standard deviations for males and females of 1.49 and 1.50 years respectively were found.

The Table below lists regression formulas for females and males with standard deviations and r^2 for calculation of chronological age in individuals with four third molars present. Different regression formulas were obtained depending on the number of third molars present.

Regression formulas	s.d.	R^2
Female: 13,0484 + 0,3056 UL + 0,4736 LR	1,51	0.42
Female: 13,0725 + 0,4773 LR + 0,3010 UR	1,50	0.42
Male: 11.5886 + 0.4493 UL + 0.4525 LL	1.49	0.45
Male: 11.5419 + 0.4426 UR + 0.4651 LR	1.49	0.45

With first letter (U=upper; L=lower) and second letter (R=right; L=left) coding for the developmental score of a particular third molar.

Conclusion: Bearing in mind the limitations of this chronological age predictor, it remains a practical and useful tool for dental age calculation.

Odontology, Third Molars, Majority

F26 Reliability of Dental Age Determination Using Demirjian's Technique on a South Texas Hispanic Population

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Refinement in age determination is proposed by extending the Demirjian's Technique to a South Texas Hispanic population. In this way, accuracy of this technique is tested and extended beyond the statistical Caucasian sample.

Age determination is important in various situations. Organizations such as law enforcement, immigration services, and school districts routinely request verification of age for proper placement. Alternative methods must be explored when an authentic birth certificate is unavailable. The methodology for determining accurate age has evolved over the years from gross estimates such as fontanel and long bone epiphyseal plate closure, to the more accurate third molar schematic method described by Demirjian and Mincer. It is generally accepted among the forensic literature that for sub adults, dental age estimation is a more reliable estimate of chronological age than bone age evaluation. Age determination is routinely used by the INS to determine correct placement of detainees. Professionals who assist in this process are protecting the rights of both juveniles and adults.

Six hundred panoramic radiographs were selected from Cameron County, TX. The panoramic films were obtained from the Brownsville Community Health Center and several local dentists in Cameron County who provide care to patients in the lower socioeconomic strata. Brownsville, TX, is comprised of a 91.2% Hispanic population with the majority being of Mexican American decent. Brownsville Community Health Center is located about one mile from the Texas-Mexico Border and surrounded by "colonias." Many poor Hispanics, particularly new arrivals from Mexico and Central America live in the county's numerous colonias, or shantytowns, a sizable number of them without electricity or running water. Cameron County is 84.3% Hispanic of which 66.8% are classified as Mexican American. The actual percentage may be higher than this census figure, since the census does not record migrant farm workers, undocumented workers, and refugees. Poverty status is 36.5% in families with children under 18 years of age. The individual poverty rate for children under 18 years of age is 43.1%. Cameron County is one of the poorest counties in the U.S.

The subjects ranged in age from 14-22 years old. The age of each subject was verified using either NHIC – Medicaid documentation and/or by parental verification. The ethnicity was verified by documentation, surname and/or parental verification. The community has strong ties to Mexico with frequent crossover to shop, receive medical care and visit relatives. This population is similar to INS detainee from Latin America in appearance and socioeconomic make-up.

The panoramic images were scanned using a HP Scan jet 7400c at 200-600 dpi. The scanned images utilized an 8 bit grayscale that included 256 shades of gray. The computer was a Dell Inspiron 2650 Intel Pentium 4. The image were scanned into Adobe Photoshop 7.0 and the contrast and histogram where adjusted to create correct balance. All panoramic radiographs were oriented correctly and labeled (R) to reduce operator error. The images were saved in a Tiff format and saved to a CD-R for independent viewing by six examiners. Initially each examiner viewed one hundred images. The data was entered into the UT-AGE Program, which utilizes the data from 1993, H. Mincer study. The researcher then tabulated inter-examiner reliability and intra-examiner reliability by providing each examiner with one hundred additional panoramic radiographs. The second set of one hundred panoramic radiographs was comprised of eighty images previously scored by the other five examiners and twenty previously scored images by the same examiner. Each examiner reviewed a total of two hundred images.

To test accuracy, the researcher then compared the known age of the subject to the average mean age of the individual stages of tooth development. To further answer the medico legal question of likelihood of classification either as a juvenile or adult, the mean age and the standard deviation at each stage of Demirjian schematic were used to calculate the empirical likelihood of having reached his/her 18th birthday.

Although still only accurate by +/- 4.8 years when using 2 standard deviations, the technique has shown validity when cross population samples are rendered. In this study, the statistical data of the patient sample was compared to the research conducted by H. Mincer and A. Solari. The results demonstrate a close correlation; however, there are significant differences described in the current research.

Cross validation is established when the research tool that applies in one population also is valid in another population. Standardization of age determination among various cultures improves reliability and accuracy that increases validity of this method of age determination. In the present research, statistical data of a known population correlated with the determination of an unknown population. In 2000, G. Willems, DDS, PhD, created new scores to more accurately estimate dental age of a Belgian Caucasian sample. In 2001, Solari, DDS, MPH, used 679 panoramic radiographs to evaluate age determination accuracy in a Hispanic population in Houston, TX. The present study further expands the sample size to include low-income Hispanic populations. Ultimately, a sample size for each region and/or each ethnic group will create a more reliable method to determine the estimated age of a subject whose age is in question. Additional studies are needed for Caucasoid sub-groups, Negroid sub-groups, and for other Mongoloid sub-groups

Forensic Science, Third Molars, Hispanic Population

F27 Questioning the Odontologist's Role in Age Determination for the U.S. Immigration and Naturalization Services

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A justification is presented to support the recommendation for all odontologists to cease assisting the INS with age determination of their undocumented, unaccompanied alien immigrants claiming to be under the age of 18.

The U.S. Immigration and Nationalization Service (INS) has been relying heavily on dentists to separate the "men from the boys" from the thousands of undocumented, unaccompanied alien immigrants crossing boarders every year. Because U.S. laws demand preferential treatment of immigrants under the age of 18, many illegal alien adults attempt to pass themselves off as children.

The most common practice used to differentiate the minors from the adults, the radiographic evaluation by a dentist of the person's third molar development, is inadequate. The research of Mincer, Harris and Berryman is cited as the reference from their article, "Molar Development as an Estimator of Chronologic Age", *Journal of Forensic Sciences*, March 1993. The schematic drawings, definitions and charts included in this article are the source from which an estimated age range is calculated. Quoted from this article: "As reported in other studies, stage of the third molar development was shown to be an inaccurate predictor of chronologic age. Standard deviations (std. dev.) for each of the grades ranged from 1.55 to 3.37 and averaged about two years. This means that age predictability within each stage includes an interval of about eight years: Plus-and-minus one standard deviation (i.e., 4 years) encompasses about 68% of the distribution and +2 standard deviation –that is, about 8 years – incorporates 95% of the sample." As in the above study, additional researchers have noted variation in different

ancestral populations. A high percentage of the recent immigrants, along the east and west coast, have been Chinese, population not often included in these research designs. So, it is not surprising is see numerous documented cases where minors have been incorrectly designated as 18 years of age or older by a dentist using this technique and unjustly exposing minors to the harsher adult environments immigrants' experience. Many of these cases have been appealed and are rallying points for Immigration Advocacy Groups.

A more accurate technique of age determination of late teenagers is readily available. Skeletal age should be used, reflected in the almost fully developed hand and wrist bones. Using the "FELS Method," the hand radiograph can be compared by a qualified radiologist to atlas standards consisting of photos of radiographs and schematic drawings of the different bone stages of the bones in the hand and wrist. This procedure reduces the range of an estimated age to 9-11 months, an acceptable degree of variance.

It is therefore recommended that dentists cease in their efforts of age determination for the INS and defer to a qualified radiologist in their area. The INS is presently reevaluating the procedures used in age determination to develop an accurate and acceptable national standard.

INS, Age Determination, Dental Analysis

F28 Standardized Age Estimation Case Report of a Living Person

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The educational goal of this presentation is to present and discuss a standardized method proposed in Switzerland that documents the findings of the final report of an age estimation that is to be presented in a legal context.

Dental structures may represent a valuable source of age information. Teeth develop, erupt, and may be present throughout the life of an individual.

The estimation of age of living persons may become of importance when: 1) suspicious or non-existent identification papers are presented or found (illegal presence in a foreign country, etc.); 2) the age is not known (refugees, adopted children, loss of memory); 3) the date of birth has supposedly been incorrectly registered; 4) identification papers are illegible.

It should be emphasized that when the identity is unknown, age estimation may be helpful in the reconstruction of the identity.

Children as well as adults may be involved. Methods of estimation are more precise in children than adults where any method may lead to unreliable results. The timing and sequence of teeth development, as contained in development charts, have been used as valid criteria for age estimation. Dental development remains the most accurate index for age estimation from before birth until the early teens, after which accuracy declines sharply. In the case of a living person, the radiographic method is the method of choice, but visual assessment of the whole dentition should also be considered and commented.

According to several studies, although third molars are the most variable teeth in the dentition, they remain so far the most reliable biologic indicator available during the middle teens and early twenties as an estimator of chronological age. In Switzerland as in many other countries, an 18-year-old individual becomes an adult. Legal implications change markedly. If reliable age documentation is lacking, the radiographic evaluation of the maturation of third molar roots can be used in several cases to assess whether an individual is a juvenile or an adult.

Except for Kvaal et al. (1995) who estimated the chronological age of an adult from measurements of the size of the pulp on full mouth dental radiographs using six types of teeth from each jaw, most recently published studies are referring to criteria described by Demirjian, et al. (1973). These authors proposed schematic drawings and definitions of the eight stages of crown and root maturation used to score third molar development. These data are widely used and form a basis on which universal dental maturity score can be calculated. This score is then translated into a chronological age with aids of tables specific for a certain amount of populations.

The Swiss methodology of age estimation of a living person used in the different forensic institutes usually refer to data published by Mincer et al. (1993), Willerhausen et al. (2001) and others which all basically refer to the criteria described by Demirjian et al. (1973). The outcomes can be somewhat jeopardized by the various ethnicities of the analyzed cases. Most of them are associated with illegal residents dealing with criminal activity.

A final case report to be presented to a judge or a court shows the following findings and results:

- date of examination, presumed identity, presumed or declared age
- name(s) and function(s) of the examiner(s)
- clinical examination (oral cavity, dental and periodontal findings)
- radiographic examination of the third molars (panoramic and apical X-Rays)
- analysis of the findings
- indication of treatment if any
- conclusion
- sources and bibliography

The final report also contains the following iconography of the case:

- full face and profile
- intraoral views
- study models
- all radiographic views
- particular details of interest if any

The progression of the analysis, the judge or court expectations, and the conclusive criteria will be discussed.

Age Estimation, Forensic Odontology, Forensic Sciences

F29 Repositories of Missing Persons and Dead Bodies in Different Countries — A Comparison

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The educational objective of this presentation is to present a survey on the inclusion of dental records in the repositories of missing persons and dead bodies, and the involvement of forensic dentists in the keeping and searching of these repositories. The attendee will also learn of the usefulness of the repositories in the identification procedures in different countries.

Thousands of people disappear in any given country each year. Fortunately, most of them are found or return within a short period of time. However, a percentage of those who disappear do not return and nothing is known of what has befallen them, causing emotional and legal problems to their families. A certain number of human remains found are not identified and these bodies are buried as unknown persons. This "Silent Disaster" never reaches front pages of the papers, nor is it broadcasted on national networks. Nevertheless, the missing and the unidentified dead often exceed the number of people who perish in real disasters each year. Repositories of missing persons and unknown bodies exist in most countries but the usefulness of these repositories

differs from country to country, depending on how they are kept, updated, who is in charge of them and who can use them.
This study seeks to compare the standard and efficacy of the repositories of missing persons and dead bodies between several countries.

A questionnaire was sent out to forensic odontologists and forensic odontology contacts in 119 countries by e-mail or snail-mail. Their addresses were found on the Internet, in the *Journal of Forensic Odonto-Stomatology* or on the lists of international contacts in the field of forensic odontology. More than one person was contacted in some countries. The specific items investigated were: Who kept the repositories? Was dental information (dental records) included in the files of missing persons and dead bodies? Was a forensic dentist involved in the keeping and searching of the repositories? How useful was the repository? (The number of unknown bodies identified per year versus the number of bodies buried unidentified per year?)

Out of the 119 countries contacted 66 responded. Among the responders were almost all countries of the Western Europe, some of the countries of Eastern Europe, a few from Asia, Africa and South America, and then the U.S. and Canada from North America. Australia and New Zealand responded as well. The results showed that the police and/or the forensic centers kept the repositories. Dental records were included in the files in 32 countries and not included in 14 countries. Among the remaining 20 countries the responses varied between "usually" and "seldom." In 25 countries the forensic dentist was involved in keeping and searching the repositories whereas he/she was not involved in 28 countries, and in 13 countries the involvement of the forensic dentist varied considerably. The statistics on identification of recovered remains varied between "less than 1% or seldom" and "100% identified or no identification rare." Also, responders from 19 countries were unable to provide the number of positive identifications versus the number of remains buried as unknown since they had no access to that information.

There were significantly fewer unknown bodies buried each year in those countries where the dental records were included in the files of repositories of missing persons and dead bodies and a forensic odontologist was involved in the keeping and making searches of these files, as compared to the countries were the forensic odontologist was not involved. This was due to the fact that the recovered remains could be identified swiftly and with greater ease by a forensic dentist with the help of dental records in the missing persons files.

It was concluded that the inclusion of dental records and the involvement of a forensic dentist in the keeping of repositories of missing persons and dead bodies greatly increased the number of positive identifications of unknown bodies and should be standard in all countries.

Missing Persons Repository, Forensic Odontology, Identification

F30 What's a Nice Doctor Like You Doing in a Place Like This? (Crime Scene Protocols for Forensic Odontologists)

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The goals of this presentation are to familiarize forensic odontologists with crime scene protocols and techniques that will ultimately aid in their contribution to being a part of the forensic team.

While many Forensic Odontologists are very clear about their specific duties once human remains are presented in the morgue, less attention has been attributed to the role of the Forensic Odontologist at the crime scene. The crime scene can be a wealth of information (and potentially lost evidence) for the savvy Forensic Odontologist; however, certain protocols must be adhered to when visiting any crime scene.

Upon the arrival of any law enforcement entity, the primary objective is to freeze the crime scene in place and time once exigent matters such as arrests of subjects and caring for injured parties are accomplished. This is accomplished through established security protocols such as posting guards, crime scene tape, establishing entry and exit corridors, and sign in/sign out logs. The Forensic Odontologist should be familiar with this protocol and have business cards and other forms of identification ready for checkpoints and log entries. The entry and exit corridors should be strictly adhered to, as well as limiting any movement within the crime scene other than what is absolutely necessary in order to perform one's duties.

Once the crime scene is secured, the lead investigator briefs the lead crime scene investigator as to the nature of the crime and any immediate evidentiary requirements. The lead crime scene investigator then performs a "walk-through" of the scene. Upon completion of the "walk-through," the crime scene team is briefed as to the condition of the crime scene, safety aspects, and evidence recovery requirements.

The lead crime scene investigator will record the time and date of crime scene acquisition, note the security level containing the scene, record the weather conditions, lighting, personnel and their duties, and prepare a narrative description of the crime scene and its eventual processing. The lead crime scene investigator is responsible for calling upon forensic specialists to assist in any crime scene processing specific to their specialty. The Forensic Odontologist should report to and work under the guidance of the lead crime scene investigator while inside the perimeter of the crime scene.

The initial processing of any crime scene is accomplished through photography, videography, and crime scene sketching. Nothing is to be moved until the scene is captured "as-is" via the aforementioned modalities. Overall (or long range) photographs are taken first, followed by intermediate distance photographs and finally close up photographs of any item of evidentiary value. Sometimes onlookers and surrounding vehicles are also photographed. A log is maintained for every photograph taken. This log records the photograph number, subject matter, the type of camera, lens utilized, lighting, film speed and type, and the use of scale.

The Forensic Odontologist can request the crime scene photographer to assist in the photographic processing of odontological specific items such as jaws, teeth, and/or bite marks "*in situ*". The advantage of utilizing the crime scene photographer is that the integrity of the photographic logs is maintained. In the event that a crime scene photographer is unavailable, it would behoove the Forensic Odontologist to utilize photographic logs and procedures that are complimentary to the law enforcement entity responsible for investigating the crime.

Evidence collection follows initial crime scene photography. At least two persons should see the evidence in place and observe its recovery. It should be noted that evidence collection and crime scene photography are not mutually exclusive. Many times, as items of evidence are examined prior to collection, additional physical evidence is noted which might be fragile or transient in nature. This type of evidence is immediately photographed and collected. Examples of this type of evidence would be hairs and fibers at an outdoor crime scene.

In addition to the immediate collection of transient evidence, all items determined to be of evidentiary value are numbered and photographed in place (with a corresponding number placard). As each item of evidence is recovered, its description, location, time and date of recovery, recovering official, and case number are recorded on an evidence recovery log and on the appropriate packaging for that item. The evidence recovery log also records the photograph number (from the photographic log), the packaging method, the type of evidence marking (direct or indirect), and any miscellaneous comments relative to the collection of that item of evidence. As a cross-reference, the photographic log would record the evidence item number and description of same, along with the approximate time of the photograph. The sketch would be continually updated as each item of evidence is recovered.

The Forensic Odontologist should attempt to utilize crime scene personnel for the collection of odontological evidence by direction. Again, this method is preferable in that the crime scene documentation would be consistent with the odontological documentation and chain of custody issues would reside within the investigating law enforcement entity. If the odontologist personally collects evidence, appropriate entries should be made in an evidence recovery log, photographic log, and on a sketch. It is not recommended that the Forensic Odontologist directly remove any evidence from the crime scene for examination. All evidence should be entered into the investigating agency's evidence recovery system prior to being examined at a remote location.

The odontologist should bear in mind that human remains are items of evidence. To that end, such items should not be collected prior to being photographed in place, added to any crime scene sketch, and entries completed in the appropriate logs. Because human remains are of evidentiary value, forensic dental computer programs such as "Win ID" which record the results of the odontologist's examination of human remains, should be shared with the investigative agency as work product, but may be subject to discovery in a court of law.

Once all evidence collection is complete, the lead crime scene investigator will conduct a final survey of the crime scene. In cases of crime scenes processed after dark, the decision may be made to secure the scene until daylight for additional processing. The Forensic Odontologist should be aware of the fact that, in many cases, once the lead crime scene investigator releases the crime scene, there are no additional opportunities to revisit the scene. Examples of these scenarios would be transient outdoor scenes on busy streets, crime scenes processed as a result of a consent search, and crime scenes processed as a result of a search warrant. Should the lead crime scene investigator conclude that no further processing of the crime scene is warranted, exit photographs and log entries will then be taken. The scene will then be released to a responsible party with narrative entries as to that party's name, identifying information, date and time of release, and the name of the releasing investigator.

Walkthrough, Transient Evidence, Chain of Custody

F31 Abuse and Neglect of Vulnerable Persons: A Community Approach to Recognition & Reporting

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The goals of this presentation are to present to the forensic community an aid to help health care professionals recognize signs of abuse/neglect on vulnerable persons (children, spouse/partner, and older persons) and on how to report their suspicions to the proper local authorities in their jurisdictions.

This presentation will provide a mechanism whereby a local professional or health care organization can educate health care professionals in their community on how to recognize signs of abuse/neglect and then on how to properly report their suspicions. It can be done on a low budget and cover the entire community, with total cooperation of local law enforcement, professional associations, and prevention organizations. A handout of a flyer used in the City of Hamilton, Ontario, Canada will be available to attendees as a reference for their own community.

In a "K-I-S-S" (Keep It Simple Stupid) format, any health care professional will be able to follow: 1) What to do in their initial consultation with the victim(s) from properly acknowledging the abuse to referring victims for ongoing care; 2) What to check for, as this pertains specifically to: a) physical abuse, b) psychological abuse, c) financial abuse or exploitation, d) neglect (active, passive, and self), e) institutional abuse, f) domestic/family violence, along with indicators of each; 3) Attendees will have a quick reference on how to OR not to interview suspected victims on an ongoing or specific basis with samples of at least eight possible interviewing questions to be used; 4) Possible intervention and considerations of the impact on the person (victim), their wishes, their willingness to change and even their ability to recognize that they are being abused are highlighted, along with having them understand the consequences of their decisions. The health care professional's role as a singular responder, or part of a team of service providers to keep the victim safe and healthy is considered; 5) A main key to this flyer is having health care professionals becoming educated and aware of appropriate resources and services within their communities, and on how to link with them in their broader local community is stressed. The flyer is a mechanism or tool to educate both the health care professional as well as the victim of abuse/neglect by providing information and support groups locally that can respond efficiently and appropriately to the needs of those being victimized or who is at risk of abuse; 6) A Safety Plan is described that recommends considering a change to an element of the victim's environment or their relationship which could result in the elimination of the role of the abuser or context of the abuse, along with specific considerations. In cases of child abuse, the health care professional will of course, still be governed by local state or provincial laws that designate them as 'mandated reporters'. For adult victims, the safety plan goes from the simple home visit by informed friends to considering an escape plan well in advance of the actual incident of abuse; 7) The main and key highlight is how to use the flyer by coordinating and consulting with your own local community's other local service and support groups outside of the health care system and by having their respective names and contact telephone numbers easily available for quick and immediate reference. Most communities have such list available on local city and/or governmental websites. Attendees will be given hints on how to package the flyer in a easily protected and maintained format; how to distribute it to all health care professionals, hospitals, EMS personnel, schools, day care facilities, etc.; how to get appropriate funding for even minimal expenses – all will be covered for those personnel in a position to recognize signs of abuse/neglect on their patients/clients.

Abuse & Neglect, Recognition & Reporting, Community Education

F32 Wound Contraction and Older Bite Mark Injuries: Aspects of Interest to Odontologists

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Following this presentation attendees will understand: (a) the process of wound healing, (b) the mechanisms of wound contracture, and (c) the effects of wound contraction on bite mark appearance.

Bite marks are found in some of the most serious crimes investigated within the criminal justice system. Odontologists are often faced with a bite mark, that, for one reason or another, presents several days, weeks or even months after the original injury. There are many reasons for late presentation, sometimes by the victim themselves or often due to the failure of investigators to note the importance of the injury to the subsequent conviction of the suspect. Such late presenting bite marks are most likely found on living victims and are often fibrous in nature as a result of scar tissue formation. It is the purpose of this presentation to describe some of the complications that such bites can present.

In the northeast of England a complaint was made against an individual for assault. The victim of the assault claimed that he had been

bitten on the lip by the accused and assaulted with a screwdriver. Some three months after the assault the odontologist was called to examine the injury. Photographs taken at the time of the assault were unsuitable for forensic use because: a) they had no adequate scale, b) they had been taken by the victim's family and were of poor quality, or c) they were taken post-treatment when a large degree of swelling was present due to the administration of local anaesthetic. The bite was located at the junction of the vermillion border of the lower lip. When the odontologist assessed the bite a number of new photographs, including UV shots, were taken. Due to the severe contraction which had occurred the odontologist determined that it would not be possible to compare the bite with a suspect's dentition, but it was possible to determine that: a) the victim could not have been responsible for the bite pattern seem, and b) that another individual's teeth could have caused the injury. When presented in Court, much was made of the discrepancy between the intercanine distances of the suspect and the alleged bite. The case details will be discussed.

It is important for odontologists to be aware of the nature of wound contracture and that bite marks will change dimension in response to both time and any medical treatment that has been provided. The stages of the healing process, including macro and micro changes will be described, with an emphasis of the effect of anatomical location on the dynamic process of wound healing. The nature of scarring and fibrous reaction will be illustrated and the reactions seen in different racial groups explained. The impact of these changes upon the forensic significance of bite injuries will be discussed. The fact that contracture of over 50% in a matter of days following some medical interventions should be of particular interest to those involved in the assessment of such injuries. The importance of seeking advice from wound healing specialists in individual cases is emphasized.

Bite mark injuries continue to represent important physical evidence. Such injuries must be carefully assessed for their forensic significance before analysis begins. In many cases, it is of value merely to determine that human teeth caused a given injury; and those bite marks that present late will often fall into this category. A thorough understanding of wound healing and the effect that this may have on the dimensions of bite injuries is essential for any operational odontologist.

Odontology, Bite Mark, Wound Healing

F33 An In-Vivo Porcine Model of Contusive Bite Mark Injuries in Human Bite Mark Analysis

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Attendees at this presentation will be able to assess the utility of a live porcine model for simulated bite mark injuries. They will learn about the different appearances of bite marks in dependent and non-dependent skin surfaces and will be informed of the differences in bite mark appearances made both prior to and, after death of the subject animal.

The ageing of bite mark wounds in relation to time of death is an important aspect of forensic odontology and one in which the opinion of dentists as expert witnesses has important legal consequences. There is a lack of objective information available on whether bite mark wounds can be accurately aged in relation to time of death and there is no sound data which measures the age of bite markings which definitively distinguishes between those made antemortem (AM) and those made postmortem (PM).

This presentation will discuss a technique used to study the age of bite mark wounds inflicted at known time intervals, before and after death.

The purposes of this study were: (1) to construct an instrument, which would permit the infliction of human bite marks on skin using a controlled and quantifiable force, and (2) to study the age of antemortem and postmortem bite mark wounds by means of conventional bite mark comparison techniques, metric analysis, specimen transillumination and histological studies.

An experimental model was utilized for the making of human bite marks. The skin of domestic animals has been investigated extensively in order to find a suitable analogue to human skin. The domestic pig is the most representative animal model for all types of dermatological and wound investigations. Pigskin has important similarities in morphology, cellular composition, and immunoreactivity to human skin that is not present in other species. The pig has been utilized in a number of studies, which have confirmed it to be the most appropriate model.

A series of simulated bites were created on a juvenile female domestic pig using a device designed to mechanically produce bite marks. This device called the bite-o-matic was monitored using a pressure-sensitive load cell for a pressure consistency of 50lbs at a pre-selected tooth. With the animal under general anaesthesia, four bite mark wounds were made on each side of the pig's flank for a total of 8 bite marks. Each bite was impressed into the tissue using the calibrated bite-o-matic and the upper and lower arches of the device were held closed for 60 seconds. Paired bite marks were made on each side of the pig 1 hour AM, 5 minutes AM, 5 minutes PM and 1 hour PM. Observations and conventional photography of the bite markings were undertaken. The pig was then transported from the animal care facility to the Coroner's Office where it was stored under normal mortuary conditions overnight. The animal was placed on one side to allow blood pooling so that there would be paired bite marks (on the dependent side and on the non-dependent side). At necropsy, to preserve the original anatomical configuration of the skin, a supporting plastic matrix was fixed to the pig's skin using cyanoacrylate and silk sutures. Each ring had a reference number and anatomical reference points for identification and orientation. The excised specimens fixed to the matrices were studied in their fresh state and following 35 days in formalin. At all stages, scale photographs were exposed for later examination.

On the day injuries were inflicted, the markings were clearly evident and viewable as distinctive oval patterns. Maxillary arch width and arch length were assessable in every specimen. As time progressed, the bite markings faded making even simple metric analysis difficult to impossible. The most stable and representative bite mark injuries were ones inflicted 5 minutes AM.

Subcutaneous hemorrhage was observed only on the antemortem bite marks on the non-dependent side.

No additional information was provided when the specimens were transilluminated using a rigorous, standardized transillumination methodology.

Histologically, two separate examiners examined the specimens independently. One of them was blinded to the identity of the bites. The slides stained with H&E showed a slight depression in the tissue corresponding to the tooth imprint. There was also compression of the epidermis and some tearing of the epidermis/dermis junction. There was no evidence of extravasated red blood cells nor leukocytic infiltration in any of the microscopic sections of the AM and PM bite mark specimens examined on light microscopy.

The external physical appearance of bite marks varies with time. Just how the pattern varies and how it is related to changes in the dermal tissue remain largely unknown. Numerous variables can influence the quality of a bite mark. No form of artificial simulation can precisely replicate the mechanics or response of tissue to a bite. However, the use of simulated bite marks enabled greater control over the injury. Variables such as anatomical location, the teeth used to create the bite, bite pressure, and collection of the evidence were easily controlled and standardized. Simulated bite marks also permitted a consistent quality of materials to be produced, allowing parity between each of the bite.

This pilot study did not provide any evidence on whether it is possible to determine that a bite mark was made before or after death but has provided evidence on the window of time showing clearly demarcated bite marks around the time of death. This information will serve for an ongoing study in a larger number of animals currently being undertaken.

Bite Mark, Porcine, In Vivo

F34 Dental Reconstruction of Mutilated Remains to Facilitate Analysis in a Case of Defensive Bite Mark Injury With Two Possible Biters

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The author will present a case study in which a deceased person bit their murderer. Attendees will be shown a novel technique for preparing damaged postmortem remains so that they can be used for bite mark comparisons. Additionally the bite mark could have been made by either the deceased or another person named by the accused as the biter indicating that in certain circumstances bite marks may not be unique. Finally Quicktime® movies were used to demonstrate the technique to the Crown attorney and the defense lawyers.

Bite mark evidence has been accepted in courts of law; however, most bite marks are made by an assailant on the body of the victim. The present case illustrates a case where a bite marking was made on the arm of a murderer by the deceased in an act of self-defense. Following the murder the victim's body was dissembled and attempts were made to burn it. Following autopsy the body was prepared by forensic anthropology staff for examination of the bones for cut mark injuries. During the de-fleshing of the body many of the teeth were separated from their sockets. This was done in the absence of knowledge of a suspected bite mark. After the body had been de-fleshed the authors were advised that the deceased might have bit one of two suspects accused of killing him.

The authors retrieved the teeth and then replaced them within their dental sockets. The teeth were air dried, and cemented *in situ* with cyanoacrylate cement. To verify the proper placement and position a complete set of periapical radiographs was exposed and the relative sizes of the periodontal ligaments around the entire root apex was assessed for uniformity. The reconstructed dentition was then used for bite mark comparison. The bite mark expert in the present case requested that the police force involved not provide him with copies of the bite mark photographs until such a time as the reconstruction of the dentition of the deceased had been completed.

Following completion of the reconstruction of the deceased biter's dentition, photographs of a bite mark on the arm of the accused were provided to the examiner who compared them with the bite. As a-consequence of this examination the examiner concluded that the bite mark on the arm of the accused could have been produced by the dentiton of the deceased. In the interim, the accused named a former girlfriend as the maker of the bite mark injury. Whilst this lady denied having produced this bite mark, an evaluation of her dentition to the wound on the accused was undertaken. The bite mark expert concluded that the bite mark could also have been made by the girl friend as the accused had stated. The expert consulted a second expert in bite marks who reached similar conclusions.

In order to facilitate the explanation of these findings to the Crown attorney and defense experts Quicktime macro movies were made from Photoshop overlay images where the dentition of each possible biter was floated over the image of the bite mark at different opacities resulting in a fade-in fade-out of the bite marks.

The authors conclude that in cases where there are a limited number of teeth making the bite mark it is possible to have more than one biter matching the bite mark and that the concept of uniqueness of each bite mark is questionable. The authors further conclude that dental reconstruction may facilitate the comparison of the dentition of the deceased to bite marks left of the body of the accused.

Bite Marks, Dental Reconstruction, Uniqueness

F35 Topographic Mapping to Improve Objectivity in Bite Mark Analysis for Adobe® Photoshop® Hollow Volume Construction

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The educational goals of this presentation are to present a method using sequenced topographic maps of teeth for improving objectivity in computer-generated, hollow volume bite mark overlay construction, while also increasing evidence collection of biting edges superior or inferior to the plane of occlusion.

As interpretive bite mark analysis continues to advance, two aspects of the process can be improved: 1) Objective differentiation of the biting edges for hollow volume construction, and 2) Construction of pseudo 3-D images for locating incisal edges relative to the plane of occlusion.

Users of Adobe® Photoshop® have recognized a need for interpretation when selecting biting edges that are responsible for a bite mark. Johansen and Bowers also noted this need for judgment in their text, *Digital Analysis of Bite Mark Evidence*: "Selecting the biting edges is the most subjective step in this entire process." Biting edges present a range of gray scale that requires operator judgment when using the Photoshop® Magic Wand tool. Enhanced contrast at these edges would reduce the subjective judgment, and increase objective differentiation for the hollow volumes. Last year, Dr. J. Curtis Daily addressed this matter with a topographic mapping technique to enhance biting edge contrast by using paired colors of dental stone for the suspects' casts and a surrounding stone matrix.

Regarding the second aspect, bite mark analysis frequently examines only two-dimensional relationships, alignment and rotation, of teeth when comparing suspects' teeth to a two-dimensional photograph. In their 1973 text, Luntz and Luntz recognized the importance of considering the position of each biting edge relative to the plane of occlusion, as well as their lateral position in the arch. While position and rotation are important for the two-dimensional location of the biting edges, the superior-inferior (S-I) location should also be evaluated to analyze more fully, the various injury intensities within the bite mark. This S-I evidence is not complex to gather and display. It can be documented and illustrated with transparent topographic overlays, as hollow volume constructions for most bite mark cases. Because a bite mark is the result of a three dimensional sequence of events, it is reasonable to analyze the evidence in all three dimensions.

The technique presented here offers an easy solution to the problem of biting edge selection, and simultaneously permits the collection of evidence relating to the three dimensional sequence of individual tooth marks within the bite mark. Sets of each suspects' casts are fabricated using the Bowers & Johansen technique, followed by the incremental S-I reduction of incisal/biting edges. Prior to scanning each reduction into Adobe® Photoshop®, the biting edges are circumferentially marked to enhance contrast on the white dental stone. This is objectively completed with a graphite pencil placed 45 degrees to the reduced plane. Each subsequent reduction, with its circumferential contrast mark, is scanned and printed as a transparent overlay, using the foregoing procedures. The successive, S-I occlusal plane overlays, or maps, are stacked

to illustrate a pseudo 3-D image of biting edges that contact the victim early in the biting stroke, versus those teeth contacting later. This third dimensional evidence cannot be collected or examined with a single overlay. Marking the biting edges with a pencil prior to scanning increases the gray scale contrast, which facilitates use of the Magic Wand tool for hollow volume construction. The technique is repeatable and reduces operator subjectivity that would influence the selection of biting edges and the resulting hollow volume overlay.

In summary, this technique increases accurate and objective bite mark evidence collection using established and familiar, computer-generated hollow volume protocol. Also, it captures S-I, third dimensional evidence to analyze more completely, the contact sequence of individual teeth and bite mark intensity, during the biting stroke. Users are encouraged to add this technique to their resources and continue testing the application.

Bite Mark Overlays, Topographic Tooth Mapping, Psuedo 3-D Computer Overlays

F36 Objective Bite Mark Analysis Using an Electronic Occlusal Diagnostic System: Part II

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The goal of this presentation is to present initial research into the use of the T-Scan® Occlusal Diagnostic System to objectively identify the person or persons responsible for inflicting bite marks on their victim while minimizing potential subjective error in the process.

This presentation is a follow-up of last year's introduction of the technology and hypothesis as to its clinical significance in bite mark analysis.

In vitro studies used a model of a human arm and study models of dentitions mounted on a device to mimic the human jaw. The T-Scan® sensor was applied to the curved surface of the arm to register the forces that occurred over time. Two-dimensional and three-dimensional computer generated charts and graphs registered the patterns of forces. Articulating paper was used to register the areas of contact on the model arm. Comparison of the computer generated bite force charts and graphs with photographs of the areas of ink registration on the model arm where compared for clinical significance.

Initial in vivo studies utilized self-inflicted light pressure bite marks on the volunteers fore arms. Using the same techniques as the in vitro study, the computer generated charts and graphs were compared to both articulator paper registration on the skin and actual photographs of the resulting bruising for clinical significance.

The next step in the study involves the use of the technology on live laboratory animals and application of the technique in actual ongoing criminal cases.

Bite Mark, Identification, Computer Analysis

F37 A Mathematical Approach To Bite Mark Analysis Using Bite2000 Software©

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The educational goals of this presentation are to present to the forensic community a method in which objective, mathematical bite mark analysis can be performed with the aid of a computer program.

The process of bite mark identification and evaluation is complex at best and requires considerable expertise by the forensic odontologist. The use of bite mark evaluation has increased dramatically since the introduction of bite mark evidence into the justice system. In 1952, *Doyle v. Texas* was the first known case in the U.S. to reach the appellate level.

In 1993, the court case *Daubert v. Merrell Dow Pharmaceuticals* explained specific factors and standards to assist the trier of fact. At present the standards require that: 1) the expert's technique or theory can be or has been tested—that is, whether the expert's theory can be challenged in some objective sense, or whether it is instead simply a subjective approach that cannot reasonably be assessed for reliability, 2) the technique or theory has been subjected to peer review and publication, 3) there is a known or potential rate of error of the technique or theory when applied, 4) standards and controls were used and maintained, and 5) the technique or theory has been generally accepted in the scientific community.

In 1994, the court case *State of Minnesota v. Stephen Andrew Hodgson* was significant in that it was the first appeal case to consider bite mark evidence resulting from the *Daubert* ruling. The findings in this case supported that bite mark evidence presented by an accepted expert was admitted correctly. The court was satisfied that bite mark analysis was neither novel nor an emerging science. Since that time, no bite mark evidence has been refused admission due to arguments regarding *Frye* or *Daubert*.

At present, bite mark analysis has no mathematical foundation. Bite mark analysis has relied on a number of empirical methods of relating the suspected biter's teeth to a photograph of the bite mark. Models of teeth have been directly placed on the photograph. Recently computer generated overlays have allowed visualization of the suspected dentition on the photograph of the bite mark. Other methods have been developed to remove documentation-method induced distortion from the bite mark. All these methods are investigator specific, are highly influenced by investigator technique and equipment, and are subjective in their rating of the linkage between a bite mark and a specific dentition. There exists a need for a mathematical basis for bite mark analysis.

A study has been undertaken to attempt to relate a series of digital images of dentitions to their mathematical descriptions. A method of assigning a mathematical representation of a dentition has been published in the *Journal of Forensic Sciences* by James McGivney, DMD and Robert Barsley, DDS, JD. (*A Method For Mathematically Documenting Bite Marks*. McGivney, J.,Barsley,R.,44(1):185-186)

In this study, dental models of 20 individuals were obtained. Many of their models were pre-operative orthodontic models and displayed various unique dental features. The models were digitally scanned to produce 20 upper digital images and 20 lower digital images. Bite2000 Software© was used to produce a mathematical description of each image. A protocol was developed to scan in the dental features of each image in a uniform manner. The mathematical descriptions were completed by two different investigators to determine the effect of investigator-induced error. Thus 80 total mathematical descriptions were produced and entered in a Microsoft Access Database.

Finally a new mathematical description was generated for a set of these images selected at random. Find Software© was used to compare the randomly selected descriptions to the database of 80 mathematical descriptions.

The study found that a mathematical description could correctly find the appropriate image at a tolerable error rate.

Bite Mark, Forensic Odontology, Computer Software

F38 Bite Mark Analysis in the Time of *Daubert*

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At the conclusion of this presentation, the participants will have a general knowledge of the requirement of scientific and technical court testimony and have a general understanding of the examination of fingerprints and bite marks. They will also understand the similarities and differences between these two analyses. The participant will also understand the need for further study in the area of bite mark analysis.

It has been nearly 70 years since the Frye decision setting the standard of "general acceptance" in scientific testimony. During that time both the law and science has changed dramatically.

Scientific testimony under *Daubert* and extending to technical testimony under *Kuhmo Tire* has set standards which science must meet in order to be admissible in a court of law.

These standards are: 1) whether techniques "can be (have been) tested," 2) whether the technique has been "subjected to peer review," 3) the known or potential rate of error…and the existence and maintenance of standards controlling the technique's operation, and 4) general acceptance.

Bite marks are often compared to fingerprints in respect to their uniqueness among individuals.

Fingerprint analysis is based on the premises of uniqueness among people, and permanence in the individual.

Fingerprints begin with the formation of friction ridges at the age of 15-17 weeks in utero and do not change throughout life unless changed by some outside force. The uniqueness of fingerprints have been used for over 100 years, first using the intuitive process, then based on the 50x50 study where 50,000 fingerprints, all in loop arrangements and taken from white males were compared with each other. It has been calculated that the chance of duplication of fingerprints is 1:10^97.

The technique of fingerprint examination is: analysis, comparison, evaluation and verification.

Analysis of fingerprints looks at the three levels of detail: general shape, Galton points and minutiae. Also the clarity of the print, and any artifacts that may be present are studied.

In comparison, if the first level of detail agrees then there is the systematic comparison of friction ridge arrangements and specific details.

After comparison the fingerprint examiner evaluates if there is agreement between subjects and exemplar, if there are there discrepancies between subject and exemplar, or is there insufficient data to come to a conclusion.

Lastly the materials are sent to a colleague for review and opinion.

Rate of error can be either method error or practitioner error. Method error is that which may be introduced through the processes of analysis. In the case of fingerprints, utilizing well-established techniques would minimize this. Practitioner error is human error that is the result of the individual fingerprint examiner. This can be minimized by training and experience.

Either of these sources could be identified and corrected by the reevaluation of the fingerprint by another expert.

The rate of error can be calculated by having a large number of examiners evaluate a large number of latent fingerprints and taking the number of errors in relationship to the total number of samples.

The human dentition differs dramatically from friction ridges. While the friction ridges generally do not change throughout life, it is the changes in the dentition from growth, trauma, and wear that individualize the dentition.

There are three areas that demand study to bring bite mark analysis to the scientific level required by *Daubert*. First, there must be large population studies to determine the uniqueness of individual's dentition. Next, the technique used in comparison must be verified, and lastly the examiners must be calibrated as to their rate of error.

There have been some studies regarding the frequency of variation within the dentition, but study of the frequency of variation of the dentition has not been exposed to the rigors of a study in the order of magnitude of the 50X50 fingerprint study.

There are a variety of techniques that have been used in bite mark analysis. Most involve photographs of bite marks or impressions of the bite marks, which are compared with exemplars of a suspect's dentition. This comparison can be through overlays made from radiographs, photocopies, scanned images, bent orthodontic wire and other techniques. There has been a study on accuracy of different techniques by Sweet and Bowers in which they concluded that of the techniques tested, the most accurate method of production of overlays is the computer-based method.

Pretty and Sweet used statistical analysis to determine inter-examiner reliability and error rates for the transparent overlays using the computer-based method in their study.

In conclusion, a Scientific Work Group for Bite Marks should be formed similar to those in other disciplines. The group could then direct more scientific studies to validate the findings of Sweet and Bowers, and Pretty and Sweet, but most importantly initiate the extensive research that is needed to show the individuality of the dentition.

Bite Mark, Technical Court Testimony, Fingerprints

F39 Bite Mark Aids in the Identification of a Murder Suspect

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The presentation will demonstrate the use of preliminary bite mark analysis to assist law enforcement in the apprehension of a murder suspect.

Bite mark analysis requires careful and precise examination and scrutiny before opinions regarding the bite mark can be presented in a court of law. However, in some cases, there may be an opportunity for general observations to be made of the bite mark that can be of significant value to law enforcement officers in identifying and apprehending possible suspects. This is a report of such a case.

The presentation will show how preliminary, onsite observations of a bite mark were instrumental in assisting law enforcement agents identify and apprehend the assailants of a 20-year-old Caucasian female. The victim, who had been sexually assaulted and murdered, was found with a human bite mark on the anterio-medial aspect of her left thigh. Law enforcement personnel, recognizing the pattern bruise as a possible bite mark, provided a set of dental stone casts of two possible suspects. The authorities had one suspect in custody. They had questioned the other suspect, a good friend of the first suspect, but had released him when they could not find significant evidence to hold him.

It will be shown how the bite mark was identified, analyzed and prepared and how the general characteristics of the mark, including arch width, arch shape, intercuspid distance, and occlusal markings of the bite mark were preliminarily evaluated at the time of the autopsy. Of particular importance was what appeared to be a missing or mal-aligned maxillary lateral incisor. These same characteristics were then compared to the general characteristics of the casts obtained from the two suspects that had been provided by law enforcement officers.

It was found that the characteristics of the bite mark were consistent with one of the suspects, including, but not limited to, a missing lateral incisor, and that they were not at all consistent with the other suspect. Of particular interest to the officers was that the bite mark on the victim was consistent with the cast of the suspect that had been released. Based on these preliminary observations and matching of the general characteristics between the bite mark and the cast, it was ordered that the second suspect again be taken into custody for further questioning. He was subsequently found guilty of first-degree murder and first-degree sexual assault. The initial primary suspect was found to be an accomplice and plead guilty to second-degree murder and second-degree sexual assault.

Successful utilization of the bite mark in this case was a result of two important factors. First was the recognition by law enforcement officers that the pattern bruise was a human bite mark resulting in having dental casts of the suspects' dentition available for immediate analysis. Second was the quality of the bite mark itself, which allowed for general measurements and evaluation at the time of the autopsy. Although it would require significantly more precise and careful examination to present the bite mark in a court of law, the preliminary observations in this case were beneficial in helping identify a suspect.

Bite Mark, Preliminary, Analysis

F40 Suspect's Finger Wound: Bite Mark or Glass Cut?

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This case will illustrate to the audience the difference between a bite mark and a glass cut.

On the evening of 3-07-02, the 42-year-old victim put his two boys ages 3 and 8 to bed and retired for the evening. His wife was working the swing shift as a nurse at a local hospital. The case was investigated by the San Carlos, CA Police Dept. At approximately 50 minutes past midnight the victim awoke and saw a man standing in his bathroom. The man rushed the dazed, confused, and half-asleep victim while he was still lying in his bed, and beat him about the face and head. The suspect pulled the victim into the living room and tied his hands and ankles. The suspect then began ransacking the house for valuables at which time the victim's wife arrived home from work. The suspect attacked her as she opened the door, punching her in the face and kicking her in the head while trying to pull her inside. The wife fought and yelled out in an attempt to wake the neighbors. During the struggle, her husband partially freed himself and came to her assistance. With both victims fighting and yelling for help, the suspect decided to flee. Responding officers were unable to locate the suspect. The San Mateo County Crime Lab responded to the scene for evidence. Numerous latent fingerprints were found at a point of attempted entry. The fingerprints were of sufficient quality for a "Cal-ID" search and a suspect was identified as 30-year-old Christopher Eugene Dixon, a parolee at-large. The victims were unsure if they could identify their attacker because they didn't see him clearly. The victims were asked to look at a photo lineup containing Dixon's photograph; neither of them could make identification. Dixon was found two days later and interviewed. He denied involvement in the robbery. Although his fingerprints proved that he was outside the residence, it wasn't enough to prove he was the man who beat and robbed the victims. At the time of his arrest, Dixon had an injury to his right pinkie finger. He claimed that he had cut his finger two weeks earlier when he punched the windshield of a car in anger. The injury did not appear to be consistent with the type of injury he was claiming. The investigator, Detective Rich Dickerson, questioned Dixon's girlfriend about the injury and she told him that Dixon had told her that someone bit his finger in a bar fight.

The victims were asked if either of them could have bitten the suspect's hand and initially neither of them thought that they had. However, a day later the female victim called the investigator claiming that she had a "flashback" of the struggle and recalled biting the suspect. The victim said that somehow during the struggle the suspect's finger had entered her mouth and she accurately described which finger and she believed that she "bit the tip off." Photographs of the suspicious injury to Dixon's finger were sent to the presenter who identified it as a bite injury and told the investigator that he had seen similar injuries in the same position that had occurred during struggles, often when a suspect attempted to cover the mouth of his victim to prevent the victim from screaming. The presenter told the investigator that it is common in these types of injuries for a suspect to injure victims in these cases while trying to get victims to release their bites - which were documented with photographs and medical reports. The proper documentation and identification of the bite mark evidence was a critical factor in the successful prosecution of this case. Although neither of the victims were able to identify Dixon, the jury convicted him on the basis that the victim "branded" him with an identifying mark. The victim's description of the position and type of injury she delivered to Dixon was supported by the expert testimony of the presenter. Also critical was the presenter's expert opinion that Dixon's explanation of how he received the injury was highly improbable.

Christopher Dixon was found guilty on all charges and is awaiting sentencing. As a three striker with a violent history, he is facing a minimum of 30 years and a maximum of 57 years to life imprisonment.

Bite Mark, Glass Cut, Oral Injuries to a Biter

F41 Pink Teeth: Postmortem Posture and Microscopy

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The goal of this presentation is to demonstrate the effects of postmortem posture on the creation of the phenomenon of pink teeth.

Pink teeth have long intrigued odontologists, pathologists, and anthropologists. From the first documentation, pink teeth have been viewed with curiosity, thought to be a clear-cut sign of violent death. While these researchers have studied the histological alteration in dentine, the perimortem and postmortem behavior(s) responsible for producing the phenomenon is idiopathic.

Perimortem variables linked to pink teeth production include head trauma, strangulation, drowning, etc., where some measure of intracranial pressure forces the pulpal ingredients, i.e., haemoglobin and other red blood cell derivatives, into the dentinal tubules. However, current research demonstrates this may not be the case. Rather, these teeth simply represent an artifact of the decomposition process and have little correlation with a cause or manner of death.

Postmortem variables to consider include surface or buried body, temperature, moisture/humidity, and body posture. This research assesses body positioning and the requisite microscopy to help discern etiology.

This study examined 12 recently deceased bodies donated to The University of Tennessee's Anthropological Research Facility to demonstrate the effects of posture on pink teeth formation. Each body was situated face down on a 30-45 degree angle with the head in a dependent position. Gravitational lividity (blood pooling) witnessed in dependent soft tissue after death are a time sensitive, though reliable means of understanding postmortem body positioning. The phenomena could not be simulated 48 hours after death. Like soft tissue lividity, these results have implications for body placement/movement for several days after death.

Microscopy is the obvious investigative tool in understanding dentine change in pink teeth. For this study to be comparative, discolored teeth were prepared using standard petrographic methods and examined using light and scanning electron microscopy. Histologically, discoloration is dominant in the coronal dentine with diminishing color nearing the apex. Van Wyk (1987, 1988) noted that coronal pulp is more discolored due to the increased vascularization in that region of the tooth. Enamel and cementum, being more highly mineralized and virtually non-porous, were resistant to any permeation of vascular contents.

The results of this study and histological examination illuminate the causative factors of the creation of pink teeth on both the macro and microscopic levels. The creation of pink teeth in an experimental setting fully demonstrates the correlation between this postmortem phenomenon and the effects of body positioning. While pink teeth may not be a sign of violent death, they provide telling information concerning the process of decomposition and positioning.

Van Wyk, CW

Pink teeth of the dead: 1. A clinical and histological description. J *Forensic Odontostomatology.* Dec;5(2):41-50

Postmortem pink teeth: in vitro production. *J Oral Pathology* Nov;17(9-10):568-72

Odontology, Postmortem Changes, Dental Histology

F42 Forensic Odontological Assessment of Unsuccessful Five Year Orthodontic Treatment of an Adult Patient

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The goal of this presentation is to show the importance of a precise treatment plan, examination of condition and orthodontic function, and the results of improvisational therapy.

The thirty-two-year-old male patient approached the institute in order to determine whether or not his five year long orthodontic therapy was professionally administered, why his dental condition worsened instead of improved – mastication problems and aesthetic dissatisfaction occurred.

Without exact aim the patient's retained 13 (FDI) tooth was extracted prior to orthodontic treatment. For undetermined reasons further extractions were indicated and performed for 34 and 44 teeth also. In light of the fact that over many years quite a few dentists examined him. The patient's "tongue thrust" (infantile) swallow was NOT diagnosed.

The inferior space closure was partially successful. Because of decrease in total inferior space, lingual resting position became unsatisfactory, interarch wedging occurred resulting in circular non-occlusion with relation to the superior arch. The ankylotic 14 premolar caused further problems. Misdiagnosis of this resulted in the extraction of 15 tooth, seizure of 14 tooth distalization was foreseen with this procedure. Because of the ankylosis, the archal expansion between the 12 and 14 teeth over the five year period was unsuccessful.

The 16 molar partially anteriorised, but because of the intended extraction of the ankylotic premolar (14) this tooth became positioned in infraocclusion and thus the circular non-occlusion extended from 16 to 25 teeth resulting in unsatisfactory mastication and speech defects.

Within the framework of the authors' analysis they assessed that the unilateral (right) maxilla hypotrophia exist which most probably caused the canine retention. During five years of orthodontic treatment this fact was not realized. Hemifacial atrophy, and unilateral extractions further increased the aesthetic disadvantages, and this resulted in a wide black corridor during smiling.

The case will be illustrated with excellent color pictures.

Hemifacial Atrophy, Dental Ankylosis, Dental Malpractice

F43 Bite Mark Analysis in Mauling Death of Child: A Case Study

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The goal of this presentation is to outline how culpability was determined when two mixed breed pit bull terriers were involved in the tragic mauling death of a ten-year-old boy. The viewer will be shown the process used in this case study to arrive at the conclusions that determined the fate of the two animals and their caretaker.

On April 29, 2000, ten-year-old Cash Carson and his young neighbor friend were walking on a public dirt road in a residential area of Halloran Springs, CA, when two dogs ran out of an open gate and attacked the decedent. He was taken to the local emergency room where he remained conscious with good vital signs for approximately 20 minutes. He then became bradycardic and went into cardiac arrest. The Coroner was called by the hospital who in turn requested a forensic odontological evaluation to determine culpability of dogs and which dog inflicted the fatal wounds.

The bite marks on the decedent were photographically documented at the San Bernardino County Coroner's Office on May 3rd with 35mm color slide film and 35mm print film. The ABFO #2 scale was used in several photos in order to obtain size measurements of each injury. Observed clinically were multiple pattern injuries consistent. On May 5th an examination of the two dogs with canine bites, including abrasions, contusions, and laceratio ensued at the Animal Control Shelter in Devore, CA, where the dogs were being kept in custody. A veterinarian anesthetized the dogs individually so that polyvinyl siloxane impressions could be taken of the dental arches of both dogs. It was necessary to first mold custom trays for each dog in order to accomplish this task. The impressions were immediately poured up in die stone. Inter-canine widths were measured and photographed at this time on both dogs with an ABFO # 2 scale in place for reference and accuracy.

Six of the print photos of the injuries sustained to Cash Carson were then enlarged to life-size dimensions. These injuries were individually compared to the teeth of both dogs for consistency in tooth location and position. The photos depicted lacerations to the front and back of the neck of the boy, a punctate and abrasive injury to his fractured right arm, and a contusion in the middle of his back.

After analysis, it was concluded that the bites on the decedent's right arm, both dorsal and ventral portions, were consistent with the upper and lower teeth of the larger male dog. The fatal ventral and lateral neck injuries were also' consistent with the lower teeth of the male. A very deep injury involving crushing of the seventh cervical vertebrae, spinal chord injury, and deep laceration to the back of the neck was found to be consistent in size and shape with the upper anterior teeth of the male. The abrasion that was made in the middle of the decedent's back was found to be consistent is size and shape with the lower anterior teeth of the smaller female dog.

Based on these conclusions, it was determined that both of the dogs were involved in the fatal attack and euthanasia was recommended. The smaller female was less culpable in terms of severity of the injuries; however, she had in fact participated in the attack. The larger male was found ultimately responsible for the fatal injuries to the decedent's neck.

The caretaker of the dogs (the owner was out of town when the attack occurred), was tried for first-degree murder in Superior Court at Barstow, CA. Witnesses stated that he had deliberately unchained the dogs when he observed the two youngsters approaching the residence. He was convicted of negligent homicide and received a seven-year sentence.

This poster presentation will demonstrate through printed text, photos and mounted dental models the sequence and technique of the various investigative methods used in determining culpability in the mauling death of ten-year-old Cash Carson.

Dog Bites, Pit Bull Terrier, Bite Mark Analysis

F44 Beaten, Bitten, and Murdered

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After attending this presentation the participant will understand: 1) The national statistics involving homicide of children under the age of 5 by a caretaker, with specific data related to this problem within the State of Florida; 2) Recent well-publicized failures associated with the Florida State agency responsible for the welfare of children; 3) The learning experience and challenges associated with this type of investigation; multiple bite marks, multiple suspects; and 4) A case study: A case involving the death of a severely retarded two-year-old male, with thirty-two human bite marks found at autopsy.

According to the U.S. Department of Justice's statistics of homicide trends in the U.S., approximately 80% of the children under the age of five who die every year are killed either by their parents or an acquaintance of one of the parents. This trend has been consistent for over 25 years.

Case Study/A Statistic: Two-year-old David suffered from Cri du chat syndrome. Severely handicapped and mentally retarded, he was totally dependent on his mother for his every need. On February 21, 2000, while attending the AAFS meeting in Reno, Nevada, the author was contacted by the District 12, Associate Medical Examiner with the request to examine and evaluate soft tissue pattern injuries, of possible dental origin, present on the remains of a two-year-old male. According to the Medical Examiner, because of a delay in immediate medical care, this child died of severe internal injuries. In addition to the injuries noted above, several bone fractures were present on the extremities and there was evidence of previously fractured ribs.

Because of a past history of possible abuse, the author was informed that a social worker had just visited the child several days prior to the murder. According to their report, they noted a well dressed (from head to toe) and well-nourished child. Sadly, evidence gathered at autopsy indicated that the social worker never bothered to examine the child undressed. During the course of the examination, 22 separate pattern injuries were examined and photographed. Several of these patterns involved double marks with indications that these injuries were done over a long period of time.

This presentation will review the techniques used in documenting these multiple pattern injuries; obtaining dental records from the four family members who had access to David; the results of the dental comparison of the postmortem records with the dental evidence obtained from the four suspects; the problems associated with multiple pattern injuries, such as are there more than one assailants; the involvement of a Forensic Odontologist prior to autopsy and the need for proper documentation and photographs at autopsy.

Multiple Pattern Injuries, Multiple Suspects, Murder

F45 What Drives a Dog to Bite?

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The presentation will familiarize the audience with the drives that can motivate a dog to bite.

In a Centers for Disease Control report for the period from 1992 to 1994, the number of people who reported a dog bite injury to a medical professional was estimated to be 4.7 million, of which about 800,000 required medical care and nearly 334,000 required visits to hospital emergency departments. Seventeen deaths were attributed to that period. From 1979 to 1998, 300 Americans were reported killed by dogs. Of the nearly 800,000 people who sought medical care for dog bites in 1994, at least half were children under the age of 18. These statistics are even more significant when it is estimated that a large number of bites actually go unreported.

Previous speakers have discussed dog bites from the perspective of what has happened to the victim and an analysis of the bite mark. Undoubtedly from the CDC's statistical information, dog bites will continue to plague the professional and to be of concern to the forensic odontologist. Rather than an analysis of the bite marks, the author thought it important to know what can drive a dog to bite and how the drive can affect how the dog bites, the intensity, and the number of bites. A general understanding of these drives, especially the prey drive, will give you a better understanding of how dogs are trained to search and track, perform obedience, and do bite work in such sports as Schutzhund protection dog training.

Dogs can become aggressive and bite for a variety of reasons. It is sometimes difficult for humans to understand canine aggression, and this discussion is an attempt to expound some of the theories that are used in Schutzhund protection dog training to help one understand what the dog is saying when it bites. Aggression is a normal behavior for dogs. Whether or not the aggression is dangerous depends on the situation. Good dogs can be aggressive, and good dogs can bite. It is all a matter of perception.

Dogs can become aggressive due to different motivating factors. These can include but not be limited to social dominance, defense, and prey drives. The 2 primary motivating drives are the defense and prey drives. The defense drive deals with the fight or flight response, which is aggression or avoidance. Aggression is the active defense, and avoidance is the passive defense. Both types of defensive drives can be triggered by the same stimuli such as staring or making threatening and aggressive movements against the dog or its owner. In protection training the dog is worked through a progressive measure of increased pressure on the dog in order to develop the aggression and lessen the avoidance response. Examples of avoidance would be running away or submissiveness as when a dog turns over and displays its belly to you. In prey drive the pursuit carries over from the wild where the dog had to survive. The dog has to find its prey, pursue it, capture it, and then kill it. You see this in dogs that chase cars, and others who chase and catch Frisbees or balls. And yet other prey dogs will also bite. Of utmost concern are children who are most vulnerable to dogs with strong prey drive. The child's small size, high pitched voices, jerkier movements make them more alluring to the prey dog, and the small stature places many vital areas of the child in easy striking distance. In training a young dog to bite, the helper displays similar characteristics. The sleeve is moved around as the helper runs pass the dog. The dog attacks the sleeve as if it is prey and bites it. The sleeve is slipped, and the dog will often shake the sleeve to kill it and then carry it away.

Some dogs will bite once and then let go, resulting in 1 to 4 canine punctures. This can advance to a bite or a series of bites with shaking. Advancing further would be biting with serious mutilation progressing further to biting resulting in death. You will note that in protection training, the dog is taught to bite with a full grip so that not only the canines are engaged but also the molars. The sleeve fits fully into the dog's mouth insuring that the sleeve cannot escape. Should the dog lose its grip, ideally the dog will attempt to regrip – rebite.

A murder occurred in December 1999 in which a park ranger was killed in Kona, Hawaii. The author was called to view the body at the Kona morgue to photograph numerous dog bites for future analysis. The agents informed the author that very vicious dogs had done the biting. Evaluation of the numerous bites led to the conclusion that the dogs (three) were aggressive but not necessarily vicious. The veterinarian called into the same case concurred after assisting the author in the examination. It appeared that the dogs might have bitten in defense of its owner during a confrontation with the ranger.

Dog, Drive, Bite

F46 Fatal Dog Mauling by Presa Canarios

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After this presentation, the participant will have an increased understanding of the analysis of multiple bites inflicted by animals in fatal attacks.

In recent years there seem to be more media reports of fatal mauling of humans by various breeds of dogs. Usually the victims are children and the attacking dogs are commonly Pit Bulls or Rottweilers. From time to time the forensic odontologist is consulted for an analysis of the bite injuries. This presentation will review the 2001 fatal mauling of an adult female by two adult Presa Canario dogs in San Francisco. There will be a brief review of two other fatal northern California attacks, the death of a young boy by two Rottweilers and the fatal attack of a female jogger by a mountain lion.

In January of 2001, a woman was returning home to her apartment in an affluent area of San Francisco. As she was about to enter her apartment she was suddenly attacked by her neighbors' adult Presa Canario dogs, one male and one female. One of the dogs' owners, a female, who was returning from a walk with the dogs, attempted to restrain the animals. Due to the large size of the dogs (approximately 130 lbs.) the dogs overpowered both the victim and their owner. Eventually the owner was able to move the dogs, one at a time, back into her apartment. The victim suffered multiple bite injuries over most of her body with the severest bites in the head and neck area. Police and paramedics attempted to administer life-saving measures. The victim died due to insanguination. One animal control officer responded and attempted to sedate the male dog with multiple tranquilizer darts. The dog continued to be combative thus the officer could not safely remove and transport the animal. At this point, one option that was discussed was for the S.W. A.T. team to shoot the dog prior to removal. Eventually the dog became sufficiently sedated to be removed by a trained police dog handler and the animal control officer. Reportedly, the victim had earlier encounters with the two dogs. Subsequent police investigation revealed earlier aggressive behavior by the dogs. Reports indicated that two Pelican Bay State Prison inmates, who were also members of the Aryan Brotherhood, originally owned the dogs in northern California. The dogs had been bred for the purpose of being sold for fighting. The owners, at the time of the mauling, were a married couple, both attorneys, who shortly following the attack formally adopted one of the inmates.

The Chief Medical Examiner of San Francisco County and the lead investigators contacted the author to examine the bite mark patterned injuries on the victim. The author also examined the two dogs. The male dog was immediately euthanized. The female dog was not destroyed until 2002. The author photographed and took dental impressions of both dogs and subsequently a bite mark analysis was performed. The maxillary intercanine measurements were 60mm for the male dog and 50mm for the female. The conclusion was that the male dog inflicted the bites on the victim's head and neck. It was not possible to include or exclude that the female dog bit the victim.

The two owners were indicted for manslaughter and second-degree homicide and were eventually tried and convicted in a Los Angeles court. Subsequently, the trial judge threw out the second degree murder conviction. At the time of submission of this abstract San Francisco prosecutors planned to appeal the judge's ruling.

This presentation will review the bite injuries on the victim and also review similar type bite injuries in the Rottweilers and mountain lion attacks.

Dog Bites, Presa Canario, Rottweiler

F47 Christopher Wilson: Unintentional Second-Degree Murder Conviction for a Killing Committed by Dogs

Daniel M. Winter, DDS, 428 Houston Street, Manhattan, KS; and Chris Biggs, Geary County Attorney, 801 North Washington, Suite A, Junction City, KS*

The goal of this presentation is to review this case that set legal precedence with a detailed review of forensic dental involvement.

On April 24, 1997, Christopher Wilson, age 11, was attacked and killed by three Rottweiler dogs while waiting at a bus stop for his school bus. The dogs' owner was charged and convicted with unintentional second-degree murder, K.S.A. 1998 Supp. 21-3402(b). Conviction was subsequently upheld in the court of appeals and eventually the Supreme Court of the State of Kansas. This case is unique in that to the knowledge of the prosecution, "no precedent existed in this state for convicting a person of homicide for a killing committed by his or her dogs."

The case involving the three dogs included a number of factors regarding the defendant including: "She selected powerful dogs with a potential for aggressive behavior and that she owned a number of these dogs in which she fostered aggressive behavior by failing to properly train the dogs. She ignored the advice from experts on how to properly train her dogs and their warnings of the dire results which could occur from improper training. She was told to socialize her dogs and chose not to do so. She ignored the evidence of the dogs getting out on numerous occasions and her failure to properly secure the gate. She ignored the aggressive behavior her dogs displayed toward her neighbors and their children."

The State presented evidence that "she created a profound risk and ignored foreseeable consequences that the dogs could attack or injure someone. The State is not required to prove the defendant knew her dogs would attack and kill someone. It was sufficient to prove that her dogs killed Christopher Wilson and that she could have reasonably foreseen that the dogs could attack or injure someone as a result of what she did or failed to do."

The three dogs involved in this case included two females and one male. The male and one female were adult dogs and the third was a female puppy. It was concluded the dogs displayed "pack" behavior with the adult male dog acting as "alpha" dog.

Forensic dentistry was consulted to evaluate the bite marks inflicted on the victim. Particular attention was focused on which dog inflicted the fatal wound. Also of particular interest was the examination and evaluation of specific bite wounds and the identification of the dog inflicting the bite. The location of these wounds on the body and the knowledge of which dog inflicted these wounds became important to the case.

The dogs' heads were retained by Kansas State University for the purpose of conducting rabies studies. This allowed forensic dentistry to examine and evaluate the dogs' dentitions. Stock impression trays could not be utilized due to the unique dental characteristics of the Rottweiler breed. A complete review of the dogs' dentitions were conducted with a consulting veterinarian from Kansas State University School of Veterinary Medicine.

The bite marks were evaluated with traditional methods utilized in forensic dentistry. These methods included the evaluation of numerous photographs. Color, black and white and V.V. photographs were taken of the victim and subsequently analyzed. Utilizing the ABFO No. 2 scale the photographs were set to a 1:1 scale. Impressions were taken of the dogs' teeth. It was necessary to constrict custom impression trays to capture impressions of the dogs' teeth. Models were made of the dogs' teeth and acetate overlays of the incisal edges of the teeth prepared. Utilizing this method, direct comparison studies were conducted evaluating the individual bite wounds with the individual dogs' dentition.

A detailed review of the legal aspects involving this case will be presented. The specific forensic dental examination, evaluation, and methods of comparison will be reviewed.

Animal, Bite, Mark

F48 Image Resolution: Digital vs. Traditional Film Photography

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The goal of this presentation is to evaluate the quality of images produced by current digital camera technology compared to traditional film photography and to determine if digital photography can be used in forensic odontology applications.

Background: Numerous scientific fields have used digital image technologies for many years; however, its application in the criminal justice system is relatively new. Forensic odontology requires imaging systems to produce images with quality adequate to evaluate fine detail particularly in bite mark cases. Until recently, the image resolution produced by digital cameras has been substantially less than that produced by traditional film photography. However, with digital technology continuing to make significant strides in equipment quality, the images produced by these cameras should be continually evaluated for forensic applications.

Resolution is defined as the ability to distinguish separate visual information such as details and fine patterns. Traditionally, the measure of resolution is expressed in line pairs per millimeter (lp/mm). High-resolution lenses can actually resolve over 100 lp/mm. Some of the best color printing papers can reproduce approximately 75 lp/mm. However, the human eye is only able to distinguish 10 lp/mm under optimal conditions. This does not mean that an image printed at 10 lp/mm will be sharp because sharpness has two components - resolution and acutance. Acutance refers to the ability to see the transition between brightness levels. As a result, a sharp image (high resolution and high acutance) is printed at a minimum of 25 lp/mm. The point is that there are a large number of factors that determine whether or not a print will be sharp. Factors common to both digital and traditional photography include: the lens' resolution, lens' aperture, camera motion, resolution of the printing paper, and resolution of the printer. Traditional film is also affected by film thickness, film grain, and enlarger parallelism while digital photography is affected by quality of the scanner chip (CCD). To further confuse the issue, traditional photography negatives are scanned prior to production of the print by many laboratories. Thus, in the end even traditional film is often digitized resulting in the necessity of including the scanner quality and resolution.

Many people also like to convert film to a "megapixel equivalent" and compare to the film resolution to the resolution of the digital camera. In other words, they assume two pixel columns represent a line pair. Thus a single frame of 35mm color ISO 200 film, rated at 50 lp/mm would contain 3600 x 2400 pixels, totaling 8.64 million pixels. Today's high-end digital cameras can produce up to a 6 million-pixel image. It should be noted that since images are two-dimensional objects. Therefore, doubling the resolving power necessitates a fourfold increase in pixel number. Using this correlation, today's 6 megapixel digital cameras should produce an image within twelve percent of traditional film resolution. However, this is an unfair comparison because not all CCDs are of the same quality and physical size or have the same size or shape pixels. Additionally, the image size produced by traditional film and digital photography will usually differ. When using high end digital SLR cameras with lenses designed for 35 mm film photography, digital image size will usually be smaller than the image produced by a comparable 35mm film camera as seen in Figure 1. The above discussion has made it quite obvious that the debate regarding resolution quality of digital versus film photography is confusing. There are too many factors to be considered. Therefore, when evaluating digital and traditional film photography, a practical comparison is in the evaluation of the printed images produced by individual cameras.

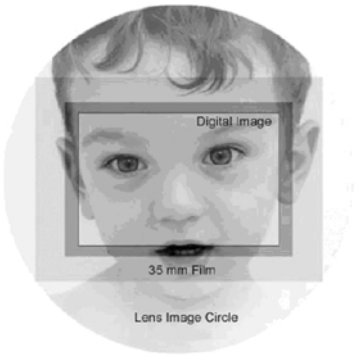

Figure 1

Methods: Image quality was evaluated and ranked between digital, print film and slide film photography using a Nikon DX1 digital camera, Nikon D100 digital camera, Nikon Coolpix 5000 digital camera and a Nikon N70 traditional 35 mm film camera. As many extraneous factors as possible were eliminated. With exception of the Nikon Coolpix 5000 (a non SLR camera), all photographs were taken using the same lens, a 105 mm Vivitar 1:1 macro lens. The images were printed using the same photographic lab processor and photographic paper. Kodak Select Royal Gold 200 ASA print film and Kodak Professional Ektachrome 200 ASA slide film was used.

Two separate images were taken and evaluated at 1X and 3X. The first image was of the PIMA proposed International standard, ISO 12233 chart used for evaluation of camera resolution. This chart allows for resolution evaluation at the center and corners of the chart as well as for the three major axes – horizontal, vertical and diagonal. Since this image is a very controlled evaluation of camera resolution of a flat surface, a second image of a human ear with an ABFO scale number 2 was also taken and evaluated for image quality. The digital images were taken on each of the cameras highest resolution setting in Tiff mode. The slide film images and print film images were taken using the Nikon N70 camera body. The slide film was scanned at a low resolution (300 dpi) and a high resolution (2400 dpi) and then printed. Therefore, a total of 5 photographs of each image were produced.

Results: The two sets of photographs were evaluated by one hundred individuals who were asked to rank the images from best quality to worst. Individuals with forensic experience were also asked to evaluate the images for forensic acceptability.

Conclusion: Results indicate that photographs produced by certain digital cameras can produce images with an image quality comparable to the print film photographs taken in the study. Dependent upon the quality of the digital camera chosen, photographic results should not be compromised when using digital systems. The data indicate there is no photographic reason that digital systems should be excluded from forensic investigations. The prints produced from slide film, whether scanned at low or high resolution, produced an inferior result to both the print film photographs and the digital photographs.

Forensic Odontology, Digital Forensic Photography, Image Resolution

F49 Observations on Endodontically Treated and Restored Teeth When Placed in Contact With Acids: Experimental Studies to Aid Identification Processes

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The goal of this presentation is to improve the human identification process possibilities by the aid of forensic odontology. Particularly the authors carried out an experimental study to learn more about the changes that endotontically treated, restored teeth and prosthetic devices (fixed prosthetic crown) undergo when exposed to acidic environment till the total destruction, defining their behavior and morphology with the aim to edit a reference table.

Following the authors' first study about a "mafia" crime case (where a cadaver was destroyed by the means of acids) and the need of further experimental researches pointed out by the unusual finding of an endodontic filling report, a study was carried out concerning the changes of endodontically treated teeth, restored teeth and prosthetic devices (fixed prosthetic crown) which undergone when exposed to acidic environment till the total destruction.

Various specimens were used for the study: (1) healthy, unrestored teeth, (2) teeth specifically restored for the research, which were first endodontically treated and sealed by means of an endodontic cement and gutta-percha (condensation technique), then restored with amalgam or composite fillings; and (3) teeth with a fixed prosthetic crown of metal alloy covered with aesthetic resinous material (acrylic based products or composite materials) or metal-feldspatic ceramic dental systems.

Group 2 specimens were carried out from healthy human teeth extracted because of periodontal diseases at the dental clinic. Group 3 specimens were undefined production samples resulting from extraction therapies at the dental clinic; in compliance with the rules concerning medical and dental devices in force in Italy and contained in the CE directive 93/42, the materials used have to be standardized. In effect, for these specimens it was not possible to define the exact composition, but it was possible to assign them to known groups of compounds or alloys. Before testing all the samples were stored in a sodium chloride 0,6% aqueous solution at environment temperature and full size oral radiographs were recorded. The following acids aqueous solutions have been used for the study: hydrochloric acid in a 37% solution, sulfuric acid 96%, nitric acid 65% and aqua regia (chloroazotic acid) i.e., hydrocloric/nitric acid 1:3. The samples were immersed in an amount of acid solution suitable to respect a correct volume ratio between the sample and the liquid phase (about 25 ml). The specimens were observed continually until they were completely destroyed; at differing intervals according to the changes observed, were taken from the container, washed in distilled water, dried and photographed and then placed in the acid again.

A results table was edited reporting the macroscopic findings for each specimen related to the changes observed. The unrestored teeth immersed in hydrochloric acid for 58 hours continually checked showed a progressive reduction in their volume until the complete dissolution; the restored teeth at the same time showed the dissolution of the dental tissues and the composite fillings, while the amalgam fillings, the endodontic products and the prosthetic devices were still present. The samples placed in sulfuric acid checked at intervals up to 190 hours showed a gradual breakdown in structure with the formation of a corpusculate deposit. At the same time, the amalgam, the endodontic residues and composite fillings were still present, while the prosthetic devices showed a dissolution of the resin based facing materials. In nitric acid at the 2nd hour the amalgam filling was destroyed, while the endodontic residues and the composite fillings were still present at 60 hours. In aqua regia the metallic component of the metal-ceramic systems was destroyed in 7 hours, while the ceramic component, the composite fillings and the endodontic residues were still present at 25 hours.

The experiments showed that the unrestored teeth were completely dissolved in all the acidic solutions. Comparing the statistical analysis between the four kinds of acids versus the data of the authors' first experiment it was relieved a significative ($p<0,001$) difference. It could be due to the different storage method of the samples before testing (dry environment in the first study Vs. the aqueous solution in this one).

The unexpected behavior of some restorative and prosthetic dental devices in acids is under discussion and has to be explained, while the authors would like to emphasize that it seems possible to recognize: (1) in the hydrocloric acid: the tooth colored prosthetic devices till the 25th hour, the composite fillings till the 40th hour, the amalgam fillings till the 30th hour; (2) in the sulfuric acid: the tooth colored prosthetic devices till the 110th hour, the composite fillings till the 150th hour, the amalgam fillings till the 70th hour; (3) in the nitric acid: the tooth colored prosthetic devices till the 11th hour, the amalgam fillings till the 12th hour, the composite fillings till the 8th hour; (4) in aqua regia: the composite filling till the 13th hour, the metal-ceramic prosthetic devices till the 4th hour, the amalgam fillings till the 8th hour. It has to be pointed out that the endodontic residues were still present in all the samples after the complete dissolution.

This study may be of great help for the Forensic Odontology Science as an aid to personal identification process since it seems possible to reach a good approximation in the correlation between the time of exposure to the different acid solutions and the degradation rate of dental structures and also in the comparison of the residuals of dissolution with the antemortem known situation. The finding of the endodontic residues could represent an important aspect in the identification process because it showed to be in an acid environment an unchangeable and stable element that can assure a positive report. The experiments did not take into account possible factors present in real-life conditions: the protection provided by soft and hard tissues surrounding the dental components and/or devices, nor indeed any other externally worn items. These *in vivo* circumstances prevent direct exposure to acids. In fact, as an example, the root part of the tooth should be much more resistant to acid insults when is incorporated within the bone.

Forensic Odontology, Acid Solutions, Dental Materials

F50 Observations on Endodontically Treated and Restored Teeth Subjected to High Temperatures: Experimental Studies to Aid Identification Processes

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The goal of this presentation is to improve the human identification process possibilities by the aid of forensic odontology. Particularly the authors considered carrying out an experimental study to learn more about the changes that endodontically treated and restored teeth undergo when exposed to very high temperatures, defining their behavior, morphology and X-Ray properties with the aim to edit a reference table.

In large scale disasters associated with fire the damage caused by heat can make medico-legal identification of human remains difficult

and as a result teeth and their dental therapies, even undergone at very high temperature, can be helpful. Following the results of these first studies on incinerated teeth and the need of X-Rays experimental researches reported by the literature, the authors carried out a study concerning the behavior, the morphology and the X-Ray properties of endodontically treated and restored teeth exposed to a range of high temperatures with the aim to edit a reference table.

Healthy human teeth extracted at the dental clinic were dived in two groups: (1) caries free and unrestored teeth, as a control group (2**)** teeth specifically restored for the research, which were first endodontically treated and sealed by means of an endodontic cement and gutta-percha (condensation technique), then restored with amalgam or composite fillings. Before the high temperatures testing, periapical radiographs of all the samples were recorded. The tests of exposure to heat were carried out in a oven: two complete sets of samples (groups 1 and 2) were each subjected to one of the pre-established temperatures (200, 400, 600, 800, 1000 and 1100°C) at a rate of increase of 30°C/minute. As soon as each target heat had been reached the samples were removed from the oven and allowed to cool to room temperature. Finally the specimens were examined macroscopically, observed by stereomicroscopy and periapical radiographs of all the samples were taken.

The results table was edited reporting the macroscopic, microscopic and X-Rays findings for each specimen related to the different temperature levels.

Experiments showed that dental tissues, endodontic treatments and restorative materials undergo a range of changes, which correlate, well with the various temperatures of exposure. These changes are a consequence of the nature of the materials and their physicochemical characteristics; individual components can remain recognizable and identifiable even at very high temperatures. For example, at 1100°C it was possible to recover and identify residues of amalgam restorations. At the same temperature the teeth were well recognizable and not completely destroyed thanks to their mineralized structure. Moreover it was possible to observe the endodontic sealing material at the apical surface by the microscopic analysis and all the endodontic sealing residues in the root by the radiographs. The experiments did not take into account possible factors present in real-life circumstances, i.e., the protection afforded by soft and hard tissues surrounding the dental components and/or devices, nor any other externally worn items. For example, the root of a tooth should be even more resistant to thermal insults since it is sheltered within the bone. These *in vivo* circumstances prevent direct exposure to fire. It was observed that it is important to carry out stereomicroscopic and radiographic analyses in order to identify the real presence of restorative materials and endodontic treatments, particularly when only fragments of the teeth remain available for analysis. Only at a temperature of 200°C the teeth did not show signs of fractures, whereas as the temperature raised cracks, fissures and fragmentation of crowns and roots occurred. In addition, in two cases the teeth exposed at 600°C fractured when handled. This highlights two important points: first, calcined teeth, being completely dehydrated, are very delicate, and secondly, teeth's fractures may not always came from trauma often associated to disasters but sometimes have to be related to the high temperatures caused by major fires. In the experiments all the materials were exposed to a single, brief, thermal insult. In real life various factors can further modify recovered remains: the duration of the exposure to fire, the way in which the fire develops, the rate of increase of temperature, and substances used to extinguish the fire.

From these experiments the authors conclude that: (1) the endodontic treatment is recognizable from 200°C till 1100°C with both the microscopic and radiographic analysis, (2) the "antemortem" and "postmortem" radiographic comparison (following the ABFO guidelines) permits constantly a positive identification, (3) the radiographic analysis could represent an important aspect in the identification process because it seems to be able to detect unchangeable and stable elements of the dental remains not recognizable by the macro-/micro-scopic study, (4) endodontic and restorative materials seem resistant to temperatures higher than those theoretically predicted, and (5) it seems possible to reach a reasonably reliable estimation of the temperature of exposure from an analysis of the teeth and restorative material's remains.

Forensic Odontology, X-Ray, Dental Materials

Pathology/ Biology

G1 Investigation of Infant Fatalities in Maryland (1990-1999)

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The goals of this presentation are to learn the value of the infant death scene investigation and to identify certain epidemiological characteristics of Sudden Infant Death Syndrome (SIDS).

From 1990 to 1999, the Office of the Chief Medical Examiner (OCME) investigated a total of 1,510 sudden infant deaths. SIDS was the leading cause of death in this infant population (51%). Since 1994, the SIDS rate in Maryland has dropped significantly. However, the number of infants that died of accidental or non-accidental injuries remained consistent during the same time period.

Sleeping locations and positions of all the infants were documented in the investigations. A total of 342 infants were found sleeping in bed with an adult or adults (bed-sharing) at the time of death. Of the 342 bed-sharing infants, 265 (77%) died of SIDS, 45 (13%) died of natural diseases, and 11 (3%) died of asphyxia due to overlay. There were 21 bed-sharing infants whose cause and/or manner of death could not be determined. Of the 778 SIDS infants, 467 (61%) were found unresponsive on their stomach, 126 (16%) on their side, and 70 (9%) on their back. More than 38% SIDS infants who were placed to sleep on their side were found on their stomach. Since 1997, the proportion of prone sleeping SIDS has reduced from approximately average 60% prior to 1997 to only 25% in 1999.

During the past 10 years, 27 infants died of positional/ compressional asphyxia due to unsafe sleeping environments, such as defective crib; defective side rails on crib/bed; mattresses that were too small for crib/bed, allowing space between mattress and the head or foot boards, or space between the mattress and the wall. All the situations allow the infants to slip down and become wedged. Eleven infants were suffocated by entanglement in bedding materials, such as plastic covers, quilts, blankets, and pillowcases. Since the risks for the accidental suffocation can be modified, it is very important for the investigators to carefully examine the scene and personally interview the individuals who were caring for the infant and who discovered the child. Such efforts could prevent potential dangerous sleeping environments and save lives.

This report focuses on the importance of infant death scene investigation in determination of the cause and manner of sudden infant deaths. Certain characteristics of SIDS victims are also presented.

Sudden Infant Death, Bed-sharing/Sleeping Position, Death Scene Investigation

G2 Sudden Infant Death Syndrome in North Carolina From 1999-2000: The Prevalence of Risk Factors and Its Relation to 2000 Census Data on a County by County Basis

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The goals of this presentation are to demonstrate the prevalence of risk factors for Sudden Infant Death Syndrome (SIDS) in North Carolina as related to type of sleeping surface, sleeping position, and co-sleeping and to show the relationship between the SIDS mortality rate per county and the 2000 census demographic data for each county.

Hypothesis: Reported risk factors for SIDS with regards to sleeping surface, sleeping position, and co-sleeping are highly prevalent in the population of SIDS deaths studied. Demographic data as presented in the 2000 census is significantly related to county SIDS mortality rates.

Methods: The North Carolina Office of the Chief Medical Examiner's autopsy and investigative records were retrospectively reviewed for all infants aged 0-1 years who died during 1999 and 2000 in which the cause of death was SIDS or undetermined. Demographic data with regards to age, sex, and county of death were tabulated. The place where the infant was sleeping, the infant's sleeping position, and the occurrence of co-sleeping were recorded when the data was available. The anatomic diagnoses on the autopsy reports were tabulated for all of the deaths. The 2000 census data for North Carolina counties was used to determine the number of 0-1 year old infants in each county so that population at risk for SIDS could be determined. State and county SIDS mortality rates for the population at risk were then calculated. The county death rates were then compared to county demographic data as reported by the 2000 census by a general linear model using a Poisson link function to see which data significantly correlated ($p<0.05$). The demographic data that was analyzed for each county included: birth rate; death rate; ethnicity; household, family, and per capita income; families, children, and persons below poverty; families with children under 16 with both parents in the workforce; female labor force participation rate; completion of high school or bachelors degree; persons who lived outside the U.S. 5 years ago or were born outside the U.S.; wood as principal heating fuel; and lacking complete plumbing.

Results: The authors examined 238 deaths. Of these, 131 (55.0%) were male and 107 (45.0%) were female. The ethnicity of the infants was 117 (49.2%) white, 104 (43.7%) black, 13 (5.5%) Hispanic, and 4 (1.7%) other. The ages ranged from 3 – 338 days with an average of 100 days. The causes of death were reported as 190 (79.8%) SIDS, 22 (9.2%) asphyxia, 7 (2.9%) other, and 19 (8.0%) undetermined. The manner of death was determined to be natural in 197 (82.8%), accidental in 24 (10.1%), and undetermined in 17 (7.1%). Prior to their deaths, the infants were placed in the following locations: adult mattress 68 (28.6%), crib/bassinet 51 (21.4%), couch/sofa 22 (9.2%), water bed 3 (1.3%), chair 1 (0.4%), playpen 1 (0.4%), other 15 (6.3%), and unknown 77 (32.4%). The position that the infants were in when found was: prone 85 (35.6%), supine 36 (15.1%), side 12 (5.0%), other 2 (0.8%), and unknown 103 (43.3%). Co-sleeping was present in 105 cases (44.7%), absent in 75 (31.9%), and no data were available in 55 (23.4%). If co-sleeping did occur, the number of adults and/or siblings sleeping in

bed with the infant was 1 in 52 cases (49.5%), 2 in 48 cases (45.7%), and 3 in 4 cases (3.8%), and 5 in 1 case (1.0%). The mother was the most common person in bed with the infant as found in 89 cases (84.8%). Co-sleepers also included: the father in 48 (45.7%), siblings in 18 (17.1%), and others in 4 (3.8%).

Risk factors for SIDS have been reported elsewhere to include not sleeping in a crib, prone sleeping position, and co-sleeping. These risk factors were examined in the North Carolina infants by examining the 102 SIDS deaths in which data was available for all three. Of these 102, 67 (65.7%) were not in a crib, 63 (61.8%) were prone, and 48 (47.1%) were co-sleeping. However, 94 (92.2%) of these 102 had at least one of the three risk factors present (i.e., were prone or co-sleeping or not in a crib). Only 6 (5.9%) deaths were recorded for infants sleeping supine and alone in a crib. Only 2 (2.0%) deaths were noted for infants sleeping on their side and alone in a crib. Thus, the vast majority of SIDS deaths occurred in infants exposed to a known risk factor with regard to sleeping surface, position, or co-sleeping.

The following anatomic diagnoses were reported in the infant's autopsy reports: pulmonary congestion/edema/hemorrhage 107 (45.0%), mediastinal petechiae 102 (42.9%), pulmonary inflammation 22 (9.2%) (includes pneumonia, bronchitis, bronchiolitis, and interstitial inflammation), visceral congestion 22 (9.2%), heart malformations 17 (7.1%), liver pathology 13 (5.5%) (includes fatty change, hepatitis, and necrosis), acute/chronic tracheitis 9 (3.8%), neuropathology 7 (2.9%) (includes encephalopathy, edema, subdural hemorrhage, and gliosis), and aspiration 6 (2.5%).

The SIDS mortality rate in North Carolina was 1.0 deaths per 1000 infants per year; the rate for counties varied from 0 – 5.9 deaths per 1000 per year. The following county demographic factors were found to be significantly related to SIDS: death rate (p=0.007), percent of families with children under 16 with both parents in the workforce (p=0.03), and percent Native Americans (p=0.05); birth rate had a borderline significance (p=0.07). A general linear model with Poisson link function based on these 4 pieces of data explained 68% of the variance in the county SIDS mortality rate data. None of the other demographic data was found to be significantly related to county SIDS mortality rates.

Conclusions: This study has found that of the 238 SIDS deaths in the state of North Carolina during the years 1999 and 2000, 94 (92.2%) were exposed to a known risk factor (i.e., not sleeping in a crib, sleeping in the prone position, or co-sleeping). Only 6 (5.9%) deaths were reported for infants without a risk factor with regards to bed, position, or co-sleeping. The mortality rate for SIDS in North Carolina was 1.0 deaths per 1000 infants per year with county mortality rates that varied from 0 – 5.9 deaths per 1000 per year. The county SIDS mortality rate was significantly related to the following county demographic data as reported in the 2000 census: death rate (p=0.007), percent of families with children under 16 with both parents in the workforce (p=0.03), and percent Native Americans (p=0.05); birth rate had a borderline significance (p=0.07). The most common anatomic diagnoses found on postmortem exam of the infants were pulmonary congestion/edema/hemorrhage and mediastinal petechiae.

Sudden Infant Death Syndrome, North Carolina, 2000 Census

G3 Epidemiological Study of SIDS in an Apulian Population

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This work investigates the trend of sudden infant death syndrome (SIDS) in the period from 1970 to 1999, as shown in the case series documented by the Legal Medicine Section of the Department of Internal Medicine and Public Medicine (DIMIMP) of Bari University Hospital. The goal of the study was to assess whether the epidemiological data on SIDS have changed over time and how data compare with those in the literature.

In recent years the number of cases of SIDS seems to have dropped, but although this positive result can be attributed to the efforts of the scientific community in terms of the progress made in pediatric medicine and neonatal care, no etiopathogenetic hypotheses have yet been formulated that can individuate all the causes of the syndrome. In 1997 the death rate in the industrialized world ranged from 0.17 in Holland to 1.12 in Australia. Despite the low incidence of SIDS, it is a real social problem because no precise cause of the death can be referred. The parents and family are unable to accept the diagnosis of "unexplained" death of the infant and tend to impute responsibility to third parties, especially the doctors. The main difficulty in nosographic classification of SIDS is due to its peculiar diagnosis by exclusion, defined by Marie-Dapena and Marion Willinger as "Sudden death in infancy unexplained after review of the clinical history, examination of the circumstances of death and postmortem examination".

The present work analyses the records of autopsy of infants who died between 1970 and 1999, reviewed by the Legal Medicine Section. After excluding all cases in which the cause of death was identified (ascertained responsibility of medical staff, maltreatment, homicide, congenital anomalies, infectious diseases, etc.), a total of 63 cases of SIDS (31 M, 32 F) were found. In these, autopsy and histological examinations had not revealed any organ disease such as to cause death but only aspecific signs, that could have been correlated to the final outcome or were chance findings, such as: acute polyvisceral stasis (45%), pulmonary congestion (30%), petecchiae at the level of the serosa (26%), pulmonary edema (25%), cerebral edema (20%), hypertrophy of the thymus (10%).

The distribution of the 63 cases of SIDS by calendar month showed that the highest number of deaths (43) occurred in the months of February, March, April, and December, although there was no significant relationship with seasonal affections of viral or influenza type. Distribution by age demonstrated that 51 deaths occurred in the first six months of life and only 12 from the sixth to the twelfth. Analysis of the national trend of infant mortality in the same period identified two different periods: from 1970-1980 the infant mortality rate in Italy ranged from 19 to 36.3% and 51 of the deaths in the authors' sample occurred, featuring peaks of 9 deaths in the years 1970 and 1973. From 1981 to 1999, instead, the infant mortality rate in Italy ranged from 7 to 18 and 12 SIDS occurred in this sample.

The population was therefore subdivided into 2 groups for statistical analysis: SIDS between 1970 and 1980, and SIDS between 1981 and 1999. The $_{X}2$ test showed that there was no statistically significant difference in age distribution between the two groups (p=0.43; $_{X}2$ 10.08), nor in distribution by calendar month (p=0.76; $_{X}2$ 6.25). The results confirm the hypothesis that SIDS is a multifactorial affliction. They also confirm that study of this syndrome is conditioned by circumstantial factors, such as a progressive reduction of autopsy orders for suspected SIDS.

SIDS, Autopsy, Postmortem Examination

G4 A Five Year Retrospective Study of Unnatural Deaths in Children 12 Years and Younger in Singapore From 1997-2001

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The goals of this presentation are to identify the recent 5 year trend of unnatural deaths in children aged 12 years and below, in Singapore, so that greater awareness can be directed at preventing such deaths. The outcome is the identification of significant characteristics in the major subgroups of unnatural deaths.

The Death Investigation system in Singapore is a Coroner's system where all sudden unnatural and violent deaths are reportable to the Coroner. Annually, some 3300 Coroner's cases are reported and of which 2000-2200 cases are autopsied. All unnatural deaths are autopsied. The Centre of Forensic Medicine of the Health Sciences Authority carries out all forensic autopsies centrally for all of Singapore.

A previous study of accidents and poisoning in children in Singapore from 1979-1984 by the late Professor T.C. Chao revealed the three leading causes as road-traffic accidents (28.3%), drowning (26.75%), and falls/falls from height (25.10%). Since then, Singapore has undergone tremendous social and technological change. Economic development has seen Singapore moving into the ranks of developed countries. The population has also increased to 4 million with the influx of foreign talent.

Over the 5-year period of 1997-2001 under study, there were a total of 139 unnatural deaths in children aged 12 and below (average of 27.8 cases per year, or an incidence of 3.17 per 10,000 population). This marks a substantial fall in the absolute number of fatalities even when compared against the narrower scope of the previous study which covered only accidental deaths. Presently, the 4 leading manners of death are: Fall from Height (25.9%), Drowning (18.7%), Road Traffic Accidents (17.3%), and Homicide/Non-accidental Injuries (NAI) (13.7%). The age distribution is 40.3% (birth to 3 year olds), 20.1% (4 to 6 year olds), 13.7%(7 to 9 year olds), 25.9% (10 to 12 year olds). Overall gender Ratio is M: F 2.2 to 1.

Some Interesting Findings:

1.The vast majority of fall from Height took place at high-rise residential buildings. Of particular interest is the appearance of childhood suicides in this group.

2. The pattern of drownings has shifted from the younger age group to the older age group. Drowning is in the majority now occurring outdoors.

3. As for Road Traffic Accidents, childhood fatalities now accounted for 2.27% all RTA fatalities over the same period, the group being almost evenly divided between pedestrians and vehicular passengers.

4. The appearance of Homicides/NAI within the top 4 leading causes of unnatural deaths.

5. Asphyxia due to Foreign Body has largely disappeared.

The presentation will provide further study of the leading causes and compare the results of the previous study and the present one. It will also offer possible reasons to explain the differences.

Unnatural Childhood Deaths, Childhood Suicides, Accidental Deaths

G5 Bone Scintigraphy and Battered Children: Limit and Indication About a Case Report

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The goals of this presentation are to clarify the place of bone scinitgraphy in the diagnosis of child abuse.

The diagnosis of battered child is difficult to make in certain cases. Because this diagnosis can have legal and administrative implications, a reliable diagnosis is crucial. A false-positive diagnosis of ill treatment could have as serious consequences as a false negative diagnosis. Bone scintigraphy may reveal some bone lesions which are undetected on standard radiography. Conversely, images on bone scintigraphy are not specific to non-accidental injury syndrome. The authors present the case of a young child who had an abnormal image on bone scintigraphy. Based exclusively upon these results, the pediatrician notified the authorities. The resulting inquiry revealed that the image was due to accidental muscular lesions and not to inflicted skeletal trauma.

Most traumatic injuries are identifiable by routine radiography which is highly sensitive, particularly in the detection of skull fractures and subtle metaphyseal injury. False negatives may occur however. The superior sensitivity of bone scintigraphy is most evident in the assessment of rib fractures, acute non-displaced long bone fractures, and subperiosteal hemorrhage. This exam also lacks specificity and should not be performed individually as it may lead to mistakes as in the presented case. In addition, bone scintigraphy is not ideal for certain body areas principally the cranium, and there is no broad consensus on indications for bone scintigraphy. Literature review indicates that certain authors suggest the use of radiological surveys before the age of 2, and after the age of 2 only perform bone scintigraphy. If images are noted on scintigraphy, examination is completed with focus radiography. Other authors suggest that both exams be carried out systematically, while still others suggest bone scintigraphy after the age of 1 with radiological survey or a scintigraphy recommended.

Faced with the absence of consensus, the authors have proposed a multicenter (5 hospital) study to clarify the role of radiographic skeletal survey versus scintigraphy in the diagnosis of child abuse. A concordance study is used between the diagnosis of child abuse based upon clinical features and skeletal survey either with clinical features or bone scintigraphy. Bone scintigraphy and radiographic skeletal surveys are performed on all children within the first 48 hours of hospitalization if possible based upon strict protocols which are followed in all centers. Independent examinations will be carried out and the findings correlated. Because the pediatrician and the medical examiner need precise diagnostic tools for the diagnosis of battered child syndrome, the final stage of the project is to quickly improve recognition of child abuse by reliable methods to limit the number of complementary examinations and irradiation.

Battered Children, Bone Scintigraphy, Skeletal Survey

G6 Fatal Capnocytophaga Infection Associated With Splenectomy

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The goal of this presentation is to correctly diagnose fatal sepsis due to Capnocytophaga in those at risk. This poster will address the source, site of colonization, and laboratory growth characteristics of Capnocytophaga. A clinical case study will be summarized.

Capnocytophaga can cause rapidly progressive sepsis leading to adult respiratory distress syndrome (ARDS), disseminated intravascular

coagulation(DIC), and death in splenectomized individuals. The forensic pathologist should be aware of the characteristic features and clinical presentations of Capnocytophaga infections in order to make this diagnosis.

This case study involves a 44-year-old male who was taken to the emergency room complaining of "not feeling well" for several days. On admission, he was hypotensive and febrile. He was placed on oxygen, but became progressively worse over a four-hour period. His X-Ray was clear on admission, but four hours later showed changes consistent with ARDS. The differential diagnoses included hantavirus, plague, and tularemia. A Wright stain of the peripheral blood smear revealed rod-shaped intracellular bacterial forms within polymorphonuclear cells. He developed DIC, and died. His medical history included a past motorcycle accident, which resulted in rib fractures, pleural adhesion, and a splenectomy for a lacerated spleen. Socially, he lived in a trailer and spent time outside collecting scrap metal to sell. He hunted squirrels and rabbits, and was recently given a German Shepherd puppy. Several cuts and scratches were observed on his forearms and hands.

Autopsy revealed congested lungs, weighing over 1000 grams each, bilateral pleural effusions, hemorrhagic skin lesions, lymphadenopathy, and status-post splenectomy. At the time of autopsy, cultures were obtained. The slow growing organism Capnocytophaga was considered in the differential diagnoses and chocolate agar cultures proved positive.

Canine Capnocytophaga is found in normal flora within the oral cavity of healthy dogs and cats. C. canimorsus and C. cynodegmi can cause localized wound infections and/or systemic infections in people who have been bitten, licked, scratched, or merely exposed to cats or dogs. The cuts and scratches on the decedent's arms may have been the exposure site for the zoonotic infection. Those at highest risk are generally individuals with an underlying disease or condition predisposing them to infection with this organism. Risk factors commonly include previous splenectomy and alcohol abusers, and less commonly chronic obstructive pulmonary disease, pulmonary fibrosis, Hodgkin's disease, hairy cell leukemia, Waldensrom's macroglobulinemia, malabsorption syndrome, renal disease, and steroid use (systemic or topical). Because the association with asplenia is frequent, it suggests that the reticuloendothelial system plays an important role in containing the infection. Illness can range from self-limited disease to severe infection characterized by DIC and death. Some of the major clinical features have included cellulitis, meningitis, fulminant bacteremia with septic shock, renal failure, hemorrhagic skin lesions reminiscent of menigococcal disease, pneumonis with empyema, and bacterial endocarditis. The clinical picture can look identical to meningococcal disease with Waterhouse-Friderichsen syndrome, DIC, purpura fulminans, and symmetrical peripheral gangrene. Capnocytophaga has previously been misdiagnosed as plague.

The diagnosis of Capnocytophaga is made by culture. Capnocytophaga is a fastidious gram-negative bacillus that grows slowly on blood or chocolate agar, leaving a yellow pigment. Because it grows slowly and will not grow on MacConkey's agar, it is advisable to inform the lab that this diagnosis is being considered. Capnocytophaga has gliding motility, requires carbon dioxide under either anaerobic or aerobic conditions, and ferments glucose.

In summary, it is important for the forensic pathologist to be aware of Capnocytophaga as an organism resulting in overwhelming sepsis and death in splenectomized individuals. A thorough social, medical, and surgical history, clinical presentation, and cultures are important in making the diagnosis of Capnocytophaga infections.

Capnocytophaga, Sepsis, Zoonotic

G7 Look Until You See: An Unexpected Delayed Death Following a Motor Vehicle Accident

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By attending this presentation, the participant should expect to gain a renewed appreciation for the fact that small and seemingly unrelated phenomena can coalesce to produce a significant outcome. This poster has three objectives: to highlight the importance of a thorough review of all available resources from the events surrounding an accident and subsequent death; to reinforce the importance of approaching the complete autopsy without bias to avoid missing important details; and, to provide a brief review of the literature pertaining to splenic injury in motor vehicle accidents.

Although deaths due to motor vehicle accidents are commonplace in today's mobile society, this case report emphasizes several important points. Careful attention must be given to multiple aspects of an individual's life when conducting a medico-legal death investigation. Coupling information from the accident scene with the antemortem medical encounter and the medical history was essential, in conjunction with a complete autopsy, to arrive at an understanding of all the contributing factors in this initially surprising cause of death.

A 37-year-old white female sustained apparently minor injuries in a single vehicle accident in which she was the belted driver. At the emergency room of a rural hospital, she complained only of a headache and some lower back pain. The physical exam noted a frontal contusion and specified that the abdomen was soft and non-tender. All imaging studies obtained (plain film only) were negative, and the only significant lab test revealed thrombocytopenia. The patient was discharged home, reportedly feeling fine, at 2000 that evening. She woke up at around 0230 with nausea and vomiting but returned to bed with no further complaints. Her parents found her cold and without vital signs at 0630.

Postmortem external exam revealed the previously noted frontal contusion and a newly prominent periorbital ecchymosis. A few scattered contusions were also noted on the extremities. Notably absent were any abdominal contusions. The internal exam began with the unexpected discovery of free blood trickling from the abdominal cavity. The hemoperitoneum was significant, with slightly over 1000cc of free blood recovered from the abdomen. Further exploration of the organs *in situ* demonstrated a pale, nodular liver and a grossly enlarged spleen with a large subcapsular hematoma. Examination and dissection of the spleen revealed a rent in the capsule in addition to the Grade III laceration in the body of the organ. The exam of the head revealed a subgaleal hematoma but was negative for any deeper trauma including epidural, subdural, or subarachnoid bleeding and parenchymal contusions.

The deceased in this case was the unfortunate victim of synergistic activity between her disease processes and the injuries she sustained in the accident. The overtly cirrhotic liver was the result of her known history of chronic ethanolism and her questionable history of viral hepatitides. The cirrhosis, in its obviously advanced stage, had caused a significant degree of splenomegaly. This splenomegaly in turn was likely responsible for the thrombocytopenia indicated by the lab results at the emergency room.

The blunt injury to the abdomen sustained in this apparently minor car accident was sufficient, partly due to the massively engorged state of the spleen, to cause a Grade III splenic laceration. The injury to the parenchyma of the spleen continued to bleed into the subcapsular space. Because of the thrombocytopenia, likely caused by the hypersplenic state resulting from the cirrhosis, the victim was apparently unable to achieve sufficient hemostasis. The subcapsular hematoma continued to

expand and eventually ruptured the capsule, perhaps by simply extending an existing defect sustained in the initial impact injury. This resulted in the generous hemoperitoneum and subsequent death of the victim. The automobile accident in this case would have caused minor to moderate injury in an otherwise healthy person. However in this victim, the diseased organ systems in conjunction with the mechanism of injury resulted in the lethal outcome.

**The views expressed in this abstract are those of the authors and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.*

Motor Vehicle Accident, Blunt Abdominal Trauma, Splenic Laceration

G8 Basketball-Related Sudden Deaths in Young Adults: A Medical Examiner Study

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The goal of this presentation is to examine the cause of sudden deaths in non-professional adult athletes playing basketball.

Twenty-three cases were reviewed of sudden cardiac death of young adults who were playing or had just stopped playing basketball at the time they expired. The time period of this study was four years, 1997 to 2000. All 23 cases underwent complete autopsy and toxicologic examination at the Office of the Chief Medical Examiner (OCME) for the State of Maryland. Of all the sports-related sudden deaths examined at this office during this time period, basketball was the sport associated with most sudden deaths. This particular type of exercise may be unusually stressful for certain people. This presentation will examine why, as well as look for the anatomic basis for the sudden deaths in this population of non-professional athletes who were relatively young adults and physically active. Of the 23 cases, all were male; the average age was 30 years. The authors found that most showed evidence of at least one significant heart condition, unknown prior to autopsy. The most frequent abnormality was atherosclerotic cardiovascular disease (almost one third of the cases). Less common findings included: congenital heart disease, left ventricular hypertrophy, right ventricular dysplasia, and myocardial scarring. Of note, several deaths occurred in those who were overweight; there also appeared to be an association between the amount of obesity and left ventricular hypertrophy observed in some.

In conclusion, in the authors' population of non-professional adult athletes dying of sudden death while playing basketball, the most common cause of death was atherosclerotic cardiovascular disease.

Sudden Death, Basketball, Autopsy

G9 The Significance of Tattoos in Forensic Autopsy

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The attendees will learn the profile of tattoos in forensic autopsies in Istanbul, Turkey, and the importance of tattoos.

The oldest tattoos have been found on Egyptian mummies with tattoos of various body parts reflecting the profession, life style, psychological state and habits of the tattooed in the past. In recent years, tattooing has become fashionable among youngsters and revision of the significance of tattooing may be required, though tattooing still remains an important indicator of the particular peer group tendencies, life style, and personality traits.

In this study, the forensic autopsy records of the State Institute of Forensic Medicine, Ministry of Justice of Turkey were reviewed for 4 years (1998-2002) and those with tattoos were further evaluated. Data regarding the personal information, the cause and origin of death, tattoos, self destructive and figurative scars, and their locations and features were recorded in detail. The data were then analyzed and discussed within the scope of the literature.

Of the 10,966 forensic autopsies in that 4-year interval, 269 (2.4%) had tattoos. 10.4% were female and 89.6% were male. In both sexes, 25.3% were in the 21-25 year age group, 39.4% had self-destructive scars, and 1.8% had figurative scars. The frequencies of cause of death in descending order were as follow: 14.9% drug intoxication, 13.4% gunshot wounds, 13.4% stabbing, and 7% methanol intoxication.

Tattoos, Death, Turkey

G10 Epilepsy—A Major But Disregarded Health Problem

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Myocardial fibrosis might be the organic substrate for malignant arrhythmia in patients with epilepsy, which can lead to sudden death either due to natural causes or due to traffic accidents.

It seems to be the general opinion that epilepsy is of no risk to traffic and there is a tendency all over the world to be less restrictive to provide a driver's license to patients with epilepsy. A study from Denmark, the Accident analysis group, Odense, has shown that epileptics have a seven times increased risk to be involved in traffic accidents compared to controls.

Moreover, epidemiological studies have established sudden unexpected death (SUDEP) to be the most important cause of epilepsy-related death as a direct consequence of seizure activity. Postmortem reports have shown patchy subendocardial fibrosis in the otherwise normal hearts of these epileptic patients, although these findings are controversial. However, it is well known that such small areas of myocardial fibrosis may serve as a potential substrate for malignant arrhythmia causing sudden death.

The following two cases illustrate this issue and should encourage researchers and the public to focus on the problem.

A 33-year-old truck driver drove for no apparent reasons in low speed off the road and into a train wagon. The front of the truck was crashed and he was found wedged in behind the steering wheel. The cause of death was bleeding due to lesion of the left axillary artery. He was known to suffer from epilepsy since the age of 17, was seen at the neurological department twice a year, and was on antiepileptic treatment. He had earlier been disqualified from driving for one year due to a solo accident and later on for 3 month due to an epileptic fit.

An otherwise 23-year-old healthy woman with drug refractory epilepsy was found death in her bed. The cause of death was an epileptic fit based on findings at the scene, autopsy, microscopy including neuropathological examination and toxicology. Especially, microscopy of the myocardium including the conduction system showed focal myocardial fibrosis of the endocardium located to the posterior papillary muscle.

Conclusion: focal myocardial fibrosis can be the organic substrate for malignant arrythmia triggered by an epileptic seizure which cannot

be avoided by antiepileptic treatment and which has to be taken into consideration when authorizing an epileptic driver with a driver's license.

An ongoing not yet published prospective case-control study from the authors' group has shown epileptics to have focal myocardial fibrosis.

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Epilepsy, Myocardial Fibrosis, Traffic Accident

G11 Death at Dinner: Foreign Body Asphyxiation – An Unknown Cause of Death in the Elderly?

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Food asphyxiation is a common problem whenever and wherever people eat. Knowledge of predisposing factors might help to prevent asphyxial deaths.

The authors reviewed 42,745 consecutive autopsies done during an 18-year period (1984 to 2001) at the Institute of Forensic Medicine, Vienna. Demographic features and predisposing factors were determined for the 232/42,745 (0.5%) cases of fatal foreign body asphyxiation.

There was a predominance of men (134 men, 98 women); the overall male-to-female ratio was 1.4:1. 105/232 persons (44 males, 61 females) were aged 65 years or older. 69% of the fatal incidents occurred in private homes, about 15% in a restaurant. The remainder died in nursing institutions (9.5%), public areas (5%), or in hospitals (1.5%).

On 137/232 (59%) occasions observers were present at the time of the incident and subsequently called the Emergency Service. In 125 (91%) cases, neither the observing laymen nor the majority of the emergency medical technicians and physicians who would have been able to intervene recognized the definite diagnosis. Only 12 cases, most of all victims younger than 65 years, have been correctly identified during cardiopulmonary resuscitation. Misdiagnoses were cardiovascular failure (59%), intoxication from medication, drugs or alcohol (26%), and epileptic seizures (10%).

By medical history 21% were considered to be chronic drinkers. Blood alcohol concentration was determinate in all of the 232 cases. 44% of the victims were sober at the time of death. The other deceased (56%) had blood alcohol levels ranging from 0.05 % to 4.35 %. In another 39 (17%) corpses, findings from toxicological analysis were positive for sedative and/or hypnotic drugs.

Only 22 (9%) victims had intact dentition. 29% had partial or complete dentures, 25% were edentulous, and 37% had defective or partial dentition without dental prostheses at the time of death.

The food most often choked upon was either a segment of unchewed meat (48%) or a large piece of sausage (20%). A bolus consisting of bread, cheese, egg, cookies or pastries was found in 14%, while fruit or vegetables accounted for another 7%.

In 71% the obstructing foodstuff or other foreign objects were located in the supraglottic region or within the glottis itself, presumably in reach of fingers. In the other cases (29%) the bolus was lodged in the infraglottic area.

Concomitant with the advanced age groups is the problem of inadequate dentition. Whereas meat and sausages were the obstructing food in all cases of the people with intact or defective dentition - soft, friable, or loosely textured foods were found predominately in the edentulous, elderly victims. Future improvements in rescue techniques should take this into consideration.

Such fatal accidents could have been prevented easily. Effective prevention depends on understanding of the nature and frequency of the accidental asphyxial deaths, the facts that led to their occurrence, and a high degree of suspicion.

Foreign Body Asphyxiation, Elderly, Autopsy

G12 Death During EMS Transportation

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The goal of this presentation is to study the cause and manner of death and other important epidemiological data of those individuals who die in an ambulance car during EMS transportation.

Materials and Methods: Retrospective analysis was made of 1,001 ambulance reports and autopsy records of deaths during EMS transportation between 1996 and 2001. According to local regulations, everyone who passes away while being in an ambulance car, after a 911 call, should undergo forensic autopsy evaluation. Statistical calculations were done from many points of view.

Results and discussion: Averagely 62% of the deceased were male, 38% were female (average m/f ratio was 1.58, but it was 2.18 in accidental deaths, and 1.29 in suicides). Natural cause of death was listed in 81.2% of the males (out of this was 71% cardiovascular mortality). Breaking down to age categories, natural cause of death was present in only 19 % in the age group between 21-30 y. and it was in 94% in the older age group (over 71 years of age). In females, the natural cause of death represented 82.2% and out of this cases 78% were cardiovascular origin, with scatter similar to males.

Upon further investigation natural causes of death, particularly cardiovascular deaths (pre-hospital cardiac arrest), it was obvious, that the majority of these events happened at home. Analysis will be given on other scenes of occurrence in different age categories by gender. Pathologic condition of the hearts was analyzed, regarding weight of the heart (left ventricular hypertrophy), myocardium (recent and old myocardial infarction), coronary arteries (AS, plaque rupture, etc.) and pulmonary arteries. Also compared were the accuracy of diagnoses made by ambulance personnel and diagnoses made after forensic autopsy.

Accidental cause of death was listed in 10.3% of males and 7.5% of females, with somewhat different age distribution curves. Major injuries will be detailed and the usefulness of resuscitation on moribund trauma patients while being in an ambulance car.

Suicide cases died during transportation represented 3.7% of all male cases and 4.6% of all female cases. Important details will be provided on the methods of suicides most likely lead to fatal outcome in such a short transportation time.

Homicidal victims were only 4.8% of all transported male patients and 5.7% of all female patients. Again, the method of homicides and the associated serious injuries will be presented.

Data will be presented on what part of the transportation process during which the patient was declared dead (before leaving the scene, first or second part of the transportation, dead-on-arrival/DOA). Also an important factor determining survival is the ambulance response time, how fast the ambulance crew can reach the patient and how they can follow the chain-of-survival concept. These particular issues will also be discussed.

Death in Ambulance Car, EMS Transportation, Out-of-Hospital Cardiac Arrest

G13 Sudden Asphyxial Death Due to Regurgitation of a Pedunculated Esophageal Lipoma: A Case Report and Review of the Literature

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The goals of this paper are to present an unusual case of sudden death due to asphyxia by regurgitation of a pedunculated esophageal lipoma is presented, and a review of relevant literature is performed.

Of all esophageal neoplasms, 20% are benign. Benign esophageal tumors include leiomyomas, which are the most common, as well as fibromas, hemangiomas, and lipomas. Lipomas are extremely uncommon, representing approximately 4% of benign esophageal tumors. They usually present in the elderly and more commonly in men, although no other definitive risk factors have been identified. Most arise in the submucosa, and may be sessile or pedunculated. When pedunculated, the most common symptom is dysphagia, followed by a sense of fullness in the throat or respiratory symptoms such as wheezing or recurrent respiratory infections. However, the first sign may be regurgitation of a mass into the mouth following coughing, eructation or vomiting. In rare patients, the mass obstructs the oropharynx, leading to asphyxia. To date, less than ten asphyxial deaths due to regurgitation of a pedunculated esophageal tumor have been reported in the literature.

The authors present a case of a 44-year-old man with a history of seizures that suddenly collapsed after a witnessed seizure. Upon arrival at the emergency room, he was apneic. The anesthesiologist identified food and gum in the mouth, which were cleared, and a white mass was identified in the pharynx. When oral intubation was impossible, a tracheostomy was performed for airway control. Unfortunately, resuscitation efforts were unsuccessful and the patient was transferred to the medical examiner's office for examination.

At the time of autopsy, a pedunculated esophageal mass was present obstructing the oropharynx. The mass was consistent with a lipoma on gross and microscopic examination. Additional significant autopsy findings included two small cavitary lesions in the left temporal and occipital lobes of the brain, which were most likely responsible for his seizure disorder.

Although rare, pedunculated esophageal tumors are important entities to consider in patients with complaints of dysphagia or vague respiratory complaints, especially in otherwise healthy individuals. When undiagnosed, the presenting symptom may be sudden unexpected death as in this case.

Sudden Death, Asphyxia, Pedunculated Esophageal Lipoma

G14 First Report of Fatal Outcome by Accidental Intrathecal Injection of Vindesine

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The goal of this presentation is to describe the first case of fatal accidental intathecal injection of vindesine.

Patients who are treated for cancer are exposed to risks including mistaken doses or routes of administration of toxic agents. The authors describe a case of the accidental intrathecal administration of vindesine which resulted in a fatal outcome. Pathologic findings of the central nervous system are reported and compared to the literature. Medical responsibility is also examined.

History: This 25-year-old woman had stage III non-Hodgkins lymphoma with clinical manifestations including asthenia. Lymphomatous cells were present in the cerebrospinal fluid (CSF), but neurologic function was reportedly good. Therapy included systemic vindesine and intrathecal administration of methotrexate and methylprednisolone. Vindesine, which should only be injected intravenously, was accidentally injected intrathecally. Prior to removal of the needle, a first washing of the CSF was performed. The woman was then transferred to the neurosurgical department to drain and wash the CSF. Her clinical course was slowly progressive over 6 weeks resulting in death. On the first week she suffered from leg pain with decrease in motor activity, and distal paresthesia and sensory loss occurred. On the second week, lower extremity paralysis occurred followed by upper extremity paralysis. Ascending sensory and motor dysfunction were observed. Her consciousness level began to decline and confusion progressed to lethargy. On the fourth week she was comatose and respiratory arrest occurred 2 weeks later; she died 6 weeks after the intrathecal injection of the vindesine. An autopsy was performed and included spinal cord examination by a pathologist.

Autopsy and Discussion: Autopsy was performed 2 days after death. The terminal event was pulmonary edema. Two fibrotic masses filling the upper mediastinum and infiltrated by lymphocytes were thought to represent residual tumor. The brain weighed 1250 g and was edematous. The microscopic findings in the spinal cord will be described.

Vindesine, a widely used anti-tumor agent, binds tightly to microtubules including mitotic spindle cell tubules and neurotubules. Experimental intrathecal administration of vincristine or vinblastine produces striking neuronal changes, creating vast aggregates of neurofilaments and crystalline masses possibly composed of neurotubules with the crystals appearing within 30 minutes of direct exposure but disappearing by 8 days. Neurotoxicity of vindesine has the same physiopathology. Some cases of accidental injection of vincristine have been reported. No case involving vindesine has been previously reported. The clinical, autopsy, and microscopic findings in this case are compared with others.

There is no recognized antidote to vindesine neurotoxicity leaving the clinician few therapeutic options. Immediate attempts to remove the toxin seem the most rational approach at present but limited experience in these cases indicates that piecemeal CSF drainage or exchange is not significant in preventing vindesine effects. In this new case, fatal ascending clinical progression could not be avoided.

Vindesine, Intrathecal, Death

G15 The Importance of an Interdisciplinary Review Process in the World Trade Center Mass Disaster Investigation

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Upon completion of this presentation, attendees will be informed about potential problems associated with the recovery and identification of human remains after a mass disaster and illustrate the value of cooperative effort between medical examiners, anthropologists, DNA specialists and other experts.

In the wake of the events of the September 11, 2001, terrorist attacks on the World Trade Center, the Office of Chief Medical Examiner, New York was faced with the daunting task of identifying the nearly 3000 victims of the attacks. For over 10 months, a constant and heavy flow of remains was delivered to the OCME with which the pathologists, anthropologists, DNA experts, dentists, investigators, and numerous other members of the OCME staff were forced to deal in a rapid fashion. During the triage process, in the interest of avoiding the potential complications of commingling the OCME pathologists and anthropologist were supposed to consider only those remains that were connected by tissue (bone, skin, muscle, etc) to be definitively the remains of a single individual and assign a single identifying case number. Due to the long shifts and large number of remains that needed to be processed this was not always the case as was discovered after the first identifications had been made and from commingled DNA results.

It could not be assumed, for example that the remains delivered in a single body bag were those of a single individual. Even remains delivered within clothing might not belong to a single individual given the number of factors that may have influenced their deposition especially later in the recovery process. Initially, during the triage process of sample collection, little effort was made to use traditional anthropological methods for sex, age, and ancestry determination. In addition, there was also a need for more detailed descriptions of the remains because victims' families were interested in receiving this information.

Hence, on May 28th, the Anthropology Verification Project was initiated. Without the same time constraints endured by the OCME pathologists, a team of anthropologists reopened each of the more than 19,000 logged in sets of remains to verify the existing descriptions and look for inconsistencies and commingling. During the verification process, the anthropologists encountered extreme levels of fragmentation, variable decomposition, varied stages of mummification and skeletonization, and the effects of prolonged exposure to fire, all of which complicate the effects of commingling. In addition to the verification of the existing file material, the anthropologists were also able to add detail to the descriptions with regard to skeletal tissue, which was often more easily recognizable than the soft tissue remains. These descriptions can be revisited in the event that DNA matches are made for individual remains. It can be insured for instance using DNA that there are no duplicated body parts sharing the same case number. Non-human remains recovered from the site were separated from the remains of victims of the attack.

DNA typing confirmed the value of this effort. All cases in which the Anthropology Verification Project decided to assign additional identifying numbers were retested and in each case at least one of the fragmented remains was determined to be from a second individual. This process not only eliminates wrong associations but might also allow for additional identifications that otherwise might have gone undetected.

Mass Disaster, Anthropological Review, DNA Typing

G16 Media Relations and the Identification of the September 11 Pentagon Terrorist Attack Victims: The Perspective of the Office of the Armed Forces Medical Examiner

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The goals of this presentation are to review challenges faced by the Armed Forces Medical Examiners in effectively responding to the international news media following the September 11 Pentagon terrorist attack; and to provide guidance to medical examiner offices when dealing with intensive media interest following mass fatality incidents.

The September 11 terrorist attack at the Pentagon posed new challenges to the Office of the Armed Forces Medical Examiner (OAFME) in responding to intensive, international media interest. This response included extensive message development coordination between OAFME's spokesperson and other Department of Defense officials; creation of a "virtual" Joint Information Center (JIC) to communicate findings; and detailed attention towards delivering the appropriate message on the status of identifications while remaining sensitive to the needs of the victims' families.

In the chaotic hours immediately following the attack, the OAFME spokesperson notified DoD public affairs officials of his availability to respond to media inquiries; provided 24-hour pager/home telephone information; and prepared background papers about OAFME's role in the investigation. This information proved essential in helping to refer media inquiries rapidly to OAFME for reply.

The spokesperson completed this preparatory phase with jurisdictional issues over custody of the remains still unresolved between OAFME and the Office of the Chief Medical Examiner of Virginia in the first 24 hours following the attack. Media inquiries began in earnest on September 12, when a reporter from The Washington Post called seeking an explanation and clarification of the situation. The resulting September 13 article ("Recovery Continues and Scientists Wait for Bodies") portrayed OAFME as prepared to act, but by that time the victim identification operation had commenced in Dover.

Communications with the media commenced in earnest two days after the attack. The JIC enabled OAFME to exchange information and coordinate appropriate responses with Dover AFB and DoD officials. U.S. Air Force casualty affairs officials held a short briefing when the remains arrived at the mortuary; however, OAFME officials did not participate, and at no point during the operation did OAFME conduct a press briefing. Instead, OAFME's spokesperson represented the chief medical examiner to the media and provided timely and accurate commentary over the next two weeks regarding the status of the operation. He referred journalists to former OAFME chiefs for expert analysis, and focused media attention on the work being conducted at the Armed Forces DNA Identification Laboratory (AFDIL).

Over the next two weeks approximately two dozen international print and electronic media representatives conducted interviews with the OAFME spokesperson or AFDIL staff, including CNN, National Public Radio, The News Hour with Jim Lehrer, the Associated Press and The Times of London. AFDIL staff also received positive coverage for their work providing DNA identifications of the United Airlines Flight 93 crash victims in Somerset County, Pa. DoD officials provided daily updates regarding the number of identified victims and the return of remains to family members.

From late September until early November 2001, media interest lessened and focused almost entirely on the identification and disposition of the terrorists' remains. At the close of the investigation in November 2001, OAFME's spokesperson participated in a joint DoD

planning session for release of information to the families. He also developed background papers for DoD officials on the complexity of the identification process and served as a contact point for questions from next-of-kin and interested media. DoD did not formally release information about the close of the investigation; however, The Washington Post on November 21 covered the story under the headline "Remains Unidentified for 5 Pentagon Victims; Bodies Were Too Badly Burned, Officials Say."

In conclusion, OAFME achieved generally positive and timely coverage for its work following the attacks. Multiple requests for information were handled simultaneously, and AFIP experts were utilized for comment as needed. Future OAFME communications following mass casualty incidents could benefit from the posting of background information on the AFIP website, and from an initial press briefing by OAFME personnel, subject to DoD guidance and approval. OAFME experience in this and other mass fatality incidents reflects the importance of appointing a single spokesperson, developing and releasing messages in a joint setting with other investigating agencies, and utilizing selected experts for public commentary as needed.

Armed Forces Medical Examiner, Media Relations, Pentagon 9-11 Identification

G17 Victim Identification Following the Crash of United Airlines Flight 93

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This presentation examines the overall victim identification forensic response to the crash of United Airlines Flight 93 on September 11, 2001. The various stages of the response will be examined, and the unique issues of this event will be discussed. Final figures on the methods of victim identification will be presented.

The last of the four terrorist attacks on September 11, 2001, was the crash of United Airlines Flight 93 (UA93). The Boeing 757, carrying 44 passengers and crew, was en route from Newark, New Jersey, to San Francisco when the plane was overtaken by four hijackers and turned back towards the Washington, DC, area. At about 10:10 am, the aircraft crashed into an abandoned strip mine near the town of Shanksville, PA. According to media accounts based on cell phone calls, several passengers attempted to take control of the cockpit shortly before the crash.

The Somerset County coroner and law enforcement and fire/rescue personnel were the first to the crash scene. It became evident to the coroner that outside support would be needed to help identify the remains. State volunteer response teams, including the Pennsylvania Dental ID Team (PADIT) and the Pennsylvania Funeral Director's Association, assisted the coroner in selecting and organizing a morgue site. The Federal Bureau of Investigation took control of the crash scene because of the criminal nature of the event. Initial confusion regarding the proper procedure of the deployment of the U.S. Department of Health and Human Service's Disaster Mortuary Operational Response Team (DMORT) delayed arrival of the team. Attempts to have the site declared a federal disaster through the state proved unsuccessful and the crash did not fall under the Aviation Disaster Family Assistance Act. Ultimately, DMORT responded under a memorandum of understanding with the FBI. A team of nearly 60 DMORT members, comprised largely of the Region III team and augmented by members from other DMORT regions, was on site for two weeks. DMORT operation focused on victim identification and the family assistance center.

This response featured several firsts for DMORT, of note because of their importance for future responses. These included the first use of a contract morgue, the deployment of the DMORT DNA team, the establishment of protocols documenting the operation of each morgue section, the response of the DMORT Family Assistance Center team, the collection of family blood reference samples, and the inclusion of a formal remains triage station.

Typically, DMORT relies on the Portable Morgue Unit (DPMU) to supply and equip the team for victim identification operations. However, the DPMU was deployed to the World Trade Center disaster, so equipment and supplies for the UA93 response was pieced together from a variety of sources. A majority of the materials for the morgue were obtained under a contract with Kenyon International Services. Kenyon maintains a mobile morgue that is a scaled down version of the DPMU. Kenyon transported the mobile morgue to Somerset and provided staff for resupply and equipment purchasing. The local hospital and area funeral homes also provided morgue materials. Other pieces of specialized equipment were obtained elsewhere from local universities and hospitals.

This activation marked the first response of the DMORT DNA team. This three-person team (consisting of a team leader/pathologist, an anthropologist, and a dentist) provides reliability in the collection of DNA specimens. Because the Armed Forces DNA Identification Laboratory (AFDIL) conducts most of the DNA identification work during a DMORT response, the team was trained by AFDIL earlier in 2001. Initial assessments of the UA 93 crash scene revealed highly fragmented remains, indicating that DNA would play an important role in ensuring positive identifications. The delay in the DMORT response allowed the DMORT team commander to meet with AFDIL staff to address DNA requirements were met before starting the operation in Somerset. During the morgue operation, DMORT DNA team personnel worked closely with AFDIL staff during the collection of DNA samples.

The DMORT Family Assistance Center (FAC) team, who had completed training a few days before September 11, had their charter deployments in Somerset and New York. The UA 93 FAC team worked out of the Seven Springs Mountain resort (nearly 25 miles from the morgue site), the location of the family center selected by United Airlines. The FAC team worked closely with the airline, the Red Cross, and the National Transportation Safety Board to collect victim information. The national travel restrictions in the weeks following the crash posed some problems in obtaining records, and some families chose not to travel to the assistance center. To assist the FAC team, the U.S. Department of Health and Human Services deployed a Disaster Medical Assistance Team nurse to collect family blood and direct reference samples for DNA analysis.

Given some of the concerns involving the numbering and processing of fragmented remains at previous responses, a triage station was established. Staffed by a pathologist, two anthropologists, and a dentist, the triage team sorted through the remains, first separating personal effects from remains. Once the personal effects were transferred to the FBI, the remains were examined to ascertain their potential for identification. Potentially identifiable remains, those with dental remains, friction ridge patterns, unique characteristics, or potentially usable for DNA analysis, were assigned a sequential number, a file was created, and the specimen was sent through the morgue. Non-identifiable remains (small pieces of fatty tissue, burned tissues, and other small fragments that would be unsafe for DNA collection) were placed in containers, weighed daily, and stored separately from the numbered remains. The triage process helped to focus work on remains that would most likely lead to identification, eliminated unidentifiable remains from

the morgue flow, reduced unnecessary paperwork, and allowed the numbering process to remain simple and easily understandable.

The nature of the crash required creating written protocols for each morgue station. Team members at each morgue station submitted the protocol to the morgue manager, who then provided them to the FBI for review. These protocols were compiled, producing a document describing the particulars of the United 93 morgue operation.

The DMORT response concluded on September 25. The final numbers for victim identification indicate that DNA was the primary tool for identification. There were nearly 1500 fragments of human remains collected during the initial response and subsequent recoveries. Of these, 592 specimens were taken for DNA analysis, and 546 yielded profiles adequate for identification. From these remains, forty positive DNA identifications were completed, and four additional unique DNA profiles were isolated (probably representing the four terrorists). Fourteen positive identifications were made using traditional methods: five dental identifications, seven fingerprint identifications, and two using both dental and fingerprint methods.

Disaster Victim Identification, United Airlines Flight 93, DMORT

G18 Domestic Homicide or International Terrorism? A St. Louis Murder Crosses the Line

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This presentation will provide forensic investigators incite into the workings of an international terrorist group set up in the U.S., and it will provide some clues to exposing and identifying them.

This case was originally presented as a domestic homicide. The daughter of a Palestinian family in St. Louis, MO, was found stabbed to death in her family's home in November of 1989. Her father said that he had stabbed her to death in self-defense. The teenaged girl supposedly had just come home after her first day at work outside of the family's business in a wild state "on drugs." She allegedly demanded $5000.00 from her father. When the father refused the request she supposedly grabbed a knife and attacked him with it. He said he somehow grappled with her and stabbed her in self-defense and she fell to the floor of their residence, unconscious. According to the father's story, he then got a better knife and finished his daughter off by stabbing her to death while she lay unconscious on the floor.

The father's story does not coincide with the autopsy findings. In addition the murder had been tape recorded by the FBI because that agency was tracking a terrorist cell at the residence where the killing took place. The FBI released some of the information on those tapes, which indicated that the girl's parents murdered their daughter with premeditation, to the St. Louis, MO, Office of the District Attorney to ensure the arrest of the suspects because it was known that the suspects were prepared to imminently flee the country.

What really happened was that the parents ambushed their daughter. The unwitting girl never attacked anyone. During a heated verbal argument with her father, the mother grabbed the girl from behind and held her while the father stabbed his daughter to death. This was all recorded on audiotape and transcribed into English and the transcripts were read into court during the ensuing murder trial. The parents were both found guilty of first degree murder and they were both sentenced to death. Because of evidence on the audiotapes, at the time of the trial it was thought that the girl's murder was a so-called "honor death" because she had shamed the family by dating a black man and working outside of the family's business. Subsequently, it was disclosed that the girl's father was being tracked by the U.S. Government because he was a member of the Abu Nidal international terrorist group. The father, Zein Isa, was to go on trial with other Abu Nidal members in the U.S. who were subsequently found guilty of terrorism, but he did not go to the second trial because he was already on death row and he was seriously ill (he died of natural causes a few months later). After the second trial it became known that the female victim, 17-year-old Palestina Isa, was probably murdered not as an "honor death" but more probably because she knew too much about her father's terrorist activity and was likely to disclose this knowledge to others if she were allowed to leave the family and go out on her own.

As a result of the scene investigation of the homicide, together with the autopsy findings and the audiotapes of conversations leading up to the murder and of the murder itself, authorities and a St. Louis, MO, jury were able to come to the conclusion that this was actually a first degree murder punishable by death. In addition, the FBI was also able to establish that Zein Isa was a member of the Abu Nidal terrorist group and that the murder of his daughter may have been a terrorist act committed in the U.S. prior to 911 and prior to the WTC bombing in 1993.

This case required extraordinary good fortune to crack; 6 separate wiretaps recorded the murder so that justice could prevail in court. In the future experts will have to be more vigilant than in the past and will have to develop even better technologies to root out terrorists and protect the public.

Honor Death, Abu Nidal, Terrorism

G19 Smallpox and the Medical Examiner/Coroner System

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The goals of this presentation are to familiarize the medico-legal community with the possible pathological presentations of the initial cases in a smallpox epidemic because of the probability that, in the event of a bioterrorist induce outbreak, such cases will be seen by these first line death investigators.

Medico-legal death investigators are very likely to be the first professionals coming into contact with deaths from a bioterrorist caused smallpox outbreak and must be prepared for this eventuality. This is because (1) in a new eruption of this disease in a non-immune population initial fatal cases often have atypical presentations, and will probably not be definitively diagnosed, even if coming under a doctor's care, and (2) few clinical physicians have seen even suspected cases of smallpox. Pathologists performing official autopsies will and should be called upon to examine such cases and must be cognizant of the possible appearance of any lesions and what specimens are required to confirm the diagnosis.

The threat of a bioterrorist attack in the U.S. using smallpox is being taken quite seriously by all, in spite of no known source of infection outside of either U.S. or Russian control. Terrorists have already done the unthinkable within the borders of the U.S. It is not impossible for bioterrorists to obtain smallpox virus from known or some unknown source. If smallpox were to be released into this country, a number of facts need to be considered by medical examiners who have a high probability of seeing the first undiagnosed cases.

- The probability of a medical examiner seeing these cases depends upon the particular state medical examiner law and the customary reporting procedures in the various jurisdictions. The laws governing public health hazard medical examiner jurisdiction and the customs in places without such statutes will be examined.
- Even without public health hazard jurisdiction, bioterrorist-caused deaths are a type of homicide and should be investigated and certified by the official medico-legal death investigation system. Medical examiners are fully aware of the legally necessary procedures, such as chain of custody in handling specimens that must be followed to support a

criminal prosecution. How this may play out in an international terrorist attack within the U.S. will be discussed.

• This presentation will show what to look for in possible smallpox cases early in a bioterrorist attack. This is important because the first mortal cases will contain a high proportion of victims with atypical disease. Most of us, particularly those who received their medical training after the supposed eradication of smallpox in the early 1970's, received a superficial instruction in the clinical and pathological appearance of the disease. It is time for a knowledge booster.

• It must also be recognized that the civilian population in the U.S. has not been vaccinated against smallpox since 1972. This means that medical examiners do not have immunity to smallpox since vaccination is not effective after about 20 years! Unless there has been a policy shift to vaccinate medical examiners and pathologists performing medical legal autopsies before this presentation, a bioterrorist attack with smallpox is likely to cause casualties within the profession. It is also time for a smallpox immunity booster.

Smallpox, Medical Examiners, Bioterrorism

G20 Autopsy Procedure and Findings in a Case of Inhalational Anthrax

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The goal of this paper is to present to the forensic community the autopsy procedures and findings in a case of inhalational anthrax so that the attendee can learn how to approach and what to expect in this type of case.

In the fall of 2001, there were eleven confirmed or suspected cases of inhalational anthrax of which 5 people died. Prior to the anthrax attacks in 2001, autopsy experience with inhalational anthrax was limited. Reporting the autopsy procedure and findings will make forensic pathologists aware of the precautions that need to be taken and of what to look for at autopsy in this hopefully rare type of case.

By report, this 47-year-old, Black male was an employee of the Brentwood postal facility in Washington, DC. He complained of "flu like" symptoms with a mild non-productive cough, sneezing, nausea, vomiting, and stomach cramps on October 16, 2001. While attending church on October 20 he had a brief self-limited syncopal episode and did not request transport to the hospital. Early the next day he went to the emergency room complaining of vomiting and profuse sweating. He was afebrile and had orthostatic hypotension and was treated with intravenous hydration and was released. Later that day he complained of myalgia, vomited and passed out again. Early in the morning of October 22 his wife found him unresponsive. On arrival to the emergency room he was afebrile, hypotensive, tachycardic and tachypnic. He required intubation and was treated with multiple intravenous antibiotics. Computerized tomography scans were remarkable for pleural effusions, perihilar infiltrates, probable mediastinitis, small bowel wall edema with small bowel air, portal venous air, and ascites. He had a progressively downhill course and was pronounced dead within six hours after arrival to the hospital. Gram stain of sputum and the buffy coat smear of the blood identified gram positive bacilli and direct fluorescent antibody test (dFA) and polymerase chain reaction performed by the Centers for Disease Control and Prevention (CDC) were positive for Bacillus anthracis on antemortem blood specimens. In addition, antemortem blood cultures grew Bacillus anthracis within 18 hours.

An autopsy, based on CDC recommendations that minimized the number and extent of procedures, was performed on October 22, 2001, using standard universal precautions in the isolation room at the OCME. It is recommended that the CDC be contacted prior to performing the autopsy for their suggestions and also to inquire about what type of specimens that they will require for future analysis. Three forensic pathologists and an autopsy assistant performed the autopsy. Since the organisms that one is dealing with at autopsy are vegetative bacteria and not spores, the primary, but minimal risks to personnel are through splashes to mucous membranes and skin injury. Therefore, the eyes, nose, mouth and any prior open skin defects must be covered and protection against cuts and puncture wounds is necessary. As the body warms up and is exposed to air, it is unclear if and when the bacilli can sporulate, therefore gross contamination of the environment that could eventually lead to spore formation should be limited.

Gross autopsy findings showed marked soft tissue edema, pleural effusions, ascites, mutifocal mediastinal and mesenteric soft tissue hemorrhage with extension along the hilar and pulmonary parenchymal bronchi and blood vessels, mild pulmonary hilar lymphadenopathy, friable and hemorrhagic hilar lymph nodes, no gross pulmonary consolidation, and a portion of hemorrhagic distal small bowel without mucosal ulceration. The mesenteric lymph nodes, terminal ileum, and large bowel were unremarkable. The brain and cerebrospinal fluid were not examined. Microscopic examination revealed hemorrhagic necrotizing hilar lymphadenitis, mediastinal soft tissue hemorrhage with mildly increased acute and chronic inflammation, pulmonary perivascular and peribronchial hemorrhage, no evidence of pneumonia, and a section of small bowel with necrotizing infection extending from the periintestinal soft tissue to the lamina propria and not involving the mucosa. Brown and Brenn special stains showed gram positive rods consistent with Bacillus anthracis in the hilar lymph nodes, mediastinal soft tissue, lungs, affected small bowel, stomach, liver, kidneys, adrenals, and spleen. Postmortem blood culture for Bacillus anthracis was negative.

Post autopsy, the isolation room, all instruments, body tray, and outer body bag were washed with at least 10% bleach with at least five minutes of contact time. The body was triple bagged, placed in the freezer, and subsequently transported to the funeral home with the recommendation that mortuarial care be limited to only what is necessary which included the avoidance of embalming and the consideration of cremation.

Investigation and autopsy determined that the cause of death was inhalational anthrax and the manner of death was homicide. The diffuse presence of gram positive bacilli in almost every organ indicates Bacillus anthracis sepsis. This report suggests an anthrax autopsy protocol and presents the autopsy findings. It emphasizes the relatively non-specific gross autopsy findings and the importance of clinical information, mutual cooperation with the CDC, and microscopic special studies that are required to make the proper determination as to the cause of death in this relatively rare type of case. In addition, it reinforces the fact that medical examiners play an important role in public health surveillance.

Anthrax, Bioterrorism, Necrotizing Lymphadenitis

G21 Discrepancy Between the Legal and Medical Definitions of Homicide

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The goals of this presentation are to compare the manner of death as certified by a medical examiner (ME) on a death certificate to a district attorney (DA) charging decision and final disposition of the case in the court system; and to measure the frequency of and identify factors

contributing to any disparity in classification of homicide by medical examiners and prosecutors.

Hypothesis: Medical examiners and district attorneys have differing responsibilities and interests in processing homicidal deaths, which results in disparity between the medical examiner classification as homicide, and the legal definition for the purpose of criminal justice.

Methods: All cases certified by the Milwaukee County Medical Examiner's Office as homicide; accidental motor vehicle deaths and accidental firearm deaths from 1990 through 1999 were matched to cases presented to the homicide unit of Milwaukee County District Attorney's office from October 14, 1991 through 1999.

Results: Of the 1247 cases certified as homicide by the ME, 766 were matched to the corresponding DA homicide cases. Approximately 40% of cases were not matched. Factors influencing successful matching included apprehension of perpetrator(s) and prosecution in adult court. In a sample of 67 homicide cases reviewed but not charged by the DA's office, almost half (47%) were determined to be self-defense, 26% insufficient evidence, 11% no defendant or death of the defendant, 3% accidental shooting, and 13% other.

Conclusions: There is significant variation in how medical and legal practitioners define "homicide." This variation results from the different goals of the practitioners as expressed in levels of intentionality and differing burdens of proof (reasonable medical certainty vs. beyond a reasonable doubt) that contribute to variations in definition of homicide. The effect of such variation requires additional research.

Homicide, District Attorney, Medical Examiner

G22 Rape/Sadistic-Homicide vs. Accidental Death During Voluntary Violent Sexual Activity: Three Case Reports Illustrating Difficulties in Assessing the Circumstances of the Deaths

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Three case-reports are presented to illustrate difficulties in assessing whether violent sexual activity has been forced or consensual. Didactic figures are displayed to illustrate various features in violent sexual intercourse and instrumental penetration.

In investigating a suspicious death, where there is evidence of sexual intercourse, the forensic pathologist has not only to determine the cause and manner of death, but also to answer the question of whether sexual intercourse was forced. The three following case-reportsillustrate difficulties in assessing whether violent sexual activity has been forced or consensual.

Case 1. A 56-year-old woman was found dead in her bed, in the morning, by her husband. According to him, they had sex in the evening and fell asleep. The autopsy showed multiple hematomas on breasts, arms, hands, legs, shoulders, and head, as well as severe damage to the perineum, vagina and rectum. The anal margin had hematomas. There were large tearings of the rectal wall and perirectal muscles, of the vagina with complete prolapse of the cervix through the vulva. The victim was found with 3.68 g/l of alcohol in her blood. Death was assessed to have been caused by massive hemorrhage. Rectal and vaginal lesions were assessed to have been caused by a fist or a foreign object. The man confessed that he had beaten his wife and forcibly penetrated her with his fist while her consciousness was impaired by alcohol.

Case 2. A 22-year-old woman was found dead in her home, in her bathtub. Her boyfriend reported that she fainted during sexual intercourse. He said he carried her to the bathroom, put her in the bathtub, and showered her with water, but she had fatal cardiac arrest. The autopsy showed evidence of asphyxia. There were hematomas in the perineum, the vagina and rectum, and large tearings of the vaginal wall. Toxicology was negative. The man confessed that they had sado-masochistic sexual activity, including fist penetration and strangulation with a dog's leash, when she fainted.

Case 3. A 40-year-old woman was found dead in her bed, by her husband. According to him, they had sex in the evening and fell asleep. At autopsy there were hemorrhages around the right carotid artery and infiltrating the right neck muscles. Lungs were found emphysematous. The anal margin was dilated with congestion of the mucosa, but there were no tearings. Histologically, hemorrhage was found in the rectal submucosa. The victim was found with 1.94 g/l of alcohol and 2.18 microg/l of Zolpidem (toxic level > 0,15) in her blood. There was no sperm. The cause of the death was assessed to have been mechanical asphyxia following neck compression. The rectal lesions were assessed to have been caused by a fist. Alcohol and Zolpidem contributed to the death.

In conclusion, severe lesions to the sexual organs are not always synonymous of sadistic/rape homicide. Thorough examination of the death scene, complete autopsy, histology and toxicology are necessary in assessing the cause and manner of death, and determining the circumstances of the sexual activity, whether voluntary or forced.

Rape, Sado-Masochism, Forensic Sciences

G23 Postmortem Genital Examinations and Evidentiary Protocol With Colposcopy

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This paper proposes to describe a sequential methodology and evidentiary protocol for the postmortem genital examination of sexual homicide victims. To this end, salient findings from baseline studies of postmortem genital anatomy, and the effects of postmortem changes, will be discussed.

A methodology for the genital exam of homicide victims by forensic nurse examiners to assist in the determination of concomitant sexual assault was first described in 1998 (Crowley, AAFS). This earlier protocol has been further defined during ongoing accumulation of baseline studies of genital anatomy and the nature of the anogenital tissues in the postmortem interval. This clinical research is done in collaboration with Brian Peterson, M.D., of Forensic Medical Group, Fairfield, CA. Further study will compare this baseline group with cases that present with genital trauma. Study of the nature and patterns of injuries found in sexual homicide victims will allow comparisons to those types of injuries previously noted in living victims of sexual assault. The use of colposcopy is well established as a component of the medical legal exam of living victims of both adult and child sexual assault. Patterns of injury have been described and findings compared to a control group of women who engaged in consensual sex (Slaughter, Brown, Crowley, and Peck, 1997).

Examination solely via gross visualization yields a paucity of genital trauma (10-30%) in living rape victims. Similarly, during the autopsy, gross visualization alone may preclude the more subtle findings of genital trauma that usually constitute injury in sexual assault. The use of colposcopy for the evaluation of postmortem cases by this author has demonstrated its usefulness and efficacy as an adjunct to the examination. The colposcope affords magnification at different settings, photographic capability via standard 35mm SLR or digital imaging, and if desired, video capacity. Photocolposcopy provides a mechanism for photodocumentation; this increases reliability and facilitates peer review. Higher magnifications afforded by the colposcope (e.g., 15X)

allow careful study of the effects of the postmortem interval and other variables on the genital tissue. Other equipment used in the postmortem genital examination in addition to the colposcope, include camera(s), various lenses, various sizes of vaginal speculums, anoscopes, Wood's Lamp +/or Alternate Light Source, sandbags, and disinfectant.

Materials and Methods: 28 postmortem patients (25 females; 3 males) were evaluated using a protocol that included colposcopy. Causes of death included suicide, accidental, and natural. All cases were examined with the mobile system of technology described by Crowley (AAFS, 2001). The postmortem interval varied from <24 hours (fresh) to 1 month (decomposed). Ages ranged from 32 months to 90 years old. Photographs were available for review on 18 of these cases, all females. Ages in this group ranged from 32 months to 89 years old, with a mean age of 47.9 years. Two of the 18 (11%) were pre-pubertal. Seven were in their 20s-40s (39%), and 9 (50%) were ? 50 years old. Two of the 18 were photographed only with macrophotography. Sixteen were photographed with colposcopy, at a fixed magnification rate of 7.5X, 15X, or both. In some cases, 35mm photographs were available for comparison to the colposcopic photos. Cases were assigned an ID number and entered into a modified version of the Sexual Homicide Database. Salient data include age, ethnicity/race, date/time body found, date/time of examination, cause of death, past medical history, reproductive status, and exam techniques. Eleven anatomic sites were evaluated on female cases: labia majora, labia minora, posterior fourchette, fossa navicularis, perineum, hymen, peri-urethral area, vagina, cervix, anus, and rectum. The genital findings were categorized by a system developed by Crowley and Peterson, to describe the nature of any postmortem changes to the anogenital tissues.

The Sexual Homicide Evidentiary Protocol is a sequential methodology for conducting the postmortem genital evaluation of the suspected victim of a sexual homicide. Specific features will vary by state/local jurisdiction. Prior to the actual autopsy, it is advisable to clarify individual roles and responsibilities in areas of potential overlap. If possible, conduct the genital examination and collect anogenital specimens prior to the general autopsy. This may be done after the medical examiner has conducted a preliminary overview of the body and noted gross features, such as clothing. This will allow prompt collection of biological evidence and avoid obscuring the genital area by leakage of body fluids through the vaginal opening. Salient features of the protocol include:

- Review of available data and historical information; much information may be missing at the time of the autopsy.
- General physical examination and general description of nongenital trauma.
  a. Head/oral: items for Sexual Assault Evidence Kit and photographs, as appropriate.
  b. Scan of body with Wood's Lamp and/or Alternate Light Source
  c. Bite mark evaluation: documented on traumagram, in a manner consistent with ABFO guidelines, i.e., location, shape, color, size, type of injury
  d. General description of nongenital trauma. Note *"Defer to Medical Examiner's Report."*
- Sexual Assault Evidence Kit and Clothing: integrated into general and anogenital examination, to ensure consistency and completeness.
- Genital/Anal Examination: includes collection of foreign matter/debris, pubic hair combings, evidentiary swabs/slides, reference standards, and lab. After patient has been positioned for genital examination, as many sites as possible should initially be evaluated using gross visualization.
- **Colposcopic** examination: Use labial separation and/or labial traction to visualize and photograph the following anatomic sites: **labia majora**, **posterior fourchette**, **labia minora**, **hymen**, **fossa navicularis**, **perineum**, and **peri-urethral** area. Inspect all aspects of the hymenal borders. Insert vaginal speculum; inspect and photograph the **vagina** and **cervix**. Use the colposcope to visualize & photograph the perianal area, including the anal verge and anal folds. Insert an anoscope into the **anus** to inspect the **rectum**; collect rectal forensic swabs and make appropriate slides. For the male, the following sites should be evaluated: penis (glans, foreskin, shaft), urethra, scrotum, anus, and rectum. Adjuncts used to augment the examination should be documented. These include a 1% aqueous solution of Toluidine Blue Dye and balloon-covered swabs. Positive dye results show up as deep, linear staining in areas of denuded tissue. Both techniques should be done after collection of evidentiary samples.
  The dye should not be applied to mucosal surfaces.
- **Specimen** packaging, storage, and chain of custody: Properly code and package all swabs, slides, and specimens. Employ measures to ensure that there is no cross-contamination of specimens.
- **Documentation** of the examination includes medical-legal forms, photodocumentation, narrative reports, summary of findings, and a discussion of the nature and pattern of genital findings. Documentation may require modification of existing medical-legal forms. Conventional terminology, i.e., blunt vs. sharp trauma, should be incorporated into the description of traumatic findings. It will be useful to develop a taxonomy, similar to that used by Crowley and Peterson (2001), to describe the nature and pattern of postmortem changes to the anogenital tissues at various postmortem intervals.

Suspect examination: a medical-legal examination of the suspect is suggested. Protocols for this will vary by jurisdiction. In addition to routine collection of reference and evidentiary samples, the Alternate Light Source is a useful adjunct. Barsley has described the use of the alternate light source with narrow-band illumination and reflective imaging (Crowley, Barsley, Peterson, Wood, AAFS, 2000). Photograph any identification marks, such as tattoos, moles, or birthmarks, which may appear in photos taken by the offender with the victim. Patterned injury may be the result of weapon use during the commission of the crime, or inflicted by the victim in self-defense.

Colpscopy, Postmortem Genital Exams, Sexual Homicide

G24 Validation of the Anthropology Research Facility in Knoxville, TN, as a Research and Training Site For Forensic Entomology

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The goal of this paper is to present to the forensic sciences community the latest findings on the scientific validity of the Anthropology Research Facility (University of Tennessee, Knoxville) as a research and training site for forensic entomology.

The on-campus Anthropology Research Facility (ARF) at the University of Tennessee, Knoxville, established by Professor William Bass in 1972, remains the only global site devoted to the study of human decomposition. The 20-year history of arthropod exposure to decomposing bodies at ARF led Tennessee v. Coe (1993) to speculate that this site is saturated with sarcosaprophagous arthropods thus rendering it biased and atypical. Here the authors report results of a comparative field test of the arthropod saturation hypothesis conducted during summer 1998 at ARF and three other sites at varying distances from ARF (S1): S2 (700 m away), S3 (6 km) and S4 (40 km). Three dead pigs

(*Sus scrofa* Linnaeus) of known weight were spaced 1.8-2.5 m apart at each of the four sites with two pigs placed on wire screens to record daily weight loss. Ground and flying arthropods were sampled from each pig using pitfall traps and sweep nets, respectively, once daily for up to 12 days. In excess of 81,000 invertebrates were collected and identified over the 12-day period representing 26 orders, 118 families, and 223 taxa. The fauna was reduced to 64,950 and 6,848 individuals after pitfall and sweep-net counts of forensically important taxa, respectively, were sorted, for a total carrion fauna of 71,758 individuals. On an experiment-wide level, pair wise tests showed carcass weight losses, surface temperatures, and maggot mass temperatures to be statistically comparable across days and sites in nearly every case. Likewise, matched abundance plots, accumulation curves, and ecostatistical tests each showed that the fauna at ARF is comparable to the other three sites with respect to colonization rates, aerial species richness, and ranked abundances of forensically important taxa. In the only exceptional case, pitfall catches were found to be statistically different in species richness (at the nominal 0.05 level) between Site 4 and the other three sites. Overall, these results support the conclusion that ARF is faunistically and statistically comparable to nearby field sites for conducting carrion ecology and forensic entomology field studies.

Forensic Anthropology Facility (ARF), Forensic Entomology, Decay Rates

G25 Extracting Human DNA From the Crops of Maggots That Have Been Collected During Different Stages of Development and Preserved Using Different Methods

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Upon completion of this presentation, participants will understand the effect of the maggot preservation method on the ability to extract human DNA from the maggot's crop and will understand how the size of a maggot and its crop affect the strategy for human DNA extraction from the maggot.

The type of corpse a maggot has been feeding on can be identified through DNA analysis of the maggot crop contents. The crop is a food storage organ located at the anterior end of the alimentary canal. Maggot dissection, followed by extraction of only the crop, is favored since it leaves the maggot's exterior available for identification purposes. Recently, Wells *et al*. identified several situations when maggot crop analysis would be useful in a forensic investigation (*J Forensic Sci* 46(3):685-687). DNA analysis could help investigators identify a missing victim if maggots are discovered at a suspected crime scene in the absence of a corpse. Maggot crop analysis also could provide a forensic entomologist with another way to associate a maggot with a victim. When making a postmortem interval (PMI) estimation, it is assumed the maggot's entire development took place on the victim. DNA analysis of the crop could reveal that the maggot had moved onto the victim from a different nearby food source. Maggot crop analysis also could be used to resolve a chain of custody dispute in which the origin of maggot evidence is in question.

The method of maggot preservation may affect the investigator's ability to successfully extract vertebrate DNA from the maggot's crop. The storage temperature and type of preservation fluid can alter the stability of human or other vertebrate DNA within the maggot crop. Also, the type of preservation fluid can change the physical characteristics of the maggot, which may inhibit the investigator's ability to dissect the maggot and remove the crop intact.

Another factor the investigator should consider during analysis is the maggot's stage of development. The size of the maggot and its crop may render different strategies for extracting vertebrate DNA from the maggot. Young maggots may be too small for dissection and crop removal. In older, post-feeding maggots, the maggot stops feeding and the crop contents are emptied into the remainder of the maggot gut. Alternative methods of analysis, such as extraction of the entire maggot, may provide better results for maggots that are too small for dissection, or for post-feeding maggots when the crop is no longer visible.

For the preservation study, maggots raised on human spleen were preserved using eight different preservation methods (70% ethanol, 95% ethanol, 4°C in 70% ethanol, 4°C, -70°C, room temperature, Kahle's solution and formaldehyde). Maggots were dissected after time periods of 2 weeks, 8 weeks and 6 months. Each maggot's crop was removed and extracted. Human DNA recovered from each crop was quantitated using Quantiblot® Human DNA Quantitation Kit (Applied Biosystems, Foster City, CA). Amplification of the human mitochondrial hypervariable regions (HVI, HVII) was attempted for all crop extractions. Amplification of STRs using Promega's (Madison, WI) Geneprint Powerplex 1.2 System was also attempted for all crop extractions. Successful HVI and HVII amplifications were sequenced using a PE-Biosystems (Foster City, CA) 310 genetic analyzer and BigDye Terminator® sequencing kit. Successful STR amplifications were analyzed using the 310 genetic analyzer.

Preliminary results suggest that the preservation method does affect the ease of dissection and the quantity of DNA recovered. For example, in maggots preserved in 95% ethanol at room temperature, the dehydrated crop became attached to other internal organs, often resulting in a broken crop during dissection. In maggots preserved in formaldehyde, although the crop was easily removed, quantitation results suggest a reduced amount of DNA had been extracted, in some cases preventing the amplification of HVI and HVII regions. Additional preservation results will be discussed.

For the development study, maggots raised on human spleen were removed and preserved at half-day intervals until the maggots began to pupate. The collected maggots were dissected and, if possible, the crops were removed and extracted. In maggots that were too small for crop removal, the entire maggot was extracted. In older, post-feeding maggots that no longer contained a visible crop, the intestines were extracted. DNA sequencing and STR analyses were performed as described above.

Preliminary results suggest that in maggots too small for dissection, extraction of the entire maggot did allow for the recovery of human DNA. However, in older, post-feeding maggots, extraction of the intestines did not result in the recovery of human DNA. Additional results will be discussed.

The results demonstrate that the chosen preservation method does have an effect on the ability to dissect a maggot and on the quantity of DNA extracted from the crop. Also, recovery of human DNA is possible in maggots that are too young for crop extraction, but is not likely in older post-feeding maggots with empty crops.

Forensic Entomology, Maggot Crop, Mitochondrial DNA

G26 Bioterrorism Response and Training: Building Upon Mass Disaster and Multiple Fatality Preparedness at the Office of the Chief Medical Examiner, Boston, MA

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After attending this presentation the participant will understand how Massachusetts has sought to continue to build a multiple fatality plan with bioterrorism applications and will understand creative

solutions to administering anti-terrorism response modalities in level-funded state agencies.

In the aftermath of September 11, 2001, the Office of the Chief Medical Examiner (OCME) has a need to both augment its ability to respond to a mass casualty event involving nuclear, biological, and chemical agents; and to increase surveillance of deaths in Massachusetts for unusual infectious agents such as anthrax, smallpox, plague, and tularemia. Currently, the OCME must rely solely on the infrastructure and personnel of its headquarter office in Boston and personnel located at three minor satellite offices, resulting in insufficient resources to respond to a mass casualty disaster. This situation has been dramatically improved by the creation of partnerships with pathology departments of major academic medical centers in the Commonwealth, which have effectively served to "virtually" expand the infrastructure and personnel available for response and death surveillance.

The Office of the Chief Medical Examiner in Massachusetts has received level funding for a period of years. The forensic terrain over that time has become more complex and expensive. To provide current investigative techniques and analyses that contribute to case documentation and eventual courtroom presentation has taxed operational budgets. As a state agency, the OCME has access to and liaisons with other state agencies that provide analytical techniques and research resources. Through programs developed in response to complying with Mass Fatality Preparedness Initiatives, the office has established linkages with departments within the Executive Office of Public Safety, Public Health, the Boston Medical Hospital Community and the University System. The coalescence of state and public agencies has provided continued opportunity for state-supported grants and research partnerships. The OCME applied and received three phases of funding through the Executive Office of Public Safety, entitled the Edward Byrne Memorial State and Local Law Enforcement Assistance Formula Grant Program. The third phase is allowing the office to implement a virtual expansion of medical staff, through the greater Boston community by providing training in bioterrorism preparedness and surveillance.

In order to achieve these goals, it was necessary to create partnerships with several academic pathology departments in the greater Boston area. The purpose of these partnerships has been to provide training to personnel at each participating department in policies and procedures used in forensic death investigation and victim identification. Additionally, an early detection and surveillance system has been developed to recognize unusual infectious agents at autopsy, and to become familiar with procedures required in the processing of deaths due to chemical and nuclear agents. Training materials developed for this project will be made available for distribution.

Bioterrorism, Training, Virtual Staff Extension

G27 Computerization of the Autopsy Report "How to Build Your Own Desktop"

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Upon completion of this presentation, attendees will understand integration of the major components of the case file as well as how current software and computer technologies allow for a personalized desktop application that increases the productivity of the forensic pathologist and support staff.

Goals of Poster: The goals of the poster are to show the stages of development of a case file on the computer screen. The authors will create case specific folders and subfolders or nests of files and incorporate them into "Palettes." Those portions of a case file the pathologist reviews most often, i.e., the diagrams, dictated report and images are made available by clicking icons that represent specific documents, digital images or drawings. In this presentation the files and icons have been chosen to meet the needs of a particular doctor. Other doctors may want different files immediately available and this presentation will show how he or she can create their own computerized case file.

Method: Flash, a *Macromedia* software program is first used to create an interface or form that will contain the palettes. Flash works with many types of media and allows the user to create his or her own case file, linked to a database of multiple file types.

First anatomy diagrams used in the autopsy room are scanned and then enhanced by using common drawing software such as *Adobe* Illustrator. The illustrations are then saved as JPEG, EPS, or PDF files in a folder. Icons of each diagram are created and organized within a palette. These diagrams or templates are now available for printing as a hard copy for use in the autopsy room or enhanced with additional icons symbolic of lesions.

The next step involves providing diagrams that show the sites of trauma for police and attorneys. A palette is designed with icons representing gunshot wound entrances, exits as well as abrasions, lacerations and sharp force injuries. Using simple drag and drop motions, the pathologist chooses an icon and places a small rendition of the lesion on a template, creating a simple and accurate diagram of the findings. These diagrams can then be printed as hard copy or attached to e-mail messages.

A third palette is created with dictation templates created in *Microsoft* WORD and saved in a folder. Icons of each template are inserted into a new palette. The appropriate template is opened and the autopsy report is dictated. A transcriptionist can then cut and paste the text into the office format.

Next a palette with icons representing digital images is added. Thumbnails of a particular case's digital images are called up from the physician's hard drive or office server. The optimum time to review the digital images is at the time of dictation and final sign out. Currently there is a tendency not to refer to the images as various browsers or steps are required to recall the files.

A file can contain any type of media, i.e., video, documents, images or recordings. Palettes for video and audio files will be used. This will enable the pathologist to record commentary while demonstrating a wound or create recorded notes about pending outstanding tests required to complete a report.

Conclusion: A personalized application has been created which reduces the steps to call up various files in the case folder. This application relies on readily available software for construction of an interface with links to many file types. Different software applications now share enough similarities in file management and language allowing for linkage. Some applications such as video rely heavily on memory as well as processor speed. Other advances in technology, i.e., cost reduction and software development have increased accessibility to the computer user. Here is an application that allows for a specific interface that is designed to suit a single pathologist.

File, Palette, Icon

G28 Using STR Analysis to Detect Human DNA From Exploded Pipe Bomb Devices

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The goal of this presentation is to inform the forensic community about this pilot study on the potential applicability of DNA testing on exploded pipe bomb devices.

Previous research has shown that DNA can be recovered from a variety of objects handled by the human hand, but it is unknown if DNA can withstand the effects of a low explosion. This study investigated

whether it was possible to recover a bomb assembler's DNA from an exploded pipe bomb device. It was hypothesized that the DNA from the sloughed skin cells may in some instances withstand the heat generated from the explosion. Two different surfaces, metal and PVC pipes were examined to determine if one surface type would have "more success" than the other due to heat conductivity properties.

Each of the ten participating subjects handled components (pipe, caps and fuse) of one metal and one PVC pipe bomb with a 10 second handling time per component, thus transferring sloughed skin cells onto the pipe bomb pieces. Using disposable gloves the Michigan State Police bomb squad assembled and deflagrated each pipe bomb in separate holes in the ground; each hole was covered with a large rock to contain the fragments. The fragments from each bomb were collected separately and swabbed using the double swab technique to recover any remaining skin cells. An AmpF*l*STR® Profiler Plus™ kit as well as an ABI 310 Genetic Analyzer® with Genescan® 2.0.2 and Genotyper® 2.1 software were utilized to generate DNA profiles from these swabbed bomb fragments.

The results indicated that enough human DNA from the "bomb manufacturer" could be recovered from exploded pipe bombs, both metal and PVC, to produce reportable genetic profiles. Overall, 1 of the 20 bombs rendered a full reportable DNA profile that matched the known DNA profile, and 3 others rendered partially reportable DNA profiles that also matched the known profiles. Additionally, there were 5 bomb samples with activity at some of the loci, although these did not meet the reportable standards followed by the Michigan State Police Crime Laboratory in Northville, Michigan.

There was no evidence to suggest one surface had more success with DNA recovery than the other; both surfaces were equally successful. The variable that appeared to have the greatest influence on the success of generating a DNA profile was the amount of fragmentation and recovery of the bomb device. The more intact the device after the explosion and the more pieces swabbed the better the results.

These findings are promising. However, problems such as allele dropout, heterozygote imbalance, elevated stutter, and contamination were observed with some samples due to low amounts of DNA and the extreme sensitivity of the method. Suggested improvements in the method could potentially double the success rate and eliminate some problems, which is exciting to consider and should be explored with future research. Recommendations for the collection of bomb fragments at a scene as well as guidelines for DNA tests on bomb fragments will also be displayed.

STR, DNA, Pipe Bombs

G29 An Atypical STR Genotype, Including a Three-Banded Allelic Pattern, From a Biopsy Tissue Sample

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The goal of this paper is to present to the forensic community an instance of a STR genotype that may have been misinterpreted as a mixture. The profile was confirmed by a comparison sample and included allelic peak height discordance and a discordant three-banded allelic pattern using the AmpFISTR ProfilerPlus™ system.

In support of a medical diagnosis carried out at a local hospital, the Centre of Forensic Sciences (CFS) was asked to identify the source of two biopsy samples due to a potential mix-up of samples using a third biopsy sample from a known individual. The results resolved the mix-up and in the process also identified, in a single source sample, allelic peak height discordance at amelogenin and vWA as well as a discordant three-banded allele pattern at D18S51.

Two paraffin blocks were submitted. The first contained two biopsies, one malignant and one benign, which raised suspicion that the two biopsies were from different individuals. The second block contained a malignant biopsy sample from a known source. The three biopsy samples were extracted using a xylene extraction technique followed by amplification of 1ng of DNA in the AmpFISTR Profiler Plus™ system. The paraffin block with the malignant and benign biopsies showed two different DNA profiles confirming that these biopsies were from different people.

One of these profiles showed peak height concordance of only 19% at amelogenin and 32% at vWA, as well as a 25% peak height concordance between two alleles as compared to the third allele in a three-banded allelic pattern at D18S51. Based on both internal and published validation studies, the presence of such anomalies is atypical when dealing with a sample known to have originated from a single individual. The fact that the anomalies are compounded is even more rare. CFS internal validation of the STR loci used in the AmpFISTR Profiler Plus™ system has shown that minimum peak height concordance observed at most STR loci where 1ng of single-source DNA has been amplified is 60%. Interpretation of this sample as an unknown or questioned sample would indicate a mixture. However, the comparison sample (of known origin) in the second block also showed peak height discordance at similar percentages at amelogenin, vWA and at the discordant three-banded allelic pattern at D18S51. The peak height discordance at amelogenin, vWA and discordant three-banded allelic pattern at D18S51 may indicate a chimeric genotype since the anomalies are seen at more than one locus and therefore occur at more than one chromosome. It is also possible that more than one genetic event may account for the observed profile.

This example emphasizes that caution should be taken when using tissue block samples as comparison samples in forensic casework. Information that a tissue sample is cancerous may not always be available. Therefore, when forensic DNA analysis involves tissues (a notable example is mass disaster identification), issues involving identification, interpretation and statistical significance regarding atypical profiles and three-banded allelic patterns may become increasingly important.

Biopsy, Three-Banded Pattern, STR

G30 DNA Databank Hits: Identification of the Perpetrator?

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Participants attending this presentation will learn of a variety of case scenarios where a convicted offender hit provided investigative information that was not a direct link to the perpetrator of a crime. This will further demonstrate the utility of DNA data banks as an investigative tool.

As a result of the DNA Identification Act of 1998, the Canadian National DNA Data Bank (NDDB) became operational in June of 2000. The Data Bank consists of two indices. The Convicted Offender Index (COI) is the electronic index that has been developed from DNA profiles collected from offenders convicted of designated primary and secondary offences as defined in section 487.04 of the Criminal Code of Canada. The Crime Scene Index (CSI) is a separate electronic index comprising DNA profiles obtained from crime scene investigations of designated offences. COI profiles are generated centrally at the Data Bank lab facility, while CSI profiles are generated at the various forensic laboratories throughout Canada. The Centre of Forensic Sciences (CFS) provides Forensic Science services for Ontario, a province with a population of approximately 10 million people.

Over the first two years of operation of the NDDB, the CFS submitted 1,803 (31%) of the Crime Scene Index profiles to the Data Bank. Of the nearly 25,000 convicted offenders profiled, 53% were from the province of Ontario.

To complement the national legislation that established legal requirements for entering profiles onto the Data Bank using CODIS software, the CFS has developed a Standard Operating Procedure, which includes the criteria for a profile to be uploaded, the format and content of reporting statements, a process for communicating and dealing with the disposition (once followed up with investigators), and the criteria and procedures for deleting profiles from the NDDB. The potential dispositions include the following categories:

Offender hit: Indicating one or more forensic samples are linked to a convicted offender sample at SDIS. This provides investigators with the identity of a known offender and thereby provides an investigative lead that may ultimately link the crime scene DNA profile to the perpetrator. Alternatively the hit may provide investigative information that subsequently eliminates the crime scene profile as having originated from the perpetrator.

Conviction Match: Indicates that a DNA profile developed from crime scene evidence match a DNA profile from an offender, but the crime from which the evidence was collected has already been solved and linked with the offender. This match serves as a form of blind external testing as the offender should match the evidence for which s/he was convicted.

The DNA profiles eligible for upload to the CSI are subject to both legal and scientific restrictions. The DNA identification act outlines the legal criteria as follows. In order to enter a DNA profile into the data bank, a designated offence (e.g. murder, sexual assault, robbery, break and enter) must have occurred. There must also be a sample of a bodily substance from an "unsolved" crime that was found at a place, on or within the body of a victim, on anything worn or carried by the victim, or on or within the body of a person, thing or place associated with the commission of a designated offence. The scientific criteria were agreed upon by a working group of scientists from the three government laboratory systems in Canada (CFS, Royal Canadian Mounted Police Forensic Laboratories, and Laboratoire de sciences judiciaires et de médecine légale). The criteria were designed to limit the frequency of adventitious matches to the databank. In contrast to similar criteria from the U.S., for an unknown profile to be uploaded to the national CSI, a result for at least 7 Profiler Plus loci is necessary, in addition, a CSI sub index is used to capture profiles derived from mixtures. To be eligible for the forensic mixture index, a result at all 9 Profiler Plus loci is required with no more than three of the loci with up to five alleles entered.

Any DNA profile, generated during the scientific examination of items submitted in connection with an investigation, that cannot be attributed to the victim or a person who has been excluded as the perpetrator is automatically uploaded to the CSI.

Over the first two years of the Data Bank's operation CFS has been notified of 287 CSI to COI hits and 72 CSI to CSI hits. Of the crime scene to convicted offender hits, 62% have been conviction matches and 32% of the hits have been classified as offender hits. Of the 32% of investigations aided a number of the offenders have been ruled out as the perpetrator, however in these instances the identification of an offender as the source of a crime scene DNA profile has nonetheless aided the investigation. Some examples of this include:

Homicide investigation where a bloodstain on the victim hit to a convicted offender who ended up being a witness to the crime, who was ultimately able to aid in the identification of the true perpetrator.

Sexual assault investigation in which the first suspect was excluded as the source of semen recovered from complainant. The profile was entered onto the CSI and hit to an offender, the complainant was interviewed further and it was determined that the person identified by the hit was actually the boyfriend. This information allowed the police to account for the semen and to re-investigate the original suspect.

Investigation of an attempted murder in which a DNA profile from the tape wrapping around a pipe bomb hit to an offender. The offender was identified as the police officer who originally collected the pipe bomb for submission to the laboratory. Upon investigation, it was found that he had been convicted of a designated offence some time after his involvement in this case.

This presentation will outline other such cases in order to emphasize how important it is for the scientist to critically evaluate all samples being uploaded to a data bank and the need to keep an open mind when dealing with data bank hits. A hit to a convicted offender does not necessarily equal a hit to the perpetrator.

DNA Databank, Offender Hit, Conviction Match

G31 Everything Old is New Again: A Program to Examine "Cold" Sexual Assault Cases

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The goal of this paper is to demonstrate the processes that can be employed in a dedicated program for the examination of sexual assault cold case. The poster will also present some of the challenges encountered and overcome in the cases submitted.

This poster will provide an overview of a purpose-built program recently established at the Centre of Forensic Sciences (CFS) to deal with the examination of cold sexual assault cases. Cold cases can be defined as cases where the police investigation has been scaled down and the case is effectively lying dormant. In addition, some interesting and challenging cases submitted as part of the program will be described to illustrate the types of samples encountered and the methods employed to extract information and contribute to the investigation of unsolved sexual assaults where investigative leads have been exhausted.

Recently, a joint initiative was undertaken by the Centre of Forensic Sciences (CFS) in partnership with the Toronto Police Service, an agency serving a large metropolitan area with a population of approximately 2.5 million. This initiative was undertaken to examine or re-examine unsolved sexual assault cases with the goal of uploading DNA profiles from perpetrators to the National DNA Databank (NDDB) of Canada. For the purposes of this project, the term 'unsolved' refers to any case for which a conviction has not been registered. Criteria for eligibility were established first and consisted of the following categories:

1. Cases for which a submission had never been made to the CFS previously;
2. Cases submitted to the laboratory but not previously examined due to the absence of a suspect (in accordance with CFS policy prior to 1997);
3. Cases in which material suitable for DNA analysis was detected, however DNA analysis had not been attempted as the identity of the perpetrator was not at issue;
4. Cases in which DNA analysis was attempted using RFLP technology but was not successful at the time (RFLP has been discontinued at CFS since 1995); and
5. Cases in which a DNA profile had been obtained but was not compatible with the requirements of the databank (i.e., profiles developed in the RFLP, DQA1, PM, or STR Quad systems).

The Centre of Forensic Sciences is a provincial government laboratory (Ministry of Public Safety and Security) that serves a population base of approximately 10 million people throughout the province of Ontario, and carries out forensic analyses free of charge for all police agencies in the province, as well as other clients. In consideration of an

already heavy caseload and a commitment to timely results, a key requirement was that the laboratory be able to regulate the number of items submitted in support of this project, while providing effective scientific consultation and expertise in the process. To this end cases were assigned to one of two stages for examination.

Stage 1 submissions were those that consisted strictly of a limited number of relevant swabs (in accordance with the case history) from the Sexual Assault Evidence Kit (SAEK). A user-friendly flowchart was developed at the CFS so that investigators could review their files and readily target only those swabs with a high probability of success, given the case history. The provision of this tool developed by forensic scientists allowed investigators1, as opposed to forensic scientists, to carry out the task of identifying relevant items according to scientific expectations of success given the case history. Moreover, restricting stage 1 submissions to swabs only allowed the development of a streamlined screening protocol for the presence of semen, which in turn allowed for batch processing and turnaround times of 30 days or less. Any case that did not meet the criteria for a stage 1 submission, as well as any case determined to be negative following a stage 1 submission, was directed for consideration at stage 2.

Since stage 2 cases normally involved the examination of clothing or other scene items not as readily amenable to rapid processing as internal swabs, a senior scientist was made available to provide consultation as to which items in these cases, if any, would be suitable for examination based on the history. Once accepted, stage 2 cases were blended with normal operations.

The Biology Section of the CFS has successfully integrated the analysis of cold cases with ongoing workload with no disruption to work flow. This is the result of an effective partnership between the laboratory and the police service and a mutual, reciprocal respect of one another's capacity and constraints. Within the first few months of implementation, DNA evidence generated from submitted items led to investigative breakthroughs in four unsolved cases through a combination of crime scene to crime scene linkages as well as linkages to convicted offenders. Approximately 50% of cases submitted under the project (stage 1 and 2) have had a DNA profile from semen generated and uploaded to the National Databank.

Based on the success of the program to date, the CFS is in the process of establishing partnerships with other agencies in Ontario to provide a similar service, and is also reviewing its case and item acceptance policies to more effectively target minimum numbers of relevant and suitable items for examination, based on the case history provided and the hypotheses being tested.

1: It is important to note that the bulk of the administrative work in this project (e.g., review of case files, tracking of old evidence, etc.) was carried out by police investigators assigned to work full-time on the project.

Cold Cases, Sexual Assault, DNA Databank

G32 Bone Extraction Procedure for Nuclear DNA Analysis Used in World Trade Center Human Identification Project

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The goal of this presentation is to demonstrate a highly effective method to extract and purify amplifiable nuclear DNA from severely compromised bone samples

The described extraction strategy was established for human bones recovered from the World Trade Center mass disaster site after September 11, 2001. Morphologically, the samples were in different states of preservation - ranging from very good with preserved bone marrow, to semi-burned, and completely burned. The heat and friction forces at the disaster site had reduced many of the bones to small, severely damaged pieces. Each sample was individually assessed visually as to the amount of the bone tissue to be taken for the extraction procedure.

Osteocytes (mature bone cells), with their central, nuclear containing region are completely surrounded by the bone matrix. The bone matrix is permeated by an extensive and complex system of lacunae (cavities occupied by the cell bodies of osteocytes) and canaliculi (narrow channels that radiate from the lacunae). The predominant organic component is collagen, while the inorganic matrix is calcium phosphate in the form of hydroxyapatite, which accounts for about 75% of the bone mass. The philosophy of this protocol is to use as much bone tissue as needed, as determined by the quality of the sample, to obtain a sufficient amount of DNA, by "untrapping" the DNA containing osteocytes from compact and spongy bone matrix.

In order to minimize contamination with any external DNA each bone specimen was cleaned vigorously using a series of disposable scalpels and brushes. After sonication in a 5% Terg-a-zyme solution, the outer surface was sanded down (using a Dremel tool equipped with a disposable emery disk), until the outer surface was completely free of dirt and debris. This step was followed by an additional Terg-a-zyme and H_2O wash step; then the bone specimen was cut into approximately 0.5x0.5x0.5 cm pieces, frozen in liquid nitrogen, and ground in a MicroMill Grinder (Scienceware, Bel-Art Products, Pequannock, NJ) into a dust. The mill was cleaned vigorously after each sample.

Depending on the condition of the bone sample, the bone dust was divided into 50 ml conical tubes (2 g of bone dust per tube). 4g for good specimen, 6g, 8g, and 10g for more compromised samples. Each dust aliquot was incubated in 3 ml of organic incubation buffer (shaken at 56°C, overnight). The DNA was extracted using Phenol-chloroform-isoamylalcohol (24:24:1) in 1.5mL Phase Lock Gel tubes (Eppendorf, Hamburg, Germany) and Microcon 100 microconcentrators (Amicon, Inc., Beverly, MA). The extracts were further subdivided into smaller aliquots. As the final step all aliquots were recombined and concentrated further using Microcon 100 vials. Samples were quantified using QuantiBlot (ABI, Foster City, CA), and amplified with the PowerPlex 16 (Promega, Madison, WI) multiplex. The resulting DNA profiles were analyzed and interpreted following the standard procedure established for the WTC Human Identification Project.

Usable STR profiles with a sufficient number of loci were obtained in ~ 75% of cases. Approximately 50% of all analyzed cases even had more than 13 loci typed. The procedure has been successful for nuclear DNA based identifications even if the bones were in an extremely poor condition. The approach of dividing samples into smaller aliquots and then recombining the extracts later allows for the processing of a large amount of bone matrix. This also allows the use of the Eppendorf Phase Lock Gel technology while avoiding clogged Microcon membranes.

Nuclear DNA, Bones, Mass Disaster

G33 Digestion Time of Human Mitochondrial DNA in Blowfly Larvae, *Calliphora vicina*

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The goals of this presentation are to determine the digestion time of human mitochondrial DNA after blowfly larvae have ceased feeding on human tissue.

This poster will display results obtained from a study measuring the digestion time of human mitochondria DNA in Blowfly larvae. The amount of time the blowfly larvae have been feeding on the human tissue will be measured over a 3-day period. Forensic entomologists

have developed a new technique that can be used to identify a corpse. This technique involves analysis of blood recovered from the digestive tract of an arthropod, which can help identify an individual host. From the blood extracted human mitochondrial DNA is recovered. Previous studies have shown that even if physical contact between the larvae and human corpse is not observed mtDNA analysis may be able to connect larvae with the corpse.

Blowfly larvae, *Calliphora vicina*, will be starved for one day before feeding on human tissue to remove previously eaten food from the larvae's digestive tract. Larvae will be placed in appropriate containers with human tissue. Three groups composed of three replicates each will feed on human tissue for varying amounts of time, 24-hours, 48-hours, and 72-hours respectively. Larvae will be placed in an incubator set at 36°C in the dark. This will help to mimic the environment of a human carcass. After being removed from the human tissue, a period of time will pass before each replicate of a group is preserved. The 3 replicates from each group will be immediately preserved, preserved after 36-hours, or preserved after 56-hour. The larvae will be preserved in 70% ethanol and stored at -20°C. An additional trial will be performed. Adhering to the protocols of the QIAamp DNA Blood Mini Kit from Qiagen, the Blowfly larvae will be analyzed to determine if human mtDNA is present in their digestive tracts.

These results will provide more adequate information for forensic investigators when determining the length of time human mtDNA remains in the larvae's digestive tract. The results of this study hold promise in enhancing the utilization of arthropods in forensic investigations, especially in the area of homicide.

Human Mitochondrial DNA, Blowfly Larvae, Digestion Time

G34 Postmortem Interval (PMI) Determined by Analyzing Temperature Variations of Maggot Masses

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The goal of this presentation is to measure temperature variations within maggot masses and compare these with published temperature studies of dipteran developmental cycles conducted in labs for forensic growth rate base lines.

Hypothesis: the in vivo maggot mass temperature will result in increased growth rate of the larvae when compared to laboratory studies on developmental cycles.

A black bear carcass approved for research by the Florida Fish and Wildlife Conservation Commission Wildlife Research Laboratory in Gainesville, FL was placed into a remote, semi-wooded location within their grounds. The bear was struck by a car and the carcass arrived in early June 2002. Within five hours of the carcass being exposed to the environment a HOBOä external logger was placed at the carcass site and set to record wet bulb temperature, air temperature, and temperature of the soil beneath the bear carcass, and in the center of the largest maggot mass present at the time. Temperature was recorded continuous @ 10 minute intervals for ca. 1.5 months. Adult insects and developing larvae were collected about 6 PM until carcass decomposition was complete. The adult beetles and flies were killed using an ethyl acetate kill jar. Fly larvae were initially placed into empty vials, and then taken back to the lab to be boiled briefly for preservation purposes and then placed into 70% ethyl alcohol. Pictures of the various insects and the growing maggot masses were taken every other day, along with shots of the different decomposition stages the carcass went through. These photos were made with a 35mm camera with macro close up attachments. A separate 35mm camera with an infrared filter was used to take IR shots of the maggot mass for observation of the heat spots. Sketches of the maggot mass locations and decomposition stages were taken daily for visual reference.

Results showed varying temperatures in the maggot mass corresponding with the ever-changing Florida summer weather. The greatest temperature was recorded at maggot mass locations with the greatest number of larvae. When the weather was overcast or immediately following rain the mass temperature was much lower than on days with clear skies and no rain. The larvae were observed moving in and out of the center of the mass in a routine motion as if they are were making a circle in to the mass and back out again. The highest temperatures were taken in the center of the mass with temperatures decreasing exponentially farther away from the center. The larvae composing the first maggot masses were first instars on June 5 and began to migrate away from the carcass on June 13. Several of these larvae were taken in to the lab to be raised during the pupal stage at a set temperature of 26°C; pupation occurred by June 15 and adults emerged on June 20. The remaining larvae left in the field on the carcass developed similarly. The maggot masses began appearing at the orifices within the first four days that the carcass was exposed to the environment. From there they moved around the perimeter of the carcass encasing all of the extremities, the head and the anus region. The masses then moved in towards the center of the carcass as decomposition progressed with the last masses being observed around the exposed vertebral column. The maggot mass was composed primarily of *Chrysomya rufifaces* (Macquart) (Diptera: Calliphoridae) larvae throughout the duration with a few other species intermixed throughout.

Conclusion: Whether the hypothesis was verified has yet to be determined because data are still being analyzed. Species found in and on the carcass are summarized in the poster tables. Variations in species may have increased if insect collections were made at a different time of year and day. The insect faunal succession change with decomposition levels as related to time of day and this could lead to a variety of temperatures and developmental rates. The maggot ball temperature varied with environmental temperature. The maggot ball consisted of the hairy blow fly, C. rufifacies. The maggots in the maggot ball moved in and out of the high temperature center of the maggot ball.

Maggot Mass, *Chrysomya rufifaces*, Developmental Cycle

G35 A Summer Carrion Study in the North of Italy

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After attending this presentation, participants will more fully understand variables affecting postmortem changes to carrion exposed outdoors during summer. The presentation will show how weather conditions, combined with effects of extensive predation, may result in incorrect assumption of an extended PMI.

Forensic pathologists are often called upon to establish the time since death in badly decomposed bodies. Physical, chemical and biological changes start immediately after death and their development rate varies according both to external factors (temperature, humidity, and sunlight, insects) and internal factors (body characteristics).

Entomological analyses for the estimation of the postmortem interval are primarily based on the fly life cycle. Flies are rapidly attracted to the body were each female can oviposit hundreds of eggs. Within a few hours, depending on species and ambient temperature, eggs will hatch and a large

number of larvae begin actively feeding on the body. In this stage, predators such as beetles, ants, or wasps are able to remove a large amount of fly larvae resulting in a slower rate of decomposition. Conversely, later foraging activity by predators while larvae are migrating from the carrion during the post-feeding stage may result in few larvae reaching the pupal stage. This interaction between insects colonizing remains may lead to an incorrect assessment of the level of Diptera activity on the decomposition rate and suggest a longer PMI.

Data concerning this problem were obtained by research conducted on exposed carrion in the North of Italy.

One pig carcass, Sus scrofa L., was exposed in a rural, grassy field. The animal, weighed 32 kg, was exposed in a wire mesh cage in direct sunlight. Hourly internal temperatures were recorded by two probes inserted into the mouth and anus. Additional information such as ambient air temperature, humidity, rainfall, wind, maggot mass temperature, soil and body surface temperature were also recorded.

At least two daily samplings were performed during the first ten days. During each sampling pictures of both morphological changes and insect activity on the carcass were taken and, entomological specimens were collected for species determinations and microbiological analyses.

The observations demonstrated that a large number of green bottle flies arrived immediately after the carcass was exposed, exploring head area. Insect colonization started from primary sites of oviposition (nose and mouth). Eggs were observed less than 2 hours after exposure. Hatching was observed 20 hours later. Few Sarcophagidae occurred on the carcass on day 2 and their larvae were noted in a small area on the head.

After 24 hours, large masses of eggs were observed on the pig skin at the interface with the soil, all around the carcass. The high ambient temperature caused the death of a large number of eggs on the dorsal surface.

Highest maggot activity was recorded at 72 hours when maggots completely covered the carcass. Stressed by both increasing temperature and ventilation, fully developed 3rd instar larvae start their migration at the end of day 4, leaving a nearly completely skeletonized carcass. Ambient conditions also affected the decomposition of the small amount of tissues spared by the feeding activity of larvae. The skin covering a small area of the abdomen was dehydrated, hardened and took on a dark brown color, usually observed in cadavers exposed for a long time after death.

Coleoptera (Staphylinidae, Dermestidae) were observed all around the carcass beginning on the afternoon of day 4; other species of Coleoptera (Necrobia) started their activity on the carcass after day 5, reaching the maximum at day 8 (Necrobia) and day 10 for Dermestidae.

Coleoptera were very abundant and their presence may explain the small number of pupae found in the ground all around the cage.

In order to clarify all variables affecting insect activity on the carcass, insects were tested for bacterial and chemical contamination by both microbiological and toxicological analyses. Results of this research are still in progress.

Forensic Entomology, Decomposition, Postmortem Interval

G36 Of Leaves and Men: Botanical Evidence Leads Investigators to a Missing Girl's Body

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The goal of this presentation is to demonstrate the importance of botanical evidence in the location and recovery of human remains.

On 29 May 2002, a sheriff's deputy in Butte County, CA, responded to a report of an apparent suicide victim in a pickup truck parked alongside a mountain road. Inspection of the vehicle revealed a 35-year-old male decedent with a single self-inflicted gunshot wound to the head. A significant amount of blood spatter and pooling on the passenger seat indicated to the investigators that a second victim might be involved, although a thorough search of the area surrounding the vehicle revealed no additional evidence.

Identification of the male decedent quickly led deputies to a missing persons report that was filed in Los Angeles County 2 days prior to discovery of the body. The decedent had reportedly picked up his 11-year-old daughter from school on 20 May 2002, with a probable destination of Lake Havasu, Arizona. When the daughter did not return home after the trip, her mother reported her missing.

Detailed examination of the decedent's pickup truck produced several pieces of evidence, including a receipt from a Las Vegas hotel and a bloodstained girl's jacket with a significant amount of plant debris inside one of the sleeves. Investigators conjectured that the girl was likely deceased or seriously injured; however, they were somewhat daunted by the size of the search area. Based on witness accounts and evidence collected from the truck, the girl could be in Arizona, Nevada, or California.

In an effort to narrow the search area, investigators took the plant material recovered from inside the girl's jacket to California State University, Chico, for examination by a botanist. Analysis of the sample, which ranged in composition from whole to partially decomposed leaves, revealed that it had been taken from the top few centimeters of leaf litter. The species present (in order of abundance) were canyon live oak (*Quercus chrysolepis*) or interior live oak (*Q. wizsilenii* var. *wizsilenii*), white fir (*Abies concolor*), greenleaf manzanita (*Arctostaphylos patula*), ponderosa pine (*Pinus ponderosa*), and black oak (*Quercus kelloggii*). Additionally, the sample also contained a whole leaf of greenleaf manzanita torn from a living shrub.

Possible sites were eliminated based on known species distributions and ecological site requirements. The species identified do not occur together in Arizona, Nevada, or the eastern Sierra Nevada. The live oak, in particular, indicated that the sample was most likely from the western exposure of the Sierra Nevada. Overlapping species distributions indicated that the sample was removed from an elevation of 762 to 1,372 m. The relative abundance of the species present was a bit unusual in that the dominants were live oak and white fir, indicating that the site had to have both slightly mesic (white fir) and slightly xeric (live oak) characteristics. It was unlikely that the site was a north- or east- facing slope due to the presence of the live oak, and a south-facing slope was equally unlikely based on the presence of the white fir. The sample must have been from a west-facing slope with some available moisture. Further, the composition and dark color of the leaf litter sample indicated a high organic content, which placed the site under a fairly dense forest canopy. The notable occurrence of the greenleaf manzanita indicated that there must be some available light at the site, despite the dense canopy.

A survey of possible sites within northern California that satisfied the botanical criteria led to the discovery of the girl's body in less than two hours. Surprisingly, she was found only 0.3 km from her father's truck, an area that had been searched thoroughly following discovery of his body 8 days earlier. The girl was wrapped in a blanket and partially buried under tree limbs and litter. The site proved to be a 30 percent west-facing slope with a close canopy of coniferous vegetation, where canyon live oak and white fir were the dominant species, and was located at an elevation of approximately 1160 m. The body was in close proximity to a small patch of exposed chaparral with greenleaf manzanita as the dominant species.

This case is an illustration of the potential significance of Forensic Botany in crime scene investigation. Botanical evidence is often overlooked or underutilized by investigators, but it has the potential to provide critical and detailed information about the circumstances surrounding death, or in this case, the actual location of the remains.

Forensic Botany, Missing Persons, Scene Investigation

G37 A Study of Three Suicidal Hangings in Jail Using Telephone Cords

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The goal of this presentation is to present three cases of hanging suicides that occurred in custody, and the specific changes that were made to address the problem.

In a three month period of 2000, three suicide hanging deaths with telephone cords occurred in North Texas jails and were autopsied at the Southwestern Institute of Forensic Sciences in Dallas. The first incident was a 36 year-old woman who was arrested for outstanding traffic warrants. She had a history of depression, drug abuse, and prior arrests. On the day of her death, the decedent was discovered in a kneeling position by the pay telephone in the cell she occupied, hanging from the metal spiral telephone cord looped around her neck. She was the only occupant of the cell, which was under video surveillance. The telephone cord measured 15 and 3/4 inches in length.

The second case occurred ten days later in a different jail in an outlying county. A 24 year-old man had been arrested for a number of charges including assaulting a public servant. Because he was already on probation, these charges would mean his immediate return to prison. The decedent was found hanging from the metal phone cord attached to the pay phone in his holding cell. He was the sole occupant of the cell, which was not monitored by electronic surveillance. Investigation revealed that the man had phoned his wife to tell her he was going to commit suicide prior to the act. The telephone cord measured 19 inches in length.

One month later, a third incident occurred in another jail. A 29 year-old man had been arrested for disorderly conduct. At the time of arrest the man was under the influence of alcohol, but no other drug use was reported. He was the sole occupant of a holding cell that contained a mounted video camera. The camera was filming, but was not constantly monitored. A telephone was mounted on the wall just inside of the cell. A review of the video tape showed the decedent hanging himself with the telephone cord ten minutes after entering the cell; he was discovered approximately two hours later. According to his family, he had made two prior suicide attempts.

Autopsies were performed in each of these cases and showed typical ligature furrows without evidence of other trauma or neck injury. Blood toxicology studies were positive for methamphetamine, methadone, fluoxetine, and diazepam in the first case, a blood alcohol level of 0.12% in the second, and a blood alcohol level of 0.18% in the third.

Because of these types of incidents, solutions such as providing shortened receiver cords have been suggested. A cord-free inmate phone that has a recessed, cordless handle is also available. These phones can function similarly to a speaker-phone, but with the privacy of a telephone. Following the incidents described above, a proposal was made to the Texas Commission on Jail Standards (TCJS) to standardize the types of telephones used in detox and holding cells. The proposal did not pass at that time, and there are currently no plans to make changes on a state-wide level. The current Texas Administrative Code for the TCJS addresses inmate rights concerning telephone calls and the accessibility of telephones, but does not define a specific type of telephone to be made available. There are also no rules written regarding the placement of telephones within or around holding cells. It is currently up to the individual jails to decide what type of phones to provide and where to mount them.

The three jails above each responded to these incidents by changing their telephones. Two of the jails shortened their receiver cords to a total length of 6-8 inches. The telephones are otherwise unaltered, and are still in the same locations. The third jail replaced their entire phone with a cordless telephone. These three incidents highlight the need to provide telephones that, if placed within holding cells or other jail cells, do not provide a possible means of suicide.

Hanging, Suicide, Custody

G38 Diabetic Ketoacidosis—A Silent Death

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The goal of this presentation is to determine the percentage of cases investigated by the Office of the Chief Medical Examiner (OCME) with a known history of diabetes versus de novo detection of diabetes

Diabetic ketoacidosis may be the initial manifestation of type I diabetes or may result from increased insulin requirement in type I diabetic patients during the course of infection, trauma, myocardial infarction, or surgery. It is a life-threatening medical emergency with mortality rate just under 5% (1). Type II diabetic patients may develop ketoacidosis under severe stress such as sepsis or trauma.

Cases investigated by OCME over a 6-year period whose cause of death was diabetic ketoacidosis were identified. For each case, the initial investigation and follow-up investigation report were reviewed to determine whether a history of diabetes was included. In all cases investigated by OCME, a specimen, usually blood is analyzed routinely for volatile substances, including methanol, ethanol, acetone, and isopropanol by Gas chromatography at a limit of quantitation of 0.01 g/dL

A postmortem diagnosis of diabetic ketoacidosis is based on either some or all of the following: a history of diabetes, increased vitreous humor glucose, or increased blood acetone. From January 1996 to December 2001, 20,406 autopsies were performed, with 34.49% (n=7039) natural deaths. The total number of deaths secondary to diabetic ketoacidosis was 1.43% (n=101), with 85.1% (n=86) of them available for review. A total of 35.2% (n=31) of the decedents did not have a previous diagnosis of diabetes and were diagnosed for the first time at autopsy. The age of the deceased ranged from 10 years to 70 years with a male to female ratio of 62:24. The race was not significantly different with African American to Caucasian ratio of 46:40. In this study, a total of 57 cases (66.2%) were diagnosed based on vitreous acetone and/or vitreous glucose, and/or blood acetone. In 18 cases (20.9%), vitreous and blood acetone were used for diagnosis. The urine and blood acetone were used instead of vitreous acetone in 6 cases (6.8%) with or without vitreous glucose. The other cases were diagnosed either based on vitreous acetone alone (2 cases; 2.3%), blood acetone and vitreous glucose (1 case; 1.16%), decomposition fluid (1 case; 1.16%), and vitreous acetone and glucose (1 case; 2.1%). The variability of specimens tested depended on the availability of test material. There were 4 (4.6%) decomposed cases, in which urine and blood acetone were used in 2 cases, liver acetone in 1 case, and decomposition fluid and blood acetone in 1 case. The blood acetone level ranged from 0.01 g/dL to 0.117 g/dL (mean=0.035 g/dL). The vitreous acetone range was from 0.014 g/dL to 0.97 g/dL (mean=0.05g/dL). The level of the vitreous glucose ranged from 89 mg/dL to 1233 mg/dL (mean=597 mg/dL).

A positive acetone can indicate diabetic ketoacidosis, isopropanol ingestion, or malnutrition. Acetone, a ketone body, is produced in the liver from spontaneous decarboxylation of acetoacetate, which is produced as a result of incomplete breakdown of fatty acids. Once acetone has been detected, the Medical Examiner routinely requests a vitreous glucose concentration. An elevated vitreous glucose with an elevated vitreous acetone indicates diabetic ketoacidosis. It is recommended that the volatile toxicology analysis at a Medical Examiner's Office should not only include ethanol, but also acetone to screen for the diabetic ketoacidosis in cases of sudden deaths.

Diabetes Mellitus, Ketoacidosis, Acetone

G39 Investigation of Time Interval For Recovery of Semen and Spermatozoa From Female Internal Genitalia

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The goal of this presentation is to investigate time intervals associated with recovery of spermatozoa from various sites of the lower genital tract in adult females thus providing new data regarding the best anatomic site from which to collect evidence in victims of sexual assault.

In cases of rape-homicide, the biological evidence obtained from the body of the victim may be the only link between the victim and the suspect. This biological evidence, in the form of semen and spermatozoa, can provide proof of sexual contact and a genetic profile of the assailant. There is limited data regarding the actual recovery of spermatozoa from various areas of the genital tract. The limited anecdotal case reports available indicate that the cervical os may be the best site for recovery. However, there have not been any prospective studies to evaluate site-specific recovery times, and most standardized kits recommend vaginal pool collection only. Because of the importance of recovering spermatozoa from the female internal genitalia in criminal investigations, the authors undertook the current study to further elucidate the best anatomic site from which to collect evidence in victims of sexual assault.

The study, including the protocol and consent form, was approved by the IRB and the University Human Studies Committee at the University of Louisville. The study population consisted of patients who presented to Planned Parenthood for routine annual examination in Louisville Kentucky from May 1999 through October 2000. Prior to examination by a nurse practitioner at Planned Parenthood, the patient was asked if she would like to participate in the research study. Once consent was obtained, each participant was assigned a number to ensure confidentiality. The participant was asked a series of questions including age, method of birth control, date and time of last sexual intercourse, and history of instrumentation (i.e. douche).

Prior to routine examination and following insertion of the speculum, a nurse investigator from the Office of the Chief Medical Examiner (OCME) used cotton tip applicators to obtain separate specimens from the cervical os and the vaginal pool. Separate smear slides were made from the swabs of the cervical os and the vaginal pool. These were air dried and packaged in containers with the subject's identification number. The air dried cervical os and vaginal swabs were then placed in separate paper envelopes and labeled with the contents and the identification number.

The specimens were transported to the Kentucky State Police Forensic Science Laboratory in Louisville Kentucky for examination by a forensic serologist. The presumptive presence of semen on a portion of each cotton tip applicator was determined by testing for seminal fluid acid phosphatase activity via thymolphthalein monophosphate. An extraction procedure was performed on the cotton tip applicators. The extracted material was placed on a slide, stained with hematoxylin and eosin, and examined microscopically for the presence of spermatozoa. The slides prepared at the time of the examination at Planned Parenthood were also stained with hematoxylin and eosin and examined microscopically for the presence of spermatozoa.

Sixty-one patients participated in this study. Semen was presumptively present on the cervical os cotton tip applicators in 33 of 61 cases. In 1 of those 33 cases, semen was presumptively present only on the cervical os cotton tip applicators. The postcoital time interval in that case was 9.5 hours. The extracted material from the cervical os cotton tip applicators demonstrated spermatozoa microscopically in 17 of 61 cases. In 6 of those 17 cases, spermatozoa were demonstrated microscopically in the material extracted only from the cervical os cotton tip applicators. The postcoital time interval in those cases ranged from 9.5 to 75.5 hours with an average interval of 47.9 hours.

Semen was presumptively present on the vaginal pool cotton tip applicators in 39 of 61 cases. In 7 of those 39 cases, semen was presumptively present only on the vaginal pool cotton tip applicators. The postcoital time interval in those cases ranged from 14 to 95.25 hours with an average interval of 53.6 hours. The extracted material from the vaginal pool cotton tip applicators demonstrated spermatozoa microscopically in 17 of 61 cases. In 6 of those 17 cases, spermatozoa were demonstrated microscopically in the material extracted only from the vaginal pool cotton tip applicators. The postcoital time interval in those cases ranged from 4.5 to 58.25 hours with an average interval of 24.9 hours.

Spermatozoa were observed microscopically in cervical os smears prepared at the time of the examination at Planned Parenthood in 25 of 61 cases. In 5 of those 25 cases, spermatozoa were observed microscopically only in the cervical os smears. The postcoital time interval in those cases ranged from 37.5 to 82 hours with an average interval of 59.7 hours. Spermatozoa were observed microscopically in vaginal pool smears prepared at the time of the examination at Planned Parenthood in 24 of 61 cases. In 4 of those 24 cases, spermatozoa were observed only in the vaginal pool smears. The postcoital time interval in those cases ranged from 17 to 95.25 hours with an average interval of 46.6 hours.

Thus, in summary, there were 2 cases from the cervical os site and 5 cases from the vaginal pool that would have been missed, had the other collection site not been included. The total number of cases from which only one site was positive was 7 of 61, or 11.4 per cent.

The information gained from this study suggests that biological samples should be collected from both the cervical os and the vaginal pool in victims of sexual assault. It also suggests that, on average, spermatozoa may be recovered from the cervical os after longer postcoital time intervals than from the vaginal pool.

Semen, Spermatozoa, Female Internal Genitalia

G40 The Role of Hyponatremia in Fresh Water Drowning and Water Intoxication: Making the Distinction at Autopsy

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The goals of this presentation are to educate the forensic community to the role of hyponatremia in both drowning and water intoxication.

Drowning is defined as death following an episode of submersion. Water intoxication is defined as the intake of a sufficient quantity of fluid to cause symptomatic hyponatremia. The role of hyponatremia in both conditions will be reviewed. The case of a 4-year-old boy that drowned and his twin brother that survived the incident will be presented. At initial exam, both boys were unresponsive and documented to have hyponatremia; however, no seizure activity or cerebral edema was documented. The theory of acute water intoxication has been proposed as an alternative explanation for the events surrounding the incident.

Numerous studies have evaluated the role of serum electrolytes in the mechanism of death in drowning deaths. Serum sodium levels

routinely remain above 126 mEq/L; however, approximately 12% of the cases will have serum sodium levels below 120 mEq/L. The hyponatremia is a consequence of absorption of aspirated hypotonic fluid, which has been calculated to be less than 22 ml/kg in 85% of drowning deaths. The hyponatremia associated with fluid aspiration resolves without medical intervention and is not considered a life-threatening anomaly. Therefore, hyponatremia is not associated with the mechanism of death in drowning.

Acute water intoxication occurs over a short period during which the individual consumes sufficient quantities of low sodium-containing fluids to cause symptomatic hyponatremia. The hyponatremia does not spontaneously resolve and results in prolonged seizure activity secondary to cerebral edema. In three cases that resulted in death, children from 6 to 16 years old were forced to consume between 3 and 6 liters of water at one time as punishment. The volumes retained averaged 41 ml/kg/hour and the serum sodium ranged from 109 to 114 mEq/L. All three children developed seizures, and cerebral edema was noted at autopsy. The literature has numerous reports of infants less than 1-year-old that developed acute water intoxication during swimming lessons. Serum sodium levels ranged from 111 to 123 mEq/L and seizure activity was documented in all cases. All of these infants recovered with medical therapy aimed at treating the hyponatremia. A single case of acute water intoxication occurring in a 12-year-old boy lodged in a drainpipe of a swimming pool has been documented. After a complete recovery from a serum sodium level of 111 mEq/L, the boy recalled swallowing large quantities of water.

In conclusion, fresh water drowning is not routinely associated with hyponatremia, but a small percentage of cases do have documented hyponatremia. Acute water intoxication is associated with symptomatic hyponatremia and requires diagnosis-directed therapy. Most of these cases have been documented in infants undergoing swimming lessons or in child abuse cases.

Hyponatremia, Drowning, Acute Water Intoxication

G41 An Unusual Cause of Sudden Death in Infancy: Hypertrophic Cardiomegaly

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Hypertrophic cardiomegaly in infancy may cause sudden death in infancy. This presentation discusses the clinicopathologic features, describes the gross and microscopic features, and addresses the differential diagnostic features.

Introduction: The number of cases of Sudden Infant Death Syndrome (SIDS) is decreased by an increasing number of cases that can be ascribed to specific medical conditions. A case of the sudden death of an infant is described that autopsy revealed was due to the unusual finding of hypertrophic cardiomegaly in a two-month-old.

Clinical History: The infant was a healthy, full-term two-month-old white male, who was found unresponsive in his crib following a morning nap. The father began CPR and called emergency personnel. The infant was transported to the hospital, where resuscitative efforts were unsuccessful, and the baby was pronounced dead.

The infant was born to a G2P2 30-year-old woman, who had a history of a motor vehicle accident that resulted in brain trauma. She later underwent temporal lobe resection for control of seizures. During pregnancy, seizure activity required that she was started on levetiracetam (Keppra), beginning at approximately 20 weeks gestation at a dose of 1000 mg per day that was later increased to 1500 mg per day. Towards the end of the pregnancy, she was also started on gabapentin (Neurontin) at a dose of 5400 mg per day. Her pregnancy otherwise was uneventful. At 32 weeks gestation, a second level ultrasound showed no fetal abnormalities, and the heart was normal in size.

Autopsy Findings: At autopsy, the body was that of a well developed and well nourished two-month-old white male, weighing 11 pounds and measuring 23 inches in length. There were no signs of trauma. All internal organs were in their normal anatomic relationships. The heart, in the fresh state, weighed 72 grams (average weight for age was 30 grams) and was structurally unremarkable. Upon sectioning, the myocardium was red/brown, without fibrosis, hemorrhage, or distinct lesions. The interventricular septum was intact. The atria were unremarkable, and no interatrial defects were present. The coronary ostia were normally located, and the distribution showed right dominance with a circulation pattern within normal limits. The valves were thin and unremarkable.

Microscopic Examination: Hypertrophic cardiomyocytes found on H&E sections of the heart. No other microscopic abnormalities were found. Electron microscopy and special histochemical stains were performed.

Discussion: Hypertrophic cardiomegaly in many ways resembles hypertrophic cardiomyopathy. There is left and/or right ventricular hypertrophy that is usually asymmetric and involves the interventricular septum. The hallmark features are myocardial hypertrophy and structural derangement. In this case, the heart was approximately double the normal weight and size.

Neonatal cardiomegaly may resemble hypertrophic cardiomyopathy. However, at autopsy a variety of cardiovascular defects, such as aortic coarctation or malformation of the coronary arteries, are usually found. In addition, in some patients without cardiovascular defects, another cause for ventricular hypertrophy may be present, such as chronic renal failure or maternal diabetes. In this case, no other cardiovascular defects, besides left ventricular hypertrophy, were found, and no additional medical conditions were known.

The differential diagnosis in this case includes amyloidosis, glycogen storage disease, and Fabry disease. These conditions can be eliminated from consideration by microscopic examination of the heart. In this case, sections of the heart showed no abnormal intracellular accumulations.

The etiology of this infant's hypertrophic cardiomegaly is unknown. The parents were concerned that the anticonvulsant medications taken by the mother during pregnancy may have adversely affected the fetus. This question cannot be answered with certainty. Both levetiracetam and gabapentin are pregnancy risk category C drugs, meaning there are no adequate studies of the drugs in humans, although animal studies have shown an adverse effect on the fetus. Category C drugs may be useful in pregnant women despite their potential risk.

It is possible that there may be a familial component to this case. The infant's paternal grandfather has a history of hypertrophic cardiomyopathy.

Conclusion: Hypertrophic cardiomegaly is a rare finding in infants and may be a cause of unexpected sudden death. This condition should be considered in the differential diagnosis of SIDS. A careful examination of the cardiovascular system is warranted in each case. Microscopic and special studies may be used to rule out other causes of cardiomegaly in infants.

Infancy, Hypertrophic Cardiomegaly, Sudden Death

G42 Use of Expert Consultation in the Evaluation of Tissue Donors With a Postmortem Diagnosis of "Hepatitis" to Determine Eligibility For Transplantation

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The goals of this presentation are 1) to emphasize the importance of attempting to specifically determine and report infectious vs. non-infectious etiologies of hepatitis in cadaveric donors of tissue for allotransplantation, 2) to emphasize that correlation of morphology with viral serologic testing results is integral to establishing the initial diagnosis of viral hepatitis, and 3) to assess the utility of expert consultation in making this determination.

Introduction and Hypothesis: Chronic hepatitis is a clinical-pathologic syndrome which may result from a number of causes including viral infections, autoimmune or metabolic diseases, drugs (medications), or other unknown etiology (cryptogenic). Chronic hepatitis is defined clinically as inflammatory liver disease continuing for at least 6 months. However, patients with chronic hepatitis may have asymptomatic clinical phases, for example in hepatitis C and autoimmune hepatitis. Patients with viral hepatitis, especially infections due to hepatitis C virus (HCV) or to hepatitis B virus (HBV) with or without hepatitis D virus (HDV) superinfection, are at significantly increased risk for developing hepatic cirrhosis and hepatocellular carcinoma. Chronic hepatitis due to viral infection is a clear contraindication for blood donation and is likewise a contraindication for allogeneic organ and tissue donation. The Federal Drug Administration (FDA) and American Association of Tissue Banks (AATB) standards require tissue donors to be screened by medical / social history for risk factors for viral hepatitis and to have negative laboratory tests for hepatitis B surface antigen (HBsAg), Hepatitis B core antibody (anti-HBc), hepatitis C virus antibody (anti-HCV), and human immunodeficiency virus, types 1 and 2 (anti-HIV-1/2). Cadaveric donation of tissue (e.g. bone, skin, fascia, tendons, heart valves, and corneas) may also be preceded or followed by postmortem examination of the donor, including liver biopsy. Since chronic hepatitis is a clinical-pathologic syndrome resulting from both infectious and non-infectious causes, it was hypothesized that many potential tissue donors with a postmortem diagnosis of "hepatitis" without reference to etiology made initially at autopsy, but with otherwise acceptable AATB donor criteria, would have minimal liver inflammation resulting from non-specific or non-infectious causes and would therefore be acceptable donors.

Methods: Seven potential cadaveric donors ranging in age from 16 to 72 years were referred to a regional tissue bank by either hospital (n=4) or medical examiner's office (n=3) staff. The causes of death included cardiac events (n=3; 1 acute myocardial infarction, 1 hypertensive cardiovascular disease, and 1 hemopericardium with cardiac tamponade), vascular rupture (n=2; 1 abdominal aortic aneurysm and 1porta hepatis), and head trauma (n=2; 1 gunshot and 1 blunt injury). Based on initial screening criteria, including a detailed medical / social history obtained from next-of-kin and an external physical examination, the donors were approved as being suitable for tissue donation. After informed consent was obtained from next-of-kin, donor tissues including skin, saphenous and femoral veins, heart (for valves), ilia, fascia lata, long bones and achilles tendons of the lower extremities were procured under aseptic conditions within 24 hours of asystole. In all cases, a postmortem examination was performed either before or after the tissue procurement by a pathologist from the referring institution. Infectious disease testing was performed on ante- or postmortem plasma or serum samples meeting acceptable plasma dilution criteria with FDA-approved cadaveric test systems for HBsAg, anti-HBc, anti-HCV, anti-HIV-1/2, HIV p24 Ag, and HIV DNA by PCR. These seven donors, each with an autopsy diagnosis of "hepatitis" without reference to specific etiology, were re-evaluated after procurement of tissues. These cases, with complete clinical and laboratory findings including routine histological sections of liver from autopsy and results of infectious disease tests, were subsequently referred to independent expert gastrointestinal / liver pathologist consultants for a formal second opinion regarding the possible diagnosis of viral / infectious hepatitis. Tissues of donors with clinical and histological findings determined by the expert to be insignificant, non-specific or non-infectious were processed to a variety of grafts at an AATB-certified processing facility and released for transplantation. Clinical follow-up was obtained.

Results: For all seven potential donors, screening criteria from the medical / social history, including risk factors for infectious hepatitis, and the physical examination were acceptable on re-evaluation. In each case, all infectious disease laboratory test results for viral hepatitis markers were also acceptable. In addition to other findings, each autopsy report from the referring institution listed "hepatitis" as a significant postmortem finding. As these reports did not specify either an infectious or non-infectious etiology of hepatitis, histological sections of liver from autopsy were obtained in order to assess the suitability of grafts derived from each donor for transplantation. Preliminary review in all cases showed only minimal to mild, patchy inflammation limited to portal areas. The histological sections, along with clinical and laboratory results, were forwarded to independent expert gastrointestinal / hepatic pathologist consultants for a formal opinion of the possibility of hepatitis of infectious cause. In all seven cases, in the opinion of the expert, the findings were either a) unremarkable hepatic parenchyma (n=2), b) non-specific portal triaditis (n=4), or c) non-diagnostic of chronic hepatitis of viral etiology (n=1). Based upon these opinions, the donors were approved as suitable for transplantation and tissues from the seven donors were processed into a total of 254 surgical allografts, potentially benefiting an equivalent number of recipient patients. At the time of this writing (12.5 to 47.5-month follow-up from date of procurement), no cases of infectious hepatitis have been reported in the graft recipients.

Conclusion: Chronic hepatitis of viral etiology is a contraindication for cadaveric tissue donation. In contrast, hepatic inflammation due to non-infectious etiologies may not be prohibitive for donation. Thus, at postmortem examination of decedents who have donated tissues for transplantation, efforts should be made to accurately diagnose hepatitis and, if possible, to further determine the specific etiology (infectious or non-infectious) of hepatic inflammation. Correlation of morphology with viral laboratory testing is often integral to establishing the diagnosis. Typical histological findings of hepatitis of varying etiologies will be discussed. Microscopic findings of only mild, patchy portal triaditis should be interpreted as "hepatitis" with caution when viral serologic tests are negative or in the absence of such tests. The use of consultation by expert gastrointestinal/hepatic pathologists may assist hospital autopsy pathologists, forensic pathologists and/or tissue bank medical directors in making this determination and may result in an increase in the supply of acceptable tissue for transplantation to many patients needing surgical allografts.

Hepatitis, Tissue, Allograft

G43 Determining the Cause of Death and Contributing Factors in Fatal Recreational SCUBA Diving Accidents

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The goals of this presentation are to provide the forensic community with epidemiological data on diving fatalities and offer guidance and resources for investigating such deaths.

Diving with SCUBA (self-contained underwater breathing apparatus) equipment while breathing compressed air is a popular pastime in the U.S. An average of 90 to100 recreational diving deaths occur in the U.S. or involve U.S. citizens diving abroad each year. Few medical examiner offices have enough experience with diving related deaths to adequately investigate such cases and errors in reporting the cause of death and contributing factors frequently occur. The goal of this presentation is to provide background data on the epidemiology of fatalities involving recreational divers and to arm the forensic community with some tools and guidance in properly determining the cause of death in such cases.

The Divers Alert Network (DAN) is a diving safety organization affiliated with Duke University Medical Center and located in Durham, North Carolina. DAN collects data on all recreational diving accidents and fatalities that occur in the U.S. or that involve U.S. citizens diving abroad. The information collected includes autopsy reports, investigational reports from law enforcement agencies and the U.S. Coast Guard, witness accounts, newspaper articles, and any other information from contributors involved in the case (e.g., medical treatment personnel, other divers, rescue personnel). Each case is reviewed by DAN staff, which includes individuals with technical diving expertise as well as a physician trained in both diving medicine and pathology. The Divers Alert Network publishes the data, including case reports, in an Annual Review of Diving Accidents and Fatalities. DAN also provides formal consultative services, free of charge, to any medical examiner office or government agency.

The Divers Alert Network fatality database was queried to obtain information on recreational diving deaths that occurred during the period 1989-1998. During that time there were 911 total diving deaths, over 70% involving male divers. Nearly half of all diving related fatalities involved divers age 30 to 49. Autopsies were performed in most, but not all, of the fatalities and in some cases a body was never recovered.

Not surprisingly, the most common cause of death was drowning (59%), though this should be considered a final common pathway in recreational water sports and the circumstances resulting in drowning are far more meaningful from a public health aspect. Other significant causes of death included cardiac events (11%) and arterial gas embolism (9%). Significant contributing factors that resulted in death while diving included running out of air at depth (17.2%), entrapment in a cave or other structure (10.7%), and having a medical problem during the dive (e.g., cardiac event (19%), asthma attack, etc.).

Diving experience varied but many were novices. Nearly half of the deaths involved divers who had made 20 or fewer lifetime dives, though a small, but significant, percentage occurred when the diver was under instruction in a formal training class. A large number of deaths involved divers who were involved in more challenging types of diving, such as cave exploration, wreck penetration, and deep diving. Of the divers who died while involved in these specialty types of dives, only a third had any documented formal training in that type of diving. Many divers in the fatality database were infrequent divers, making only a few dives each year. Diving dogma dictates that one always dives with another diver (the dive buddy). For the fatalities in the database, 40% became separated from their dive buddy during the dive; 14% chose to dive alone and had no assistance available when a problem occurred in the water.

Deaths that involve recreational divers are infrequent but can occur in almost any jurisdiction. For the ten-year period of data used in this report, nearly a third of the fatalities occurred in the southeastern part of the U.S. The states with the greatest number of diving related deaths were Florida, California, and Hawaii. However, a significant number of diving fatalities occurred in New England, the states bordering the Great Lakes, and the Pacific Northwest.

The medical examiner or forensic investigator involved in the investigation of a diving related fatality should either have a solid foundation in diving techniques and underwater physiology or seek expert consultation. To correctly assign a cause and manner of the death, these cases require a thorough investigation of the scene, knowledge of the circumstances surrounding the death (including a detailed history of the dive, if available), professional evaluation of the diving equipment used, and a complete autopsy with proper toxicological studies. Some modification in the autopsy protocol to look for pneumothorax and air embolism are necessary and a carboxyhemoglobin should be part of the standard toxicology for these cases.

Despite being uncommon events, recreational diving fatalities often involve young people with a large number of years of productive life lost and the cases nearly always go to litigation. The importance of a thorough investigation and arriving at accurate conclusions cannot be overstated.

SCUBA Diving, Drowning, Air Embolism

G44 Sphenoid Sinus Petechiae: Incidence and Significance

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After attending this presentation, participants will gain insight as to the incidence and significance of sphenoid sinus petechiae.

Purpose: Petechial hemorrhages, while a non-specific finding, may be indicative of an asphyxial death. Many studies have reviewed the importance of petechiae in a variety of sites, such as the conjunctiva, skin or visceral surfaces, however information regarding petechiae of the sphenoid sinus mucosa is not often commented on. The consensus of many investigators suggests that the pathogenesis of petechiae is related to the combined effects of increased venous pressure and hypoxic damage to endothelial cells, although the latter has been discounted by some authors. It is surmised that petechiae of the sphenoid sinus occur by the same mechanisms. The following investigation aims to demonstrate the significance of petechiae discovered in the sphenoid sinus, as well as to correlate their presence in conjunction with petechiae at other sites on the head.

Materials and Methods: The Southwestern Institute of Forensic Sciences in Dallas, Texas conducts approximately 3500 autopsies per year. Over a 30-day period, a series of autopsies were prospectively examined for the presence or absence of petechiae of the sphenoid sinus. Near the conclusion of the autopsy, i.e., after all organs had been eviscerated, the roof of the sphenoid sinus was removed via a triangular shaped opening made with a Stryker saw. Cuts were made through the lesser wing of the sphenoid bone on each side of the sphenoid sinus and just anterior to the sella turcica. Once the piece of bone was removed, the sphenoid sinus mucosa was examined with the aid of a halogen lamp or penlight. Petechiae were described as none, few or many; the latter equating to too numerous to count. Other variables documented in each case were: age, race, sex, cause and manner of death, the presence or absence of facial or conjunctival petechiae, body position at the time of death and whether or not cardiopulmonary resuscitation was attempted.

Results: As with petechiae identified in other sites, the presence or absence of sphenoid sinus petechiae neither confirms nor disputes the cause of death. However, they are seen in certain types of deaths with a

higher frequency than others. In cases where autopsy findings are subtle or vague, such as in drowning deaths or certain asphyxial deaths, the presence of sphenoid sinus petechiae can be useful corroborative evidence to support a particular cause of death. The position of the body at the time of death is important information when interpreting the usefulness of sphenoid sinus petechiae, as they are seen with increased frequency in specific body positions. While not specific for any particular cause of death, sphenoid sinus petechiae can provide pathologists yet another piece of information in certain settings, and when interpreted in the total case context, help support a particular cause of death.

Sphenoid Sinus, Petechial Hemorrhages, Incidence

G45 Homicide in the Elderly— Paris and Its Suburbs, 1996-2001

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Be it intra or extrafamilial, violence against the elderly has become an important source of concern. Surveys suggest that domestic violence and elder abuse and neglect are underestimated. The present study examined the circumstances surrounding homicides in the elderly, and autopsy findings.

As the population of the industrialized countries ages, the problems associated with the care of the elderly increase. Of those, violence against the elderly is an important source of concern. Most surveys indicate that the frequency with which elderly persons are assaulted or abused is likely to be underestimated. Among other forms of violence, domestic elder abuse and neglect has been suggested to be perhaps the most underreported crime. Homicide might be the extreme and most tragic form of abuse and neglect, and therefore may represent an accurate indicator of violence against the elderly. However, medicolegal autopsy-based studies and international comparisons are infrequent.

The aims of this study were to examine the circumstances, demographics, and autopsy findings in homicides involving persons aged 65 years or older, in Paris and its suburbs, between 1996 and 2001.

Results: 99 homicides occurred during the 6-year study period, 23 in 1996, 11 in 1997, 21 in 1998, 15 in 1999, 11 in 2000, and 18 in 2001. There were 59 female victims. The mean age of victims was 77 years, 79 in females (range, 65-97) and 74.5 in males (range, 65-87). There were 18, 24, and 17 females in the 65-74, 75-84, and ³85 age groups, respectively, and 25, 9, 6 males in these age groups, respectively. 76% of victims were killed in their home. In 43 cases, the perpetrator was unknown to the victim. The murderer was a family member in 28 cases and an acquaintance in 28 cases. The most common motive for homicide was robbery, 40 cases. 30 of those occurred in the victim's home. 7 women were raped. There were 12 homicide-suicides. Disputes involving acquaintances or relatives accounted for approximately 25% of cases. In 12 cases, the perpetrator and motive could not be determined. Among the 99 homicides, 28 were domestic, including 20 intimate partner homicides, with the husband being the perpetrator in 14 cases. Guns were used in 14 of the 99 cases, 12 of which involved intimate partner homicides. Guns were never used in rapes or robberies. Stab wounds were found in 15 cases. Fifty-six persons died of blunt force injuries. In 39 cases, asphyxia was the cause of the death, with 25 of these in combination with blunt force. In 5 of the robbery cases, a cardiac disease, in addition to blunt force, contributed to the death.

Conclusion: During the 6-year study period, the number of elderly homicide victims, older than 65 years, in Paris and its suburbs has been approximately 16 per year. Males were at highest risk in the 65-74 age group, whereas females accounted for 75% of victims in the ≥85 age group. The elderly homicide victim was most likely to die from blunt force injuries. Domestic violence accounted for less than 30 % of homicides, whereas robbery was the most frequent motive for homicide, accounting for 40 % of cases. Frailty and social isolation that come with illness or advanced age render the elderly more vulnerable to crime and make it impossible for some elderly individuals to protect themselves.

Elderly, Homicide, Forensic Sciences

G46 Abuse and Neglect: A 10-Year Review of Mortality in Elders

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The goals of this paper are to present the prevalence and pertinent findings of elder abuse and neglect in a major metropolitan city in Kentucky.

Methodology: to analyze data representative of or suspicious for elder abuse from a ten-year (1992-2001) retrospective case review of morbidity and mortality among elders (greater than or equal to 60 years old) at a State Medical Examiner's Office serving a major metropolitan city in Kentucky conducting both medicolegal autopsies and examining living cases pursuant to a Clinical Forensic Medicine Program.

Elder abuse refers to an act or omission, which results in harm, including death, or threatened harm to the health or welfare of an elderly person. Between one to two million Americans experience elder abuse and neglect per year. Elder abuse may be divided into six discrete, but often overlapping, categories: physical, sexual, and psychological abuse; neglect; financial exploitation; and violation of rights. While elder neglect is the most commonly discovered and investigated form of elder abuse, it represents the least well-defined and most controversial form of maltreatment. The abused elder often is over the age of 75, lives in social isolation with few social contacts, and suffers from poor health and cognitive impairment. The abuser frequently lives with the elder, has a history of mental illness and/or substance abuse, commits violence, displays antisocial behavior in relationships, and is financially and/or emotionally *dependent* on the elder.

The 10-year retrospective study included 74 postmortem examinations and 22 living patients evaluated at a clinical forensic center in Louisville, KY. The authors present the 74 postmortem cases of victims age 60 and older, in which 52 deaths were attributed to a homicidal act and 22 deaths were suspicious for neglect. The homicidal causes of death included gunshot, beating, stabbing, and asphyxia. The primary cause of death in neglect cases was bronchopneumonia. Distinctive factors among this elderly cohort, such as the frequency of cancer and Alzheimer's disease, were uniformly evaluated.

Forensic pathologists or emergency room physicians and forensic nurses through the Clinical Forensic Medicine Program evaluated 22 living individuals greater than or equal to 60 years old. Among these clinical investigations, 19 cases constituted physical and/or sexual assault and 3 victims suffered from neglect.

The authors summarize the characteristic features of elder abuse in both postmortem and living cases and underscore the necessity for multi-agency collaboration in order to reach an accurate conclusion in case work. Policies gleaned from a well-established elder abuse task force enable the interaction necessary to formulate criteria for future prevention. In the majority of physical and sexual assaults evaluated in the Clinical Forensics Program and at autopsy, which appear to be inflicted by "unknown perpetrators," further in-depth investigative work must be done. These initially termed "unknown perpetrators" may represent acquaintances, family members, and people who live or work in the vicinity of the victim. With the ongoing communication between agencies, assailant identification and clarification of the circumstances will increase the likelihood that the case is brought to litigation.

Elder Abuse, Elder Neglect, Clinical Forensic Medicine

G47 Elderly Neglect/Abuse

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This presentation is designed to bring awareness to the forensic community of elderly neglect/abuse which is a widespread problem possibly affecting hundreds of thousands of elderly across the country. It is still underreported due to a variety of reasons. This will discuss in detail what constitutes elderly neglect/abuse, medical, investigative, and autopsy assessment with presentation of several case reports from the State of Hawaii.

On June 18, 2002, the U.S. Congress heard detailed accounts of case reports of elderly neglect/abuse by a panel of experts and a report issued by the National Research Council stating, "Based on the available estimates, between one to two million Americans 65 and older have been injured, exploited, or otherwise mistreated by someone on whom they depended for care and protection." The overall national response to elder mistreatment currently remains weak and incomplete. Information on neglect/abuse cases and policies on how to deal with it vary from state to state. Therefore, they requested that someone at the Federal level take charge of the situation, gather statistics, and try to find a way to deal with the problem that will only grow worse as the population ages.

The National Center on Elder Abuse has defined three major categories of abuse/neglect as domestic, institutional, and self-neglect. The types of abuse are physical abuse, sexual abuse, psychological abuse, financial exploitation, and neglect. If not considered in the differential diagnosis, like a disease, elderly neglect may not be diagnosed. Inconsistent statements by the caretakers, evaluation of the environment, medications, nutritional evaluation, and statements in regard to the explanation of injuries/ulcers should be considered in investigating deaths due to the neglect/abuse. Medical and autopsy assessments should indicate the nature and extent of injuries, evaluation of hydration and metabolic status, detailed documentation of decubitus ulcers with the size, extent, and appearance with reference to staging, determination of the cause of death with evaluation of the duration of specific conditions, and documentation for legal proceedings.

Preventive measures include public awareness through education and early identification, intervention, and treatment for elders and their caregivers in high-risk situations, increasing the staff in the care homes, and even criminal prosecution of caregivers.

Elderly, Abuse, Neglect

G48 Morphological Considerations of the Hyoid Bone

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This presentation will demonstrate the tremendous variation that characterizes the hyoid bone

Combining the anthropological focus upon skeletal variation with the pathological interest in trauma, this study reveals the immense variation and complexity in laryngeal structures, and dispels the common notion of a causal relationship between advancing age and fusion of the hyoid bone.

Fractures of the laryngeal structures are frequently associated with manual and ligature strangulation, although external manifestation of such trauma is not always evident. Often, assessment of the condition of the hyoid bone may merely involve palpation of the laryngeal tissues at autopsy. Unfortunately, such interpretations are plagued by the unquestioned acceptance that the skeletal elements of the hyoid bone unite with advancing age. Understandably, this erroneous consideration of the development of the laryngeal skeleton is frequently assumed in forensic interpretations.

The hyoid bone is comprised of several distinct skeletal components, the body and pairs of greater and lesser horns. However, throughout the anatomical and scientific literature the hyoid bone is traditionally described as a "U" shaped bone of a consistent form; a form that develops and fuses with advancing age. This interpretation, therefore, biases the potential anatomical, pathological, and clinical evidence that can be gleaned through examination of the components of the hyoid bone. Although the literature produced within these disciplines contains a wide variety of references to hyoid conditions, these reports suffer from a failure to recognize the variability that characterizes the human hyoid bone. Clearly, a thorough appreciation of the range of variation inherent in this structure is crucial for the accurate assessment of the hyoid in both antemortem and postmortem situations.

Toward this end 1,814 hyoid bones from individuals ranging in age from 2 months to 101 years, maintained in the Department of Anthropology at The University of Tennessee, were examined. Specimens were assessed for fusion and categorized as unfused, unilaterally fused, or bilaterally fused. Additionally, a series of measurements were performed to quantify overall size and shape. The structure of the hyoid, as revealed by the extent of fusion and overall size measurements was then compared against known age, sex, and ancestry data.

Results indicate that the hyoid is sexually dimorphic, though no significant differences exist between males and females with regard to fusion. However, age is a factor when considering a union between the body and greater horns in that among the young (0-9 and 10-19) no union occurs. There is minimal evidence for the occurrence of fusion between the body and greater horns during the third and fourth decades of life. Although an increase in the frequency of union occurs during succeeding decades, this study demonstrates that advanced age cannot be equated with fusion between the body and greater horns.

This enhanced awareness of the variability that truly characterizes the hyoid will enable more accurate pathological, anthropological, anatomical, and clinical descriptions of the hyoid in forensic settings.

Hyoid Bone, Laryngeal Trauma, Morphological Variation

G49 Relevance of the Autopsy as a Medical Tool: A Large Database of Physician Attitudes

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The goals of this presentation are: 1) to examine a large data base of physician attitudes about the value of the autopsy, 2) to attempt to correlate physician opinions about autopsy to their levels of experience with and knowledge of the procedure, and 3) to determine whether there is sufficient interest in the autopsy to make revitalizing it worthwhile as a contributor to medical practice.

Background: Autopsy rates for patients dying in hospitals have declined from approximately 50% in the 1950s to at or below 10% of similar patients today. A previous pilot study survey distributed to attending physicians in a large, urban, university hospital center suggested that in spite of this decline, physicians believed strongly in the usefulness of the autopsy. Most disagreed that diagnostic procedures were so accurate that autopsies had become irrelevant, and most disagreed that concern over litigation affected their desire to request autopsies. Given the results in this pilot survey, physicians' positive opinions about the value of the autopsy appeared to contradict their apparent declining requests for the procedure. It became important, then, to confirm that these attitudes hold true in a larger and more varied sample, perhaps more indicative of the population of physicians in general.

Methods: This study uses essentially the same survey on autopsy knowledge and opinions that was distributed in the pilot study. A slightly revised survey was distributed to all attending physicians in a second large, university-affiliated medical center and a large military-affiliated medical center. The database of physician responses now includes three major hospitals, two university-affiliated (one private and one public) and one military, as well as one east coast and two west coast hospitals. Including the pilot study, the 10-question survey has now been distributed to 723 full-time attending physicians. The survey was an anonymous, one-page, multiple choice format questionnaire, that could be completed in under five minutes. Clinicians first identified their department, years of practice, and the number of autopsies they had observed or participated in as a student, resident, or attending physician. They then estimated their departmental autopsy rate and opined on the sufficiency of that rate to meet departmental goals for education and research. The remaining questions examined, among other topics, physician belief in the value of the autopsy for confirming diagnostic results, its potential affect on medical practice, the effects of possible litigation on autopsy requests, and how prepared physicians felt to discuss autopsy with families of patients.

Results: A total of 113 military physicians and 94 university physicians provided 207 (29%) total responses to the survey. Departmental response rates varied from 13% to 80%, with response rates slightly higher on average at the military facility. Attendance was fairly evenly spread in years of practice from less than 5 to over 20 years. Physicians at the military center had been in practice somewhat longer than their civilian counterparts and, as a result, seemed to have had slightly more exposure to autopsy. However, overall exposure to autopsy by observation or participation was low, with 52% of physicians being involved in fewer than 5 cases (11% responded 0 cases) and only 21% indicating involvement in more than 20 cases over their careers. Respondents in nearly equal percentages (35% and 40%) agreed and disagreed that their departmental autopsy rates were sufficient to meet departmental goals, with this bimodality probably traceable to 46% indicating no knowledge of the rate. Fully 36% (the largest response category by far for this question) could not say whether or not results were reported in a timely fashion. The pattern of responses of military-affiliated physicians did not appear to be statistically different from those of university-based physicians on opinion-based (non-demographic) questions, so the two groups were combined for much of this analysis. Physicians across years of practice, autopsy experience and knowledge, and departments agreed (72%) that autopsy results could affect their medical practice and disagreed (74%) that the accuracy of modern diagnostic procedures makes autopsy obsolete. Interestingly, one of the largest concentration of responses in the survey (77%) disagreed that litigation concerns played a role in the request and use of autopsy. This result directly contradicts one of the principal conclusions in the literature offered to explain declining autopsy rates. Also, in spite of the apparent collective lack of experience with autopsies indicated by responses to the demographic questions, physicians mostly (79%) claimed to be comfortable with discussing the autopsy with family members. However, the most resounding result from the 207 physician responses to the survey appears to be that both military and civilian physicians feel that the autopsy is a relevant clinical instrument and medical tool, even when they have experienced, requested, discussed, or personally used very few of them.

Conclusions: The expanded survey data confirms that physicians highly value the autopsy as a clinical tool, in spite of declining rates and decreasing exposure to autopsy over their professional lives. These opinions do not appear to vary significantly across types of institution or years of experience. The survey data does not support (in fact, seems to refute) causes of the decline in the use of autopsy often cited in the literature, i.e., delayed reporting of results, concern over litigation arising from findings, or belief in the accuracy of current diagnostic procedures. The next step of this research will be to model the effects of implementing changes in autopsy education and procedures on physician request rate and use. The anticipated changes would include, at minimum, more widespread exposure to autopsies at each stage of medical education, better pathologist to clinician communication, and prompt and relevant reporting. The autopsy, a procedure that physicians claim to value so highly, should not be allowed to become only a forensic tool and slip out of existence as a contributor to medical knowledge.

Autopsy Rates, Autopsy Relevance, Physician Attitudes

G50 Analysis of Five Thousand Forensic Medical Expert Opinions

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The goals of this presentation are to describe and characterize the major types of forensic expert medical opinions done by forensic pathologists in Hungary and explore strategies that may help improve service.

Methods: In majority of European forensic institutions, forensic pathologists play an important role to formulate expert medical opinion, additional to their regular medico legal autopsy workload. In many places these expert opinions even outnumber the forensic autopsies performed. At the Institute of Forensic Medicine, nearly 15,000 written opinions have been prepared (non-autopsy cases) during the last four years on wide variety of cases. Although majority of these involved forensic psychiatrists and psychologists, approximately 5,000 cases were clearly completed by the Institute's forensic pathologists.

Results: Cases include medical malpractice but also homicides, accidents, disability, worker's compensation, fight injuries, interpreting toxicological results, etc. Results of expert opinions will be provided based on the type of case and authorities' requests (civil or criminal court, police, DA's office, other institutions). The major categories of cases will further be broken down and scrutinized from many aspects. Preparing the expert opinion does not necessarily require complete patient examination; the percentage of giving opinion from documentation and charts only varies widely (i.e. in 6% of civil cases and in 23% of criminal cases no patient examination was involved). The increasing number of suspected mistakes in medical treatment allowed the authors to point out recurrent mistakes, and to categorize and statistically analyze the causes of claims. (i.e., misguided allegations, error of judgment, incompetent care, failure of communications, lack of expertise, etc.). Dealing with medical malpractice cases by forensic expert sometimes require input from clinicians to overcome the gap between academic approach (theory) and the care and treatment of an individual patient (practice). The authors will present personal experiences on why and when clinicians are asked to participate in formulating an expert opinion.

Disability evaluation is an important part of forensic medical evaluation in caseloads. The Institute represents a 3rd level forum. All patients were examined twice before a civil court, specializing in disability issues, referred them to the Institute for a final opinion. Further details will be provided on cases involving temporary and permanent injuries (what is done, how is it accomplished). Additionally, the number of questions submitted and the most often asked relevant questions, which an expert opinion should answer in each of the expert opinion categories, will be discussed.

Finally, challenging the forensic medical opinion in court of law works in Hungary will be explained. A very important index of the Hungarian forensic expert's work is the acceptance rate of expert opinion in the court, which will be presented.

Forensic Expert Medical Opinion, Medical Malpractice, Disability Evaluation

G51 The Happy Land Homicides: 87 Deaths Due to Smoke Inhalation

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After attending this presentation, the participant will understand the roles of carbon monoxide, cyanide, ethanol, and hydrochloric acid in fatal smoke inhalation.

On March 25, 1990, eighty-seven people died of smoke inhalation at the "Happy Land Social Club" in New York City. A 36-year-old man, who earlier had been ejected from the unlicensed club after a verbal altercation with his former girlfriend who worked at the club entrance, intentionally started the fire. He went to a nearby service station, filled a plastic container with a dollar's worth of gasoline, and returned to the club. He threw the gasoline and lit matches into the only entrance of the two story social club. Smoke quickly filled the club. Although the fire was extinguished within minutes, all but five of the occupants of the building were found dead within the building.

Within 36 hours the New York City Office of Chief Medical Examiner performed 87 autopsies on this group of healthy, young people, all of whom quickly died from smoke inhalation from a common fire source. All decedents were visually identified and all had soot in the airway extending to the major bronchi. Only 30% of the decedents had thermal injuries and most were partial thickness burns involving less than 20% body surface area.

Carboxyhemoglobin (COHb) concentrations ranged from 37% to 93% with a mean of 76.5%. The vast majority (92%) of the decedents had COHb concentrations over 60%. Ethanol was detected in 72% of decedents with a range of 0.01 to 0.29 g% and a mean blood concentration of 0.11 g%. Of the 24 decedents with no ethanol detected at autopsy, the average COHb concentration was 79%. The 15 decedents with blood ethanol concentrations of 0.15 g% or higher had an average COHb concentration of 73%. Cyanide concentrations ranged from 0 to 5.5 mg/L with a mean of 2.2 mg/L. Nine decedents had no cyanide detected and seven had cyanide concentrations of less than 1 mg/L. The tracheal pH ranged from 5 to 7 (mean 6.4).

Since all decedents in this instance died from smoke inhalation in the same smoke filled environment, if cyanide was a reliable indicator of smoke inhalation, then all the decedents would have detectable cyanide. The fact that nine of the decedents had no cyanide detected and another 7 had less than 1 mg/L demonstrate that cyanide did not play any role in several deaths. In fire deaths, cyanide concentrations do not provide helpful, interpretable information and need not be performed on suspected smoke inhalation deaths. Alcohol does not appear to cause death at a lower COHb concentration as the mean COHb concentrations in the intoxicated (BAC >0.14g%) and sober groups were similar (73% vs. 79%). Hydrogen chloride inhalation, as judged by comparison of the pH of tracheal mucosa to controls, was not a factor. The cause of all deaths was smoke inhalation and the manner was homicide.

Forensic Science, Carbon Monoxide, Smoke Inhalation

G52 Documenting Patterns of Injury in Fire Victims

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The goals of this presentation are to review 1) problems associated with documenting burned human remains, 2) recording patterns from fire trauma, 3) identifying features that may indicate body position and fire dynamics, and 4) suggestions for charting victims of mass disaster fatalities.

Dynamic burning processes affecting a human body produce one of the most complex alterations of form by distortion into the pugilistic posture. Additionally, further obfuscation occurs from superficial thermal changes to skin (charring, blistering, and splitting) and as damage progresses, exposure and destruction to deeper layers of subcutaneous tissue, musculature, viscera, and bones. Adequate records and documentation of burning changes are vital since it is known that the sequence of tissue changes correlates with heat source, origin, and body position especially if the expected pugilistic posture is not attained. The ability to use pathological examination of the body in this manner allows results to be integrated with independent investigation by anthropologists, fire marshals, and arson investigators. In such instances mere dictation of the findings fail to capture all the salient features and would otherwise be long and cumbersome. Borrowing on the ancient wisdom of a picture is worth a thousand words, a graphic presentation seems to be in order; however, accomplishing that in a constructive way is challenging.

One of the most difficult tasks in forensics is the ability to produce records for public consumption that are also useful as a court document and effectively convey the necessary information to communicate the same concepts understood by the examiner. Even more difficult is documentation limited by two-dimensional representation of a complex three-dimensional process. The emphasis on mass disaster preparedness compels experts to improve the entire process for all types of fatalities but this seems more so in the burn victim. These fatalities are virtually always out of the anatomical position, and usually have various layers of tissues or organs exposed. Photographs are very useful but hardly fit for public release and if overly graphic, may even be considered too inflammatory in the autopsy protocol and render it unsuitable for jury use unless redacted.

At the University of Tennessee, Memphis physicians have undertaken several methods to achieve a permanent record of observations that retains a continuity of interpretation readily discernable after the passage of time and serves as an effective basis of communication to investigators and juries alike. Taking advantage of this active research in the burning process the authors are now sufficiently aware of the expected sequence of the changes to the body to identify what parameters are more useful to record. The manner in which they are recorded may vary with the case and several examples are presented.

With the advent of the digital age it is possible to take photographs of any sort and convert them into digital images (if not so originally) and digitally redact them to the point of abstraction with a subsequent loss of inflammatory content. Although this has not been subject to challenges in court, the digital images are not tendered as evidence so much as an aid to testimony. It is also important to be able to describe the process by which the redaction occurred. Most often the techniques used are to eliminate the color aspect and present the photo in grayscale (black and white) followed by use of computer filters to portray the edges of the image. At times retaining the color scheme does enhance clarity and is retained. It is then helpful to graphically add text to point out the various landmarks and interpret the image so orientation and understanding are not lost.

Another method goes back to the time honored process of diagramming various views of the body using charts depicting the skeleton outlined by the body contour. In this fashion changes in the skin, soft tissue, and skeletal elements are charted together, merging the pathology and anthropology findings into the same document. Charts depict the body in anatomic position since this is a reference standard, and allows for notation of any deviation from the expected pugilistic posture. Using either different colors or textured fills can document the stages of soft tissue changes. Once recorded, a comparison with diagrams depicting the expected pugilistic posture, patterns of soft tissue loss, exposure, and direction of skeletal exposure can be easily accomplished. This creates a permanent visual record to be utilized by other agencies or investigators as an adjunct to their investigation and serves as a non-inflammatory source document to educate the jury.

Skeletal Trauma, Anatomical Charting, Fire Investigation

G53 Suicide Attempt Using a Self-Made Rifle

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The literature reports mainly the use of self-made guns but more seldom the use of self-made rifles. As a contribution to the understanding of this unusual firearm, the author presents a case involving a suicidal gunshot wound to the head from a self-made rifle that fortunately did not result in the death of the victim.

The use of self-made guns is quite unusual because of the general public's ready access to professionally manufactured handguns or rifles, especially in the U.S. In France, the policy is very different and it is difficult to purchase a handgun or even a rifle for hunting purpose. Nevertheless, the use of self-made guns is rare in France and the experience of pathologists with firearm injuries caused by such guns is fairly limited. The literature reports mainly the use of self-made guns but more seldom the use of self-made rifles. As a contribution to the understanding of this unusual firearm, the authors present a case involving a suicidal gunshot wound to the head from a self-made rifle that fortunately did not result in the death of the victim.

A 34-year-old, depressed man with medical history of suicide attempts was discovered in his bedroom with a rifle near him. Still alive, he was rapidly carried by helicopter to the hospital of Strasbourg and underwent cerebral CT-scan examination and skull radiography. The local prosecutor requested the authors examine the victim.

The victim was examined in the emergency unit. He was maintained artificially unconscious. Skin examination showed a mediofrontal contact gunshot wound located 10 cm above the glabella. No exit wounds were seen. The CT scan showed a right subdural hematoma and a fragmentation of the bullet through the entire right hemisphere. A major element of the bullet was found in contact with the right occipital lobe, under the skull. Skull X-Ray showed the fragmentation of the bullet following a horizontal direction. The direction of the bullet was from front to back, slightly from left to right, and quite horizontally. The maximum distance between the frontal wound and the right or left second finger was 76 cm. The victim was known to be right handed.

The prosecutor informed examining physicians that the distance between the muzzle of the rifle and the trigger was of 84 cm. This was inconsistent with a suicide. Therefore a decision was made to review the scene and rifle.

The rifle was a self-made weapon with a broken trigger, and the only manufactured part was the barrel. The needle was broken and the butt was missing. A striker had been made with a plain pipe sliding within a boiler tube. The posterior part of the plain tube was pointed. On the scene ground and the walls were examined for a crack. A 12 cm vertical recent crack was found on a wall, starting 173 cm from the ground. The victim was 176 cm tall. He had certainly put the muzzle of the rifle on his forehead and fired the weapon by hitting the wall with the posterior part of the rifle. This could explain the direction of the bullet within the skull and the location of the entrance wound. This could also explain how the rifle had been fired making any consideration regarding the distance between the trigger and the muzzle irrelevant.

Epilogue: the victim survived with a left hemiplegia, and confirmed a few months later exactly what the authors had supposed on the scene.

Self-made Rifle, Suicide, Zip Gun

G54 Suicidal Jumping

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The study was undertaken to investigate the pattern of injuries, the survival times, and the demographics of people who committed suicide by jumping from a height.

The authors reviewed 495 forensic autopsies performed at the Institute of Forensic Medicine, Semmelweis University, Budapest, Hungary between 1996 and 2001 in which the manner of death was suicidal falling from height (all jumps resulted from suicidal intent). During this period suicidal jumping was responsible for 16 % of all suicides in males and 18% in females. In the case of suicidal jumping the male/female (m/f) ratio was 1.35; the overall suicide m/f ratio was 1.6.

Important to note is that 78% of the males and 82% of the female victims immediately upon impact in a public place. The hospital was listed in the authors' database as the place of death in 13% of the males and 14% of females, although a fraction of these people actually committed suicide by jumping while being treated in a hospital. Statistical data pertaining to what department and why the jumper was hospitalized will be provided. Of the remote suicides, 4% of males and 2.4% of females could not reach the hospital and died during EMS transportation.

Demographic analysis shows that age distribution curves run fairly together for males and females after the age of 40. In younger age groups a strong male predominance was present (m/f ratio was 10 under 20 years of age, 2.7 in age group between ages 21-30 y).

The most important aspect of this work evaluates the injuries sustained during landing. All victims sustained wide range of multiple injuries. The frequencies of bone injuries (upper, lower limbs, pelvis, vertebrae, chest, and cranium) and soft tissue injuries (chest, abdominal organs, and aorta) were collected and analyzed statistically. The most common injury patterns were fractures of lower extremities and the spine. The Injury Severity Score was used to grade injuries for quantitative comparison with the height of falling. Most suicides (two-thirds) had serious mental illness. The blood alcohol level in toxicological reports on all victims was also reviewed. Overall 19% had positive results, although alcohol was present in blood of 38% in the youngest age group (16-20 years of age) and it was present in only 8 % in the oldest victims (age 71 and over). Positive alcohol tests revealed alcohol levels less than 0.15% in 62% of the jumpers and 17% of positive cases showed blood alcohol levels higher than 0.25%.

Monthly periodicity revealed the highest number of cases occurred in June and the lowest number of cases occurred in February in both sexes. Weekday analysis revealed that Monday is a critical day for males and Tuesday for female suicidal jumpers.

Falling From Height, Injury Severity Score, Survival Time

G55 Suicide in Eastern Crete

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The goals of this paper are to present data on suicide cases from autopsy records of the Forensic Sciences Department of the University of Crete, during the years 1997-2001 and to inform the forensic community of the variation extent of parameters like sex, age, time, and method of suicide.

Introduction: When pain exceeds pain-coping resources, suicidal feelings are the result. Suicide prevention programs try to lower the incidence of the event but it is still a serious public health problem. It is well known that geographic variation and ethnic composition are very important parameters affecting suicide. This study is an attempt to provide detailed information of the present situation in Eastern Crete and try to find the slope of the relationship between the suicide cases in this area and the rest of the country.

Methods/Results: Data collection involved medico-legal records of completed suicide cases from January 1, 1997 to December 31, 2001. A total of 139 records were reviewed. Results indicated that 25.18% of the victims in successful suicides were females and 74.82% were males. Spring was the period of the year with the most elevated numbers and the highest month recorded was May. Of the cases reviewed, 15.82% of suicides were under the influence of alcohol and 8.63% under the influence of illegal drugs. Only one case under the age of 20 years old was observed, whereas in the U.S. approximately three fourths of all deaths among persons aged 10-24 years result from only four causes**:** motor vehicle crashes, other unintentional injuries, or homicide and suicide. Suicide rates among elderly were found to be low. A finding that is quite contradictory with the rest of Europe where the suicide cases in elderly are approximately equal to the youth levels. Suicide methods were mostly violent. The most frequent method was hanging, seen in the 36.69% of the all cases followed by fatal poisoning with an incidence of 29.5%. Poisoning was generally the result of pesticide ingestion and was very widely used by females. The use of firearms forms 13.67% of the cases and is used exclusively by males. Although some studies indicate that rural men of all ages are twice as likely to commit suicides as their urban counterparts, the authors' study showed that 79.14% of suicides occurred in Heraklion the mostly populated city of Crete.

Conclusion: Suicidal events are initiated in order to change the contents of awareness of personal existence. Potential victims regard their lives as having unacceptable values because their understanding of meanings converges on a self defined criteria for which death is preferable. As this convergence approaches congruence, the wish to return to an earlier more satisfying state is approximated by a wish to die. The facts of termination and the occurrence of a physical death are expected to change distressing awareness without causing cessation of all awareness. Even those who deny life after death will imply that nothing will feel better than the present situation. However, there is always a window of opportunity to introduce prevention efforts.
The authors believe that reliable and valid data of the present situation in an area will be beneficial in combating this very serious problem and establishing prevention programs.

Suicide, Crete, Autopsy

G56 Postmortem Findings in 22 Victims Due to Two Grain Silo Explosions in France

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The goals of this presentation are to describe and recognize the injuries and types of wounds resulting from explosions.

Silos located on industrial sites in Metz and Blaye, France and containing barley grain exploded; the first on October 18, 1992 in Metz and the second on August 20, 1997 in Blaye. In total there were 25 victims including 23 deaths (12 in Metz, 11 in Blaye) and one survivor in each case. This retrospective study concerns 22 cases, 11 at each site.

All 22 victims had multiple lesions due to the explosion and its consequences. The lesions demonstrated the effect of the blast associated with falling and projection of concrete fragments, heat, intoxication, and asphyxia. Death was instantaneous for all victims except one in whom the autopsy findings and complementary tests suggested an extremely short period of survival. The role of the forensic doctor is therefore essential and should be included in emergency plans in order to facilitate the initial assessment, shorten the time taken to identify the victims, and improve thanatological procedures. Although dust explosions in agro-business plants, particularly cereal units, are becoming more and more frequent, postmortem data are rare in the literature.

Explosion, Postmortem Findings, Injury

G57 Injuries of an Armored Vehicle Occupant During Armed Robbery: A Case Report

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The goal of this case report is to illustrate, by means of text and photographs, peculiar passenger injuries related to gunshot damage of the parts of an armored vehicle.

Armour plating is a system of reinforcement of a vehicle designed to protect passengers from attacks perpetrated from the outside for various purposes (robbery of valuables, homicide, abduction, car theft, etc.). The vehicle is usually built in such a way as to resist penetration by bullets from firearms. However, hi-powered military guns can damage the vehicle's structural parts and may cause high velocity fragments (secondary bullets) to be projected, which can seriously wound passengers. The authors report the results of an investigation carried out to establish the dynamics of the wounding of a policeman seated in a valuables transport van during a robbery.

In June 2002, along a main road in the district of Bari, a Fiat Ducato armored van was assaulted by unknown muggers and was robbed of a large sum of money. After the robbery, 25 cartridge shells were found lying in the road belonging to three different military weapons (a .223 Remington automatic rifle and two 7.62x39 Kalashnikov assault rifles). One of the members of the crew inside the van was wounded in the right buttock, diagnosed at the hospital E.R. as a firearm injury with retention of the bullet. The victim underwent surgery to extract the foreign body, a steel rod with an irregular circular section of about 7 mm in diameter and 3 mm in thickness with a concave surface while the other convex side was lined by thin parallel longitudinal stripes. These features excluded the possibility that this metal fragment could be a component of a firearm cartridge. Inspection of the van revealed no less than 29 points of bullet damage; 7 of these had struck glass surfaces (the windscreen and left back window) without breaking them, and the others had pierced the metal bodywork of the vehicle; 7 in the posterior part; 5 in the anterior part; and 10 in the left lateral part (including the driver's door). The 7 holes discovered in the rear of the vehicle were regular in shape, almost perfectly circular, with clean borders and a diameter of around 6 mm; all the other holes had different characteristics (irregular shape, 8-9 mm diameter, etc.). Further examination of the rear part of the vehicle showed that two bullets had reached and penetrated the armor plating protecting the cabin, perforating the backs of the anterior seats; the right one was completely pierced and blood stains were found on the anterior covering. The two seats were removed and disassembled; in the back of the left seat two very small metallic fragments were recovered. Nothing was found in the back of the right seat. The above data enabled the authors to conclude that one of the .223 Remington bullet had penetrated the rear part of the vehicle, with a horizontal trajectory, and detached the fragment of armor plating that had wounded the victim.

The recommended strategies for accurately determining causes of injury are discussed, including ballistic and medical data that have to be considered and evaluated in order to gain an overview of the mechanisms underlying injury of armored vehicle occupants.

Armed Robbery Assault, Armored Vehicle, Occupant Injuries

G58 Roll-Over Automobile Accident Survived By the Author as a Passenger

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The attendee to this presentation will learn that most transportation accidents are multifactorial and that 3-point restraints are very effective in preventing serious injuries and deaths in vehicular accidents.

Trained investigators and attorneys recognize that most, if not all, transportation accidents are multifactorial. Rarely does a survivor of a vehicular accident such as this have both the desire, and the opportunity to document the scene of the accident and the condition of the vehicle soon after the event. Images of vehicle and scene will be presented.

In England, four friends took a day trip by automobile in late winter. The owner and driver of the 1992 Toyota Carina 4DS was a 76-year-old male. Three friends accompanied him, the author in the left rear seat. The owner-driver drove about 184 miles with several stops on two-lane roads in cold wind and rain. The destination was reached in late afternoon. The return trip was begun at about 7:30 p.m. on two-lane roads and in pitch-dark and rain.

Nearing the driver's home and on a straight, smooth, two-lane asphalt road, he allowed both left-side wheels to suddenly fall onto the shoulder. He quickly over-corrected with the car sliding right and into the center of the road. Over-correcting again to the left, the driver narrowly avoided a telephone pole on the left shoulder as the car left the road and traveled obliquely down a 2-3 foot steep bank turning onto its right side. The right front nosed down into a muddy field, the car then overturning in its longitudinal axis and coming to rest on its top facing the direction of travel. Each occupant was belted; each escaped through his/her window. Three occupants each sustained minor injuries.

The next afternoon, the author obtained the driver's permission to take Kodachromes for teaching purposes. The windshield was extensively cracked, and was detached at its crown. The roof was indented back to the center posts, but passenger space was otherwise preserved. The accident scene was also documented.

Analysis - This accident was clearly multifactorial: 1) an elderly driver with chronic disease, 2) poor weather, 3) driver fatigue, 4) a slick, newly paved road at the accident site, and 5) the driver, once in trouble, over-correcting twice.

Ameliorating factors: 1) speed slowed by braking before leaving the road, 2) no other traffic, 3) driver avoiding the telephone pole, 4) rain-soaked field absorbing roll-over impact, and 5) all passengers were restrained.

Conclusion: A potentially serious multifactorial accident in which the restrained occupants were nonetheless fortunate to survive.

Automobile Accident, Multifactorial, Restraint Systems

G59 Intracranial Internal Carotid Laceration at the Site of an Atherosclerotic Plaque: A Case Report

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The goals of this paper are to present to the forensic community an unusual injury and an analysis of its mechanism with respect to both trauma and natural disease.

This is a case of a 35-year-old man who received a blow to the face that abruptly and forcefully hyper-extended and rotated his head to the left. Autopsy revealed an intracranial right internal carotid artery laceration extending from a calcified atherosclerotic plaque, with an associated basilar subarachnoid hematoma. This injury is unusual both because of its intracranial location and because of the presence of the atherosclerotic plaque.

Hyperextension of the head can cause injury to the vessels at the base of the brain. Generally, the extracranial portions of the vessels are affected, and laceration is believed to be caused by the sudden stretching of these vessels due to the abrupt movement of the head. In this case, the intracranial internal carotid is affected, which can be partially explained both by the rotational acceleration of the brain within the cranium as the head moves in response to the blow, and the abrupt increase in intravascular pressure caused by vessel stretching. During hyperextension or rotation of the head, the brain oscillates in the cranium due to its inertia, and this oscillation is opposite to the movement of the head, exposing tethered vessels within the head to shear forces. The quick and exaggerated movement of the head also stretches vessels, particularly those present in the neck, causing an abrupt increase in intravascular pressure that is transmitted to the intracranial portions of the vessels.

The atherosclerotic plaque found at the site of the laceration may also have contributed to the injury. Atherosclerosis has been documented to alter the structural integrity of vessel walls by destroying and altering tissue. Additionally, atherosclerosis changes the elastic property of arterial vessels and therefore lessens their ability to respond to abrupt or large changes in pressure load, with the response being more impaired the greater the pressures applied. Syngergistically, the effects of atherosclerosis may have made the intracranial carotid more vulnerable to trauma than a healthy, non-atherosclerotic vessel might have been.

In order to delineate the roles of trauma and natural disease in the formation of this unusual lesion, photographs of the case are shown, and several published references on both traumatic injury to the head and neck vessels and atherosclerosis are reviewed and cited.

Hyperextension, Atherosclerosis, Subarachnoid Hemorrhage

G60 An Unusual Case of Crossbow Homicide

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The goals of this paper are to present a case of homicide due to a cranial encephalic wound provoked by an unusual lethal means identified also through experimental investigation.

A homicide is presented. A male is first rendered defenseless, blinded by a caustic substance and suffered head and chest wounds by a penetrating weapon missing from the scene of the crime. The peculiarity of the wounds and the scarcity of circumstantial evidence made additional investigation necessary in order to identify the weapon, including firing tests on experimental cranial models, for comparison.

A 52-year-old Caucasian male, a farmer missing from his home for two days, was found in a comatose state by the police in a forest in the Tuscan countryside. No weapon was found at the scene of the crime. The subject was revived in intensive care where wounds from a caustic substance were revealed on the face, eyes, shoulders, and back. In the left occipital region there was a round wound 1 cm in diameter and on the left hemithorax an oval wound 0.8 x 0.3 cm in diameter. The CT cranium revealed a large area of hemorrhage (25-30 cm) in the left temporal-mesial capsular nucleus, with hemo ventricle and shift to the right of the median line, the encephalic trunk appeared compressed with an obliteration of the pons mesencephalic cistern; the CT chest revealed integrity of the pulmonary and cardial structures. The subject died 98 hours after he was found. The autoptic macroscopic exam confirmed the presence of wounds due to liquid burns on the face, eyes, shoulders, and back. The chest revealed, on the cutaneous level, an oval shaped wound,

with the dimensions of 0.8x 0.3 cm. On the skull, in the left occipital region, the scalp revealed an oval shaped wound, 0.8x 0.3 cm in diameter that continued into the soft tissues provoking a small semicircular sternal bone erosion, 0.3 cm in diameter. On the cranium, in the left occipital region, the scalp presented an oval shaped wound, on the main traversal axis, 1x 0.3 cm in diameter, surrounded by traces of reddish color; in correspondence to this wound the left occipital bone revealed a round wound with clean cut outlines, 1 cm in diameter. The frontal left bone presented, on its external surface, an area of irregularly shaped estrous flexions of the bone 1.3 x 1 cm in diameter and, on the internal surface, a round wound with clean cut outlines, not along the entire depth, 0.5 cm in diameter. The brain was sectioned with coronal cuts according to the Pitres technique. The left occipital pole presented a round wound 1cm in diameter along all of the encephalic lining, from the base upwards, crossing the hypothalamic region, the anterior horn of the lateral left ventricle until reaching the left frontal pole, where a round wound, 0.8 cm in diameter, was present. The entire distance from the left occipital region to the frontal left bone measures 23 cm. The histological findings of the brain revealed subarachnoid and intraparenchymatous hemorrhage, "red neurons," diffuses axonal damage, confirmed by the positive results to the immunohistochemical dye for amyloid precursor protein (BAPP). According to the findings from the sectioning table it was possible to conclude that judging from the position and extension of the caustic wounds, acid was used to render the subject defenseless and successively strike him with greater ease. The chest wound was attributed to the use of a weapon with a pointed apex and scarce penetrating potential (2-3cm). In the cranium, the penetrating weapon once perforating the left occipital bone completely penetrated the brain and terminated in correspondence with the frontal bone, where it did not have the necessary force to completely perforate it. These findings permitted the authors to direct the investigation towards identifying a long penetrating object, 1cm in diameter and not less than 15 cm in length. It must have been animated by a weapon supplying the necessary force to penetrate the bone surface in such a clean cut manner and the cerebral substance so deeply; also it must allow a manual extraction of the arrow or dart, or one via automatic mechanisms of return, incorporated in the weapon utilized. The hypothetical weapon compatible with similar penetrating means must be capable of firing a manually extractable dart (crossbow, bow, spear gun, etc) similar to the pistols used for animal slaughtering with captive bolt. In order to establish the lethal weapon, firing tests were effected utilizing both mechanisms and, in particular, a Bernet "Wildcat II" model crossbow with a 150 pound bow, loaded with a 38 cm long, 1cm in diameter aluminum arrow with a conical head of the same diameter and a captive bolt pistol with a 20 cm long, 1 cm in diameter stylus loaded with caliber 22 ammunition, a model conventionally utilized in many Italian slaughterhouses. Experimental models of human craniums were constructed using plaster to simulate the bone structure and filled with a synthetic spongy material, easily penetrable, but minimally resistant, in order to reproduce the brain. The test with the crossbow, from a distance of 12 cm, produced a wound perfectly compatible with the postmortem data. The test with a captive bolt pistol resulted compatible with the wounds observed in the postmortem examination only if a modified weapon was utilized (a. with a prolonged external stylus, b. removal of the blocks that limit the internal path of the stylus) producing a 23cm wound, much longer than the 7-9 cm normally produced by common pistols used for slaughtering animals. The wounds produced in the experimental models with both types of weapon have characteristics compatible with those observed in the cranium of the subject, however the captive bolt pistol created a wound superior to 21 cm only when subject to difficult handmade modifications of the weapon, possible but extremely complicated. These data led the authors to consider as feasible the hypothesis of a manually extracted dart. Thanks to this technical support and to testimonial evidence some months after the homicide, the investigation led to the arrest of an individual. A search of his property produced a crossbow and modified metal crossbow arrows (removal of the head and filing of the penetrating extremity, positioning of the distal extremity of a device that facilitates manual extraction of the arrow). According to the postmortem findings and observation of experimental data, the sequestered crossbow and arrows proved to be the most probable scientific hypothesis of the weapon utilized for the crime. Only few cases of wounds due to crossbow mostly accidental or suicidal and rarely homicidal are reported, therefore, this rare case of homicide due to crossbow seems even more unique if the combined use of caustic substances to render the victim defenseless and the penetrating device (arrow) was not found on the scene of the crime was considered.

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Homicide, Crossbow, Caustics

G61 Body Found in the Waterway of Lille—Accident, Suicide, or Homicide?

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The authors report the case of a man found in a waterway and discuss the differential diagnosis for bodies found in water. These data are compared to those of the literature.

History: On June 20, 2002, a 42-year-old man is found floating face down in the waterway of Lille, France. At 8:00 p.m., a forensic pathologist performs a first examination at the edge of the waterway. He observes several wounds on the face with fracture to the skull and a periorbital bruise. The lesions are recent and could be attributed to a boat's propellers. This waterway is used as a barge crossing. There is a large brown bruise at right thoracic area. There is no suicide letter found and the man has no history of depression. An Autopsy is performed the next day and time of the death is estimated during preceding night.

Autopsy findings: The cadaver is not putrefied and is easily identified. The lesions on the face are not parallel. Some are small and blood flows out the wounds. The lesions have vital characteristics. Two hypotheses are considered: 1) the barge's propellers created the face lesions while he was still alive or 2) he was thrown in the waterway dead. The skull examination confirmed the second hypothesis. The brain was contuse with lesions. A round wound is observed. An entrance wound is present on the right temporal area and an exit wound is seen on left parietal area. This case was classified as a homicide. On X-Ray, no foreign bodies are found. All lesions on the face were penetrating. The cause of death is a hemorrhage of the brain with bruises.. After investigation by the police, the aggressor was found. He is a 40-year-old man. He reported that he used a large tool to strike the decedent in the head and face in a garage.

Discussion: A body recovered from water presents many challenges to the forensic pathologist. Drowning is a diagnosis based upon the circumstances surrounding the death with exclusion of other causes of death. Often, identification of subjects is complicated by decomposition. As in this case, the determination of cause and manner of death can be a daunting challenge. Moreover, many of the essential questions surrounding water deaths are answered after performing an autopsy. Was the individual alive prior to entering water is the essential question.

This case is a good illustration. The diagnosis of drowning is one of exclusion. Most of drowning deaths are accidental. This case was compared to suicides by drowning. The characteristics are studied to point out the difference between homicide and suicide during the crime scene investigation. The importance of crime scene investigations is reviewed. This case illustrates the difficulties in obtaining forensic evidence to conclude a homicide or suicide. Characteristics of skull bones lesions were compared to discover the important time of immersion with lesions as in this case. The characteristics of these lesions are important to when reviewing a subject without putrefactive changes.

Homicide, Drowning, Autopsy

G62 Pink Teeth in a Series of Bodies Recovered From a Single Shipwreck

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The goals of this presentation are to review the causes and distribution of the phenomenon of pink teeth among a series of bodies.

Pink staining of the teeth is more common in victims where sudden death occurred because the blood can remain liquid due to increased fibrinolytic activity. Hemoglobin is the most likely pigment responsible for this postmortem process that can be considered analogous to postmortem lividity. In fact, there is general agreement that the first requirement for the occurrence of pink teeth is an increase of blood in the pulp. All the reports on pink teeth indicate that the diffusion of the blood in the pulp into the dentinal tubules causes the red discoloration of the teeth; this seems to be favored mainly by blood accumulation in the head either due to congestion (as observed in prefinal insufficiency of the right heart) or a postmortem head-down position (as in cadavers floating with their head in a downward position).

Pink teeth have most often been observed in victims of drowning but have also been reported in subjects who died suddenly and unnaturally by strangulation, hanging, knifing, and carbon monoxide poisoning. Since there is no obvious connection between the occurrence of pink teeth and the cause of death, the condition of the surroundings (especially humidity and temperature) must certainly play an important role in the development of pink teeth. This is supported by the fact that the majority of the cases described in the literature were exposed to a wet or moist environment, most having been recovered directly from the sea. The existence of water or a high concentration of aqueous solution intimately surrounding the teeth is one of the most important requirements for this postmortem phenomenon. Further prerequisites are hemolysis either by autolysis or by osmosis leading to subsequent diffusion of hemoglobin into the dentinal tubules.

Since in some of the retrospective studies not all jaws and/or teeth may have been examined thoroughly, the real frequency and distribution of the phenomenon remains unknown. In fact, forensic pathologists must have observed that the distribution of pink teeth can vary in a mouth and not all teeth are necessarily involved. The purpose of the present investigation is to study the frequency and distribution of postmortem pink coloration of the teeth among a representative sample of 52 cadavers. All bodies were victims of a single shipwreck, which occurred on March 13, 1997 in the middle of the Otranto Canal (Mediterranean Sea). An Albanian ship trying to land clandestinely on the Southern Italian coast sank following a collision with an Italian Navy warship patrolling the border. All the passengers in the four holds died as the ship was engulfed and settled on the bottom of the sea at a depth of 800 meters. The bodies were recovered from the seawater on October 21, 1997 after approximately seven months. All the cadavers shared the same cause of death (drowning), the same storage time in water (7 months) and identical environmental conditions (the temperature of the water at 800 meters depth was 4°C). A team of forensic pathologists carried out the pathological examinations while two forensic odontologists performed all odontological examinations separately and at different times. Sex, age, degree of decomposition, and dental examination were registered for each cadaver. A distinct pink coloration of the teeth was found in only 23 cadavers (17 females and 6 males) of ages ranging between 13 and 60-years. The average age of the deceased was 27 years in accordance with the fact that the phenomenon is more pronounced in younger individuals because the dentinal tubules become narrower or are obliterated with age and are less penetrable by the pigment responsible for postmortem pink staining. It was also possible to confirm another common observation that the pigmentation is more prominent on the anterior teeth with single roots than in the posterior teeth with multiple roots. Using histochemical methods the causative pigment was also identified as hemoglobin and/or its derivatives.

Pink Teeth, Postmortem Staining, Marine Environment

G63 Calcified Primary and Metastatic Pancreatic Carcinoma Discovered in Skeletonized Remains

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The goals of this presentation are to report a case of interest detailing the unexpected discovery of calcified masses during reduction of a body to bone for anthropologic study

Calcification in adenocarcinoma is not unusual and is reported to occur in many types of gastrointestinal neoplasia. Calcification associated with pancreatic carcinoma has been reported in the context of both discrete calculi formation and diffuse calcifications. Calculi are usually described within pancreatic ducts proximal to the tumor mass, presumably as a function of obstruction. However, stone formation has also been reported to precede identifiable carcinoma, making the causal and temporal relationship a topic of debate. Diffuse calcification of a tumor mass, surmised to be a type of calcinosis, is described in both primary and metastatic sites. Diffuse calcification in pancreatic neoplasia is described largely as either peripheral plaques or central, irregular nodules. This is a report of an archival case of calcified pancreatic cancer that is unusual with regards to the nature of the calcified masses and the circumstances in which they were discovered and obtained. Two relatively large, previously undetected finely trabeculated hard masses representing the calcified remains of the primary tumor and a hepatic metastatic focus were retrieved after the rendering of retained remains to bone for the purpose of anthropologic study.

A 76-year-old female first reported acute symptoms of weight loss, epigastric pain and nausea to her family physician in April of 1978. A diagnosis of cholelithiasis was made at that time. She was temporarily lost to follow up for one year and was eventually admitted for work-up and evaluation of her progressive epigastric pain. During her admission history she reported marked weight loss over several years that she attributed to poor diet. A history of pancreatitis was denied. Abnormal findings upon physical exam included a pelvic mass, hypokalemia, anemia, and malnutrition. There is no record of abnormal calcium metabolism or radiologically identified abnormal calcifications. An exploratory laparotomy was performed that revealed an inoperable carcinoma of the head of the pancreas resulting in palliative care. Her clinical course deteriorated until she was found to be unresponsive. An autopsy was not performed.

Since the body was not claimed, New Mexico State law provided for the retention of the remains for medical education purposes via the department of Anthropology, Forensic Division, The University of New Mexico. In August 1979, the process of reduction to skeletal remains began. During the cut-down procedure, the initial harvesting of bones from the decomposed remains, previously undetected hard masses were found in the pancreas and liver. These were retained for continued enzymatic flesh removal. Subsequently, two calcified masses and a smaller dense stone were recovered. Current study of the archived stones revealed a 19.8-gram ovoid, white, trabecular, hard mass measuring 5.6 x 4.3 x 3.9 cm and a smaller, similar curved mass that measured 2.7 x 2.1 x 2.0 cm and weighed 4.5 grams. Chemical analysis of the masses revealed a composition of calcium carbonate. The small dense gallstone was rough, ovoid, light brown and measured 1.9 x 1.4 x 1.2 cm.

The calcifications in this case are unique in that they are apparently completely calcified primary and metastatic tumor masses that were not detected during medical evaluation. The masses consist of calcium carbonate in a lattice-like pattern recapitulating the extra-cellular space of the tumor. In the literature, calcifications in pancreatic neoplasia are commonly described as discrete nodular calcifications or peripheral plaques. The architectural complexity of the calcifications in this case is noteworthy. Since an autopsy was not performed, the discovery of hard hepatic and pancreatic masses during the initial bone harvest was unexpected. Although, there was a 5-month interval between death and discovery of the masses, it is unlikely that this represents some type of postmortem calcification. It is probable that evidence of the existing calcifications was either lost or not collected. Viewed from the standpoint of forensic anthropology, this case begs a different type of question. It can be speculated whether a positive identification would have been made if this were a case of discovered skeletal remains including the two calcified masses, given the above medical history of a missing person.

Pancreatic Cancer, Skeletal Remains, Forensic Science

G64 Undefeated by Surgery: The Utility of Post-Surgical Foot and Ankle Radiographs for Identification: Focus on the Ankle

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After attending this presentation, the participant will 1) understand that radiographic comparisons of the ankle for positive identification can reliably be made even if there has been an alteration in the anatomy, 2) be able to quantitatively evaluate the "matchability" of such an identification, and 3) be able to recognize when such a comparison may be limited and more information is required before an opinion can be rendered.

Foot and ankle radiographs can be utilized as a basis of identification in forensic investigations. This type of information may be especially useful when examining fragmented, mutilated, and decomposed remains. The process of radiographic comparison is usually binary in nature, yielding a "yes" or "no" answer to the question: within a reasonable degree of medical certainty, did these radiographs come from the same individual? The authors have previously outlined, with respect to the foot, a quantitative method of reporting results, allowing for a systematic approach to the identification process. The same method had been applied in this study. This study focuses on the bones of the ankle joint; specifically, the talus and the distal segments of the tibia and fibula.

Experimentally, 53 sets of pre-surgical (antemortem) and post-surgical (simulating postmortem) radiographs of the foot and ankle were obtained from a tertiary care medical center. Up to four different radiographic views were considered: lateral, medial oblique (MO), ankle mortise, and antero-posterior (AP) projections. As in the previous study, the radiographs were not actual antemortem and postmortem radiographs, rather a simulation utilizing radiographs taken in the course of routine medical care. Sets of radiographs were selected by one of the authors, and included both legitimate matches and actual mismatches to simulate forensic context. The time lapse between the antemortem and simulated postmortem radiographs included a surgical procedure on the foot and / or ankle, and ranged from 2 months to 48 months allowing for alteration in anatomy by surgical repair and subsequent healing. As in the previous study, the authors wished to evaluate and grade, by a numeric system, the reliability of the match results. Radiograph sets were compared by two of the authors (NET and DED). Ten characteristic skeletal features were considered in the simulated postmortem radiographs. The antemortem radiographs were then evaluated for the same features. The results were scored as follows:

(+1): If the feature was present and matched.
(0): If the feature was either not present or its presence could not be determined.
(-1): If the feature was present, but did not match, or (-1) if the trait was present in either the pre- or post-surgical radiograph but not both.

The radiographic sets were then independently evaluated, considering only the ankle joint, according to the medicolegal standard, "with a reasonable degree of medical certainty, these radiographs came from or did not come from the same person". Additionally, it was noted if there was not enough data visible in the ankle joint portion of these radiographs to determine a positive identification. Spearman correlation coefficients, to measure how the two methods of evaluating correlate, were calculated from the raw data.

Results were consistent with previous studies, and indicate that surgical intervention with subsequent healing does not preclude positive identification in foot and ankle radiographic comparisons. However, because the ankle joint is structurally less complex than the foot it contains fewer features that may provide the basis for identification.

Forensic Pathology, Human Identification, Ankle

G65 To Rave or Not to Rave: A Report of Three Fatal GHB Poisonings

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Gamma-hydroxybutryate (GHB) has surfaced in the "rave" and "club" scene as a recreational drug, which is believed by users to be safe. There are increasing reports of near fatal and the occasional fatal outcomes of the use of this drug. It is simple to make, has euphoric effects, and has associated amnesiac effects, which make it an ideal candidate for use in the arena of date rape.

This report is of three deaths where GHB was the primary or sole toxic agent. In one case, death resulted from a suicidal consumption of drug where polypharmacology played a role. In the second case, hypothermia was a significant contributor to the cause of death. The third fatal case represents an accidental, isolated drug poisoning.

All blood samples obtained and analyzed were autopsy or admission blood and stored in sodium fluoride (NaF). Analyses were by liquid chromatography in the laboratory of Hospital for Sick Children in Toronto for Cases 1 and 2 and in the Virginia Division of Forensic Sciences in Case 3.

Results identified the levels of GHB to be: Case 1: 690 mg/L, Case 2: 55 mg/L, Case 3: 269 mg/L.

While GHB may be produced postmortem and may also be identified as a normal metabolite especially in the central nervous system, levels detected in these three decedents were well into the fatal ranges. The overlap with survivable intoxication is large. Why some individuals die with lower concentrations is unclear. Combination with other drugs or environmental conditions as in Case 1 and 2 respectively may have resulted in enhanced toxicity.

While GHB compared to other illicit drugs such as cocaine, opiates, or alcohol appears to be less serious to users, the clinical presentation of toxicity including death needs to be recognized by clinicians involved in the care of these patients. Pathologists performing forensic autopsies need to be aware of the use of this drug by this group of at risk individuals.

Samples from autopsy with subsequent testing of well preserved blood (in NaF), urine, and tissue needs to be processed in a laboratory geared to the identification of this drug. Interpretation of results must bear in mind the natural production of GHB for correct conclusions to be reached.

Lastly the dangers and legal implications of the use of GHB in date rape situations need to be remembered.

GHB, Fatality, Rave

G66 Methadone-Related Deaths in Palm Beach County

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The goals of this presentation are to examine the role of methadone in drug-related deaths in Palm Beach County from 1998 to 2002.

Methadone is a long acting oral opioid agonist used therapeutically to treat opiate dependency and in the management of chronic pain. Recent media accounts of an increase in the number of deaths attributed to methadone toxicity in Palm Beach County, FL, particularly among teenagers, have raised public concern over the illicit use of the drug. The authors examined cases investigated by the Palm Beach County Medical Examiner's Office over the period from 1998 to 2002 in which postmortem toxicologic studies indicated the presence of methadone, to examine the role of the drug in these deaths. The reports of the postmortem examinations and toxicologic studies and the investigative reports were reviewed.

Identified were 70 methadone-positive cases. There was a dramatic increase in the number of cases during the period, from 2 cases in 1998 to 37 cases in 2001 and 18 cases in the first quarter of 2002. The cases included 57 males and 13 females. Ages ranged from 16 to 72 years (mean 37.1 years). All decedents were white except for one black male. Methadone had been prescribed for chronic pain to 16 of the decedents. There were no cases in which the decedent was known to be enrolled in a methadone maintenance program.

The methadone-positive cases included 57 in which the death was classified as an accident due to drug toxicity. In 12 of these cases the cause of death was attributed to methadone toxicity alone and in 35 cases methadone was identified as contributing in combined drug toxicity. Non-toxic levels of other drugs were present in 9 of the methadone toxicity cases. Cocaine and/or cocaine metabolites were identified in 27 of the 36 cases of combined drug toxicity, morphine in 9 (5/9 with 6-MAM), oxycodone in 8 and ethanol in 8, with blood alcohol levels ranging from 0.024-0.183 G/dL (mean 0.095 G/dL). In 23 deaths methadone was detected but was considered to be an incidental finding. These included 9 deaths attributed to other drugs and 13 to non-drug related causes (5 natural, 3 suicide, 4 accident due to trauma, and 1 undetermined gunshot wound). Methadone was detected only in the urine in six cases.

There was considerable overlap in the postmortem blood methadone levels among the groups. Levels ranged from .114-.984 mg/L (mean .430 mg/L) in cases where death was attributed to methadone toxicity; trace-1.243 mg/L (mean .331 mg/L) in cases of combined drug toxicity; .069-.664 (mean .242 mg/L) in deaths attributed to other drugs; and .072-.782 mg/L (mean .303 mg/L) among non-drug related deaths.

Data indicates that most deaths in which methadone plays a role are due to the use of the drug in conjunction with other prescription or illicit drugs. Establishing the role of methadone in these cases can be difficult in light of the other drugs present. The levels of methadone detected in these cases indicate that it may not be possible to determine what constitutes a lethal methadone range since the majority of cases involved drug interactions and since individuals may have different levels of susceptibility and/or tolerance. However, the data demonstrate that death can occur at methadone levels below the previously reported lethal ranges. Determination of the cause of death in methadone-positive cases necessitates correlation of the postmortem toxicologic results with autopsy results and investigative findings.

It is possible that the increase in methadone-related deaths may be in part due to more physicians prescribing the drug in light of the recent recognition of the hazards of other analgesics such as oxycodone. Street users of methadone may be unaware of its long half-life, with frequent use resulting in its accumulation to dangerous levels.

Methadone, Death, Drug Levels

G67 Comparison of the Distribution of Fentanyl in Deaths Related to Use and Abuse of the Duragesicâ Patch and Intravenous Administration of Patch Contents

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The goals of this presentation are to provide the audience postmortem distribution data of fentanyl relating to its route of administration

Fentanyl is a synthetic narcotic analgesic of high potency and short duration that has been in clinical use since 1963. Initially the drug was used as an adjunct to surgical anesthesia. The transdermal fentanyl system, under the trade name of Duragesic®, was developed for chronic pain control. The product labeling for the patch states that it is a schedule II controlled substance that can produce drug dependence similar to that produced by morphine. The transdermal system allows for the maintenance of a relatively even steady state blood concentration. The patches are available in three dosage forms: 25, 50, and 100 mcg/hr. Because of its relatively short half live of 3 ½ hours and high potency, an addicted individual is likely to constantly seek a source (supply) of the drug. The Sedgwick County Regional Forensic Science Center has seen increasing numbers of cases where death was due to or related to use and abuse of the Duragesic® patch.

The 6 individuals in this series, 3 males and 3 females, ranged in ages from 30 to 53 years of age. All were Caucasian. Five of the decedents were reported to have chronic pain syndrome: fibromyalgia, lower

back pain, chronic headaches, Crohn's disease, and pain due to remote blunt force injuries from a traffic accident. Three of the individuals had been prescribed the Duragesic® patch as part of their pain management therapy. The patch had been obtained by 2 individuals without a prescription. The prescription history of the last individual was not known. Found dead in bead were 2 decedents, 1 of the decedents was found obtunded in bed and died a short time later, and the 3 remaining decedents were found dead either seated or lying on a couch or chair.

On external examination, 2 individuals had transdermal patches on their trunk, 1 of the individuals, a 45-year-old white male had 6 100 mcg/hr patches on his lower chest/upper abdomen, 1 decedent from another county had the patch removed at the scene of death, and 3 of the decedents had injected the patch contents intravenously.

At autopsy, 4 of the individuals had bilateral pulmonary congestion; 3 had aspirated gastric contents. All the decedents had mild to moderate cardiomegaly with heart weights ranging from 370 g to 470 g. In one case, coronary artery atherosclerosis was listed as a contributory cause of death. All of the individuals with a history of intravenous injection of the patch contents had extensive amounts of polarizable material in the lungs on histologic examination.

Toxic effects of fentanyl were listed as the cause of death in 3 of the cases. The cause of death for the remainder of the cases was mixed drug intoxication. Toxicological analyses revealed multiple prescription medications in 5 of the 6 cases. Toxicological analysis in one case revealed the presence of benzoylecognine, fentanyl and amphetamine. The presence of ethanol was detected in only one case.

The analysis of fentanyl (identification and quantitation) was accomplished by gas chromatography-mass spectrometry in the selective ion-monitoring (SIM) mode.

The average postmortem blood/tissue distribution of the "patch" cases were as follows: heart blood, 13.3 ng/ml (range 4-25); femoral blood, 10.3 ng/ml (range 4-18); vitreous, 10.0 ng/ml (range 3-14); brain, 32.0 ng/g (range 12-52); and liver, 35.6 ng/g (range 28-42). The average postmortem blood/tissue distribution of the "IV" cases were as follows: heart blood, 11.3 ng/ml (range 5-17); femoral blood, 4.0 ng.ml (range 2-7); vitreous, 3.3 ng/ml (range <2-5); brain, 26.6 ng/g (range 21-34; and liver, 25.6 ng/g (range 11-38).

Fentanyl concentrations did exhibit site dependency. The average heart/femoral blood concentration in the "patch" cases was 1.2 (range 1-1.3); whereas the "IV" cases demonstrated a greater concentration, averaging 3.3.

The data from these case studies demonstrates that the distribution of the fentanyl is similar, irrespective of the two common routes of administration: transdermal absorption or intravenous injection of the patch contents.

Duragesic®, Fentanyl, Postmortem Distribution

G68 Sufentanil Toxicity in Healthcare Professionals

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The goals of this paper are to present to the forensic community an awareness of two recent cases of sufentanil toxicity involving healthcare professionals.

This presentation demonstrates two autopsy cases from the Harris County Medical Examiner's Office involving sufentanil toxicity among healthcare professionals. Sufentanil citrate is available under its generic name of sufentanil and is often used in the surgical suite by anesthesiologists as an adjunct to general anesthesia. Sufentanil is available in Dosette ampules of 50-mcg/1 ml, 100-mcg/2 ml, and 250-mcg/5 ml. It is a Class II controlled synthetic narcotic, which is about 5 to 7 times as potent as fentanyl and 500 to 800 times as potent as morphine. The usual adult dose is 1 to 2 mcg/kg. Supplemental doses of 10 to 25 mcg may be given as needed. Profound analgesia is achieved with doses of 2 to 8 mcg/kg. Deep general anesthesia is achieved with doses of 8 to 30 mcg/kg. Sufentanil easily crosses the blood-brain barrier and is quickly routed to body tissues. After 24 hours, approximately 80% of the drug dose is excreted in the urine. Sufentanil is metabolized into N-desmethylsufentanil and O-desmethylsufentanil. Approximately 30% of a dose metabolizes as conjugates in both urine and feces. Sufentanil has a number of toxic effects including respiratory depression, acute respiratory arrest, seizures, hypotension (also sudden hypotension), euphoria, dizziness, muscle rigidity, drowsiness, nausea, vomiting, bradycardia, and irregular heartbeat. The literature reports 2 deaths in adults after self intravenous administration of sufentanil indicating blood levels of 1.1 and 7.0 mcg/L and liver levels of 1.8 and 3.4 mcg/L. It is not clear if these adults were healthcare professionals.

The following are details of two cases involving sufentanil toxicity that have occurred in less than a two-month period. Case one is a 41-year-old Caucasian male anesthesiologist who was found, in the bathroom, sitting on the toilet with his pants on and unresponsive. An empty syringe was found inside a dry beer can. A small vial of sufentanil 50 mcg, ¾ empty, was found in the bathroom. The autopsy findings included: a recent injection site in the left antecubital fossa with a 3/8 inch hematoma, cardiomegaly (450 grams) with moderate atherosclerotic cardiovascular disease, bilateral pulmonary edema and congestion, hepatomegaly (2550 grams), and erosions of the gastric mucosa.

Case two is a 34-year-old Caucasian male registered nurse who was found at work in the ladies bathroom face down on the floor with his pants and underwear down around his ankles. In addition to the 1 opened ampule of sufentanil, 15 different ampules, vials, and bottles of medications were found in the bathroom. In addition, 1 previously used syringe with needle and cap was found at the scene. The autopsy findings included: bilateral injection sites on the medial thighs, cardiomegaly (550 grams) with right ventricular dilatation and concentric left ventricular hypertrophy, and hepatomegaly (2400 grams).

Sufentanil can be assessed in the laboratory by multiple methods including gas chromatography with nitrogen specific detection, radioimmunoassay, and gas chromatography-mass spectrometry (GC-MS). The blood analysis for sufentanil was identified and quantitated by GC-MS method. Biological specimens were made alkaline (pH 13) using 2N, NaOH. Sufentanil was extracted using a mixture of hexane:ethanol (19:1). D5-fentanyl was used as an internal standard. The dried extracts samples were injected onto the GC-MS and the ions 250, target ions, 194, 195, 151 for D5-fentanyl and 250 (target ion), 290, 291, 140 for sufentanil were monitored. Postmortem blood in case one was positive for ethanol 0.12 g/dL and sufentanil 2.95 mcg/L. The syringe wash was also positive for sufentanil. No other drugs were identified. In case 2, sufentanil was the only compound in concentration of 2.63 mcg/L. The cause of death of death was sufentanil toxicity for both cases. The manner of death was ruled as accidental for both cases.

In conclusion, these 2 deaths resulting from sufentanil toxicity in Harris County Medical Examiner Office in less than 2 months are warning signs of the popularity of this potent, narcotic substance among healthcare professionals with substance abuse problem.

Sufentanil, Harris County Medical Examiner Office, Healthcare Professionals

G69 Acute Fatal Propafenone Toxicity: Drug Concentration, Distribution, and Clinical Features in Two Suicides

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The goals of this presentation are to illustrate clinical and toxicological features of deaths due to acute propafenone toxicity.

Propafenone is a class 1C antiarrhythmic agent, an agent that reduces the upstroke velocity of the cardiac muscle cell action potential by inhibiting the fast inward sodium channel. Propafenone is indicated in the treatment of paroxysmal atrial fibrillation/flutter and supraventricular tachycardia in patients without structural heart disease, and nonsustained ventricular arrhythmias. Potential proarrhythmogenic effects of propafenone are recognized. However, few cases of fatal propafenone toxicity are reported in the literature. This presentation reports two autopsy cases of acute propafenone toxicity, including history, and postmortem propafenone concentration and distribution.

The first case is a 29-year-old white female with a long medical history of benign conditions including an ankle injury with multiple orthopedic surgeries and borderline diabetes mellitus. She had a complaint of cardiac palpitations; Holter monitor evaluation in 1999 demonstrated episodes of atrial fibrillation/flutter. No structural defects were identified by echocardiogram. Treatment with propafenone was begun. Her clinical course was uneventful with regard to cardiac complaints, until approximately 2 years later when she presented with a complaint of chest pain of four days duration. Evaluation at that time, including electrolytes, chest X-Ray, and V/Q scan were normal; an EKG had first degree atrioventricular block, and nonspecific T wave changes. Following spontaneous symptomatic relief she was discharged home. She returned to the same hospital approximately 16 hours later, with migration of pain to the epigastric region. Additional laboratory studies included a normal gallbladder ultrasound. An EKG at that time indicated a first-degree atrioventricular block with slight prolongation of the QRS interval. During a four-hour period of observation, she was administered lidocaine, compazine and ketorolac, with symptomatic relief and was discharged home. EKG prior to discharge revealed slight narrowing of the QRS interval compared to what was seen in the previous EKG. The QTc interval was not appreciably prolonged in any EKG. Propafenone is known to cause some prolongation of PR and QRS intervals, but has no effect on QTc intervals. She returned to the hospital by ambulance eight hours later, after collapsing with seizure-like activity at home. An agonal arrhythmia was documented during unsuccessful attempts at resuscitation. At autopsy, the mildly obese female had hesitation scars on the left wrist, and contusions and lacerations of the tongue. Her lungs were congested. The heart and brain had no structural anomalies. Complete toxicology analysis revealed blood temazepam (0.17 mg/L), lorazepam (0.01 mg/L), oxazepam (< 0.01 mg/L), venlafaxine (<0.25 mg/L), and nortriptyline (0.28 mg/L; liver nortriptyline 4.0 mg/Kg). Lidocaine was also detected. Unexpectedly, the postmortem blood level of propafenone was 5.4 mg/L. Total amount of propafenone in gastric contents was 70 mg. The blood level of propafenone indicated intentional overdose (the plasma therapeutic range of propafenone is 0.06 – 3.2 mg/L). Hesitation scars, and the presence of other psychiatric medications provided further support for a suicidal manner.

The second case is a 32-year-old Hispanic male with no previous medical history who checked into a motel room with a female companion. The female subsequently left the room; the male was discovered dead on the floor of the bathroom 13 hours later. A brief suicide note was under the body. A bottle of propafenone, 150 mg tablets, prescribed to the female companion, was in the room, with approximately 68 tablets missing. At autopsy, the lungs were edematous and congested. Blood and vitreous ethanol were 0.20 g/dL and 0.28 g/dL, respectively. Less than 0.1 mg/L cocaine and cocaethylene were detected in the blood, along with 0.65 mg/L benzoylecgonine. Blood propafenone was 9.1 mg/L, and liver propafenone was 230 mg/Kg. A total of 135 mg of propafenone was in the gastric contents.

These two cases provide data on suicidal intoxication with the antiarrhythmic drug propafenone, including data on drug distribution, and evolution of EKG changes.

Class 1C Arrhythmic Agents, Propafenone, Suicide

G70 Flecainide: A Suicidal Pharmacist's Choice

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The goals of this presentation are to illustrate scene findings and toxicologic analysis of an unusual death of a pharmacist involving flecainide toxicity.

Flecainide is a class 1C antiarrhythmic agent that reduces upstroke velocity of the cardiac muscle cell action potential by inhibiting the fast inward sodium channel. Class 1C agents are approved for treatment of nonsustained ventricular arrhythmias. Proarrhythmogenic properties of flecainide and other class 1C agents are known. The authors report a case of suicidal ingestion of flecainide, with additional unusual toxicology findings and bizarre scene findings. The toxicologic findings and pharmacokinetic considerations are discussed in the context of the scene findings.

A 44-year-old black male pharmacist had no significant medical or psychiatric history. He was an avid diver; a dive logbook found in the apartment indicated over 255 dives. He had recently been depressed because of a busy work schedule, and having been denied vacation time for his annual dive trip. A coworker became concerned when he did not show for work for two days. On the third day, police were summoned and gained entry into the secure apartment where they found him deceased, supine in the bathtub. He was clad only in a pair of swim trunks. The tub was partially filled with water, the water was off, and the drain was plugged. At the time of discovery, water did not completely cover the face, and the nose and mouth were above water level. Two partially submerged, full, sealed 5-gallon water bottles were on the decedent's left abdomen and right chest. Several pieces of clear plastic wrap were adjacent to the decedent, on the edge of the tub, on the nearby toilet seat, and on the bathroom counter top. An open box of plastic wrap was on the floor just outside the tub. Complete toxicology analysis revealed flecainide with the following distribution: blood 11 mg/L, liver 324 mg/L, and gastric 367 mg. A large amount of flurazepam (1 g) was also in the stomach, although flurazepam was not detected in the blood. Blood and vitreous ethanol were 0.02 g/dL and 0.03 g/dL, respectively.

The high blood level of flecainide indicated a suicidal manner of death (the reported therapeutic serum concentration of flecainide is 0.2 – 1 mg/L.). Moreover, the decedent did not have a prescription for flecainide; in fact, he had no preexisting arrhythmia or other known cardiac problem, suggesting that he sought out a medication specifically for the purpose of ending his life. As a pharmacist, he had access to a variety of agents and had knowledge of pharmacologic mechanisms and pharmakokinetics. Perhaps flecainide was chosen because the mechanism of death was considered to be similar to a myocardial infarct, potentially less violent than other means. Perhaps he thought the unusual nature of the drug would preclude its detection on routine postmortem toxicology.

The large amount of flurazepam in the gastric contents further supports a suicidal manner, and the lack of flurazepam in the blood indicates preterminal ingestion.

The complex scene findings and unusual toxicology suggest purposeful activity by this decedent; several aspects remain puzzling. For example: why would flurazepam have been added? What was he doing with the plastic wrap? Why was he holding bottles of water on his chest and abdomen? Is his extensive knowledge of diving relevant? These aspects will be discussed during the presentation.

Class 1C arrhythmic Agents, Flecainide, Suicide

G71 The Use of Lidocaine to Commit Homicide: A Case Report and Review of the Literature

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The goals of this presentation are to report the first case of Lidocaine being used to commit homicide outside a hospital setting, to pull known cases of iatrogenic homicidal Lidocaine poisoning into the forensic sciences literature, to review and compare the two groups highlighting similarities and differences, and to distinguish those situations where an elevated Lidocaine level should trigger a more extensive investigation.

Lidocaine is a drug that is commonly used during the course of resuscitating critically ill patients. It is most effective at treating ventricular tachycardia associated with a myocardial infarct. It is therefore a common finding on the toxicology reports of medical examiner cases. It is so common one could even say that it has become part of the "normal flora" of drugs found in people who die suddenly and unexpectedly along with Cotinine and Caffeine. It is also not uncommon for Lidocaine levels to be elevated, even above the "potentially toxic" level because of the grave situations in which the drug is administered. As a result, medical examiners/forensic pathologists can become desensitized to the dangers of this drug. Above therapeutic levels, it can cause severe cardiovascular and neurologic effects including immediate asystole, apnea, and convulsions. It lowers seizure thresholds and may increase the risk of bradycardia and asystole. Yet, the common assumption about Lidocaine is that if it is found in a patient's blood, the careful hand of a physician or paramedic with the goal of saving the patient's life administered it. The cases presented here illustrate that this is not always true. One case illustrates how Lidocaine was used as a tool to commit homicide by a non-professional while the other three show that when used in the medical setting, it is not always with a therapeutic intent. The former case is the first reported of its kind.

In this paper, the cases of iatrogenic homicide are briefly reviewed, characterizing the perpetrators, the victims, the motives, and the keys to recognizing the deaths as homicides. The majority of the focus is on the case involving the homicidal Lidocaine poisoning outside the hospital. Similarities and differences between that case and the hospital-based homicides are highlighted with the goal of raising awareness as to when an elevated Lidocaine level should trigger a more extensive investigation.

The majority of known Lidocaine homicides have been committed by so called "Medical Murderers." These are health care providers of one form or another who made Lidocaine their weapon of choice. Robert Diaz was a 46-year-old nurse who killed 12 patients (and possibly 50 more) by Lidocaine injection while he worked as a nurse at two California Hospitals. His motive stemmed from his desire to appear to have a "doctor's" knowledge of how sick patients were and to "predict" when they would die. Joseph Dewey Akin was convicted of killing a quadriplegic patient by injecting him with Lidocaine for the "fun of watching him die". He committed this crime in Birmingham AL but was suspected to have killed 17 others while working at a hospital in Atlanta GA. And finally Randy Powers was a 26-year-old respiratory therapist who was never convicted of murder but was convicted of "assault with a deadly weapon" and "practicing medicine without a license." He gave an eleven-month-old child an intramuscular injection of Lidocaine inducing a high fever and seizure activity. He participated in the resuscitation and was originally thought to be a hero. Physicians however identified a needle puncture wound on the child's thigh and toxicology revealed elevated Lidocaine. Powers was suspected to have been involved in many other unexplained deaths. However, the bodies that were exhumed failed to show needle puncture wounds or elevated Lidocaine levels.

The case of homicidal Lidocaine poisoning outside a hospital involved the husband of a 69-year-old female with a past medical history most significant for Alzheimer's disease, schizophrenia, and macular degeneration. He was her sole caretaker but was also an active volunteer at the Red Cross and a local Michigan hospital. On the day of her death, he found her lying on her bed around 8:00 a.m. She was unresponive and this prompted him to notify emergency medical personnel. On arrival, paramedics determined that she had been dead for some time and pronounced her dead at the scene. Her husband reported that she was in her usual state of health and had no complaints when he put her to bed on the prior evening (around 11:00 p.m.). The police and the medical examiner investigator found the scene secured with no evidence of a struggle. She was lying on top of the bedding in her nightshirt with a pillow lying over her right leg. There was no evidence of injury to the body. At autopsy the diagnosis of Alzheimer's disease was confirmed and there was no evidence of injury or needle injection marks. Two EKG leads were the only evidence of therapy. She was a normally developed female and had moderate atherosclerotic cardiovascular disease. Postmortem urine toxicology revealed Lidocaine, Tocainide, Meperidine, Salicylate, and Caffeine. A postmortem blood drug screen (subclavian blood) revealed Lidocaine 12.4 mcg/ml (potentially toxic >8 mcg/ml) and Salicylate (non-toxic levels). Discussions with MEI personnel confirmed that EKG monitoring was the only resuscitative procedure performed on the decedent and that there was no evidence of accidental ingestion of topical anesthetics. A police investigation was started and revealed information that suggested her husband would have the knowledge to administer the drug and may have been involved in previous attempts to kill her. Follow up testing (including DNA analysis) confirmed the presence of Lidocaine and ruled out the possibility of specimen mix-up at the laboratory. Based on this information the cause of death was determined to be Lidocaine poisoning and the manner of death was homicide.

This paper is valuable for multiple reasons. It first pulls cases of homicidal Lidocaine poisoning into the forensic literature. Secondly, it highlights how the deaths of elderly people and the severely ill are not infrequently treated with benign neglect despite the fact that they are precisely the people most likely to be the victims of homicidal poisoning. It highlights how elevated Lidocaine levels are treated with similar benign neglect. This is clearly illustrated in the comment by one forensic pathologist who was asked to evaluate the toxicology report knowing only that it was a case of an elderly person who died at home. He quickly stated, "There is nothing here" automatically attributing the elevated lidocaine level to "an artifact of resuscitation." This paper illustrates how the hobby or profession of the assailant/caregiver can give important clues as to the cause of death and to the poison used. And finally it illustrates how doing a through scene investigation including a detailed medical and social history of the decedent and the family can alert you to a situation perfect for homicidal poisoning.

Lidocaine, Homicide, Forensic Science

G72 The Normal Heart Weight: Diagnostic Criteria for Cardiomyopathies

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The definition of normal heart weight is discussed. Various features and causes of cardiac hypertrophy are examined and illustrated. Criteria for the diagnosis of cardiomyopathy are discussed.

In medicolegal practice it is not uncommon that the cause of a death cannot be determined by autopsy, histology, and toxicology. Among other questions, the following deserve special attention: Was the heart weight normal? Can an isolated cardiac hypertrophy be a cause of death? What can be expected from cardiac histology?

In the first part of this presentation, the definition of the normal heart weight is discussed on the basis of a personal series of normal hearts and the literature. For this purpose, the weights of 973 hearts from adults with normal hearts who died of violent death were measured in order to determine the upper limit of the normal heart weight as a function of sex, age, body weight, body height, and body area. In the second part, gross and histologic findings in 38 hypertrophic hearts were examined. The meaning of myocyte disarray is discussed. Diagnostic criteria for the diagnosis of primitive hypertrophic cardiomyopathy are examined. Contribution of cardiac histology to the assessment of the diagnosis of cardiomyopathy is also analyzed.

Heart, Hypertrophy, Cardiomyopathy

G73 Normal Fat in the Right Ventricle vs. Arrhythmogenic Right Ventricular Cardiomyopathy/Dysplasia

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Fat is a normal component of the right ventricle. In this presentation, the diagnostic criteria for right ventricular cardiomyopathy are examined. The role of fat *per se* in sudden death is discussed.

Fat is a normal component of the right ventricle. However, in some hearts the proportion of fat is dramatically increased. The question of whether fat infiltration of the right myocardium *per se* can be responsible for sudden death has not yet been answered. In a previous series of sudden cardiac deaths related to arrythmogenic right ventricular cardiomyopathy, the authors showed that in this disease, fat was constantly associated with fibrosis[1]. The significance of fat infiltration without fibrosis in the right ventricle was not discussed. In a first part of the present study, the authors examined 30 right ventricles with an increased amount of fat, which was semi-quantitatively evaluated using a score of severity ranging from 1 (minimal increase) to 4 (transmural involvement). These hearts were obtained from persons who died of violent or natural death, but sudden cardiac deaths were excluded. The hearts were compared in blind conditions to those from the authors' previous sudden death series. In the non-sudden death group, the mean age was 62 years (range, 42-97), 80% of victims were female and 20% of right ventricles had grade 4, 45%, grade 3, 30%, grade 2 and 5%, grade 1. Fibrosis was never observed. In a second part of the study, case-reports of the literature were analyzed, in which fat infiltration *per se* was considered the cause of sudden cardiac death. A personal case-report is also reported in which sudden cardiac death occurred in a person who had only fatty replacement of the right ventricle.

Conclusion. Fat is a normal component of the right ventricle, and may be increased in certain persons, especially obese and/or old women. Sudden cardiac death is most likely to occur when fat is associated with fibrosis. Sudden cardiac deaths have rarely been reported to have occurred despite absence of fibrosis. In such cases, additional factors may contribute to the arrhythmogenicity.

[1] Fornès P, Ratel S, Lecomte D. Pathology of arrhythmogenic right ventricular cardiomyopathy/dysplasia. An autopsy study of 20 forensic cases. *J Forensic Sci* 1998 ; 43 : 777-83

Arrhythmogenic Right Ventricular Dysplasia, Sudden Death, Cardiomyopathy

G74 Isolated Noncompaction of the Left Ventricle: A Rare Cause of Sudden Death

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This presentation will review the literature and the autopsy findings of Isolated Noncompaction of the Left Ventricle, a rare congenital cardiomyopathy.

A 44-year-old black female with no known medical history was witnessed to collapse suddenly at work. Upon arrival, paramedics found an initial rhythm of ventricular fibrillation; their initial efforts resulted in conversion to sinus tachycardia, which quickly deteriorated into ventricular fibrillation. The patient was taken to a nearby hospital where she was pronounced dead in the emergency room.

Autopsy examination showed a well developed, well nourished black female weighing 158 pounds and measuring 5' 2" in height. Internal examination revealed a 409 gram heart with no evidence of coronary artery disease. The left ventricle measured 1.3 centimeters in thickness, the right ventricle measured 0.5 centimeters, and the septum ranged in thickness from 0.5 to1.3 centimeters. On cut surface, the left ventricle had a sponge-like appearance. Filling the left ventricle, from the apex to the level of the mitral valve were extensive trabeculations with deep intertrabecular recesses. An area of scarring and hemorrhage was present along the anterior third of the septum. Autopsy also showed pulmonary edema and congestion, emphysematous changes of the apex of the upper lobes of the lungs bilaterally, and nephrosclerosis. Histologically sections from the heart showed trabeculations lined by ventricular endocardial endothelium, which was continuous with the ventricular endocardium. The trabeculations showed areas of endocardial thickening and ischemic changes with myocyte necrosis and hypertrophy of the surrounding myocytes. Sections from the lung showed chronic congestion. Toxicology tests were negative.

Isolated noncompaction of the ventricle (INLV) is a rare congenital cardiomyopathy thought to be caused by an arrest of compaction of the loose meshwork of myocardial fibers during embryogenesis. Noncompaction results in the formation of muscular trabeculations that fill one or both ventricles imparting a spongy appearance. The overall incidence in the adult population is 0.05 percent. Genetic studies have shown an X-linked recessive inheritance pattern with mutations in the gene G 4.5 on the Xq28 chromosomal region associated with INLV. However, the occurrence of INLV in women suggests a possible non-X -linked inheritance pattern.

Patients have been identified ranging in age from 1 week to 71 years. The onset of symptoms, commonly related to depressed left ventricular function, frequently develops during adulthood. The diagnosis in adults is often delayed because the symptoms, which are nonspecific, are similar to more frequently diagnosed conditions such as congestive heart failure. Patients can also present with various arrhythmias. The arrhythmias can be associated with Wolf Parkinson White Syndrome, bundle branch blocks, or ventricular arrhythmias. Some patients present with embolic events that include transient ischemic attacks, stroke, and pulmonary embolism. INLV has specific echocardiographic findings, and it is not until this test is performed that the diagnosis is confirmed.

Isolated noncompaction of the left ventricle is a rare congenital cardiomyopathy affecting both sexes through a wide range of ages, has nonspecific clinical manifestations, and can result in sudden death.

Isolated Noncompation of the Left Ventricle, Spongy Myocardium, Congential Cardiomyopathy

G75 Trauma-Related Hemorrhage vs. Spontaneous Rupture of Vascular Malformation: Three Case Reports Illustrating Medico-Legal Aspects

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In medicolegal practice, cutaneous and visceral hematomas are often caused by trauma. In some cases spontaneous rupture of a hemangioma can mimic trauma-related hemorrhage. Three case-reports illustrate this issue.

In medicolegal practice, cutaneous and visceral hematomas are often caused by traumas. However, in some cases, a hemangiomas/vascular malformations can be involved. These can be overlooked if histology is not performed. The matter is further complicated by the fact that rupture of hemangioma can be provoked by slight trauma. Three autopsy case-reports are presented to illustrate medicolegal aspects of this issue.

Case 1: A 6-month-old boy was found dead in his bed by his parents. The GP who examined the body found the child's anus enlarged and considered the death suspicious. At autopsy, the anus was considered normal, but there was an ecchymotic area at the surface of the left ventricular epicardium, 2 cm in diameter. No resuscitation attempts had been performed. There were no rib fractures or any other cutaneous or visceral hemorrhages. Histology revealed a small hemangioma in the anterior left ventricular wall. Such vascular malformations have been reported to cause sudden cardiac death in infants and older children.

Case 2: A 5-year-old boy was found dead in his bed by his parents. The cause of death was found to have been a tamponnade due to a hemopericardium. The right atrium was found ruptured. There were no rib fractures or any other hemorrhages. Histology showed a ruptured hemangioma in the right atrial wall. Such vascular malformations have been reported to cause death in infants and older children This localization has been reported to be the most frequent.

Case 3: An 18-year-old man was found dead in jail. During the days prior to the death, he had complained of various neurological symptoms, including headache and difficulty in standing and walking. He reported that these symptoms developed in the days following a dispute, when he had been punched to the face. Neurological examination showed no objective abnormalities. At autopsy there was a meningeal hemorrhage surrounding the cerebellum and the upper part of the brain stem. Edema in the underlying parenchyma caused death. Histologically, there was a ruptured hemangioma in the cerebellum.

In conclusion, hemangiomas are rare causes of hemorrhages. Rupture can be spontaneous (cases 1 and 2). However, in medicolegal practice, the question often arises of whether a slight trauma may have facilitated the rupture (case 3). Histology is essential in revealing the hemangioma and dating lesions.

Hemangioma, Heart, Brain

G76 Esophageal and Pharyngeal Injury Associated With the Esophageal-Tracheal Combitube®

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The goals of this paper are to present a series of cases of esophageal and pharyngeal laceration associated with the use of the Combitube®.

The esophageal-tracheal combination tube or Combitube® is a ventilatory device used for the intubation of patients in a number of different clinical settings. Its basic design consists of a twin lumen tube with proximal and distal inflatable cuffs. This design allows for placement of the device in either the trachea, or more commonly, the esophagus, and through appropriate inflation of the proximal and/or distal cuffs provides a conduit for ventilation. The major benefit of the Combitube® is that its design and function allow for non-laryngoscope-assisted or blind insertion into the oropharynx. Therefore, it is frequently used in emergency situations such as cardiopulmonary resuscitation in both the hospital and pre-hospital setting. As with any invasive procedure, intubation using the Combitube® is not without complications. The majority of complications is relatively minor and includes sore throat, dysphagia, upper airway hematoma, and a more pronounced hemodynamic stress response. A rare and serious complication reported primarily in the anesthesiology literature is rupture of the esophagus. However, this reportedly rare injury is increasingly seen by medical examiners/coroners in the forensic setting.

A series of three cases of esophageal rupture and a single case of laceration of the hypopharynx associated with the use of the Combitube® that were identified at the time of medico-legal autopsy at the Milwaukee County Medical Examiner's Office between 1997 and 2002 will be presented. The cases involved patients between the ages of 15 and 78. The cause of death in three of the cases was determined to be sudden cardiac death due to atherosclerotic and hypertensive cardiovascular disease while acute asthmatic attack was the cause of death in one case. All individuals were intubated in the field by emergency medical personnel during cardiopulmonary resuscitation. The Combitube® was inserted in the esophagus in the three cases of esophageal rupture and in the hypopharynx in the case of pharyngeal laceration and placement of each was confirmed at postmortem examination.

A review of select literature is also presented. This includes a review of the development of the Combitube®, its design and function, and the manufacturer's recommendations for its use. Case reports from the anesthesiology literature are also provided. In addition, the presentation will review information regarding possible mechanisms of injury focusing on recent reports that investigate the importance of anatomic location, cuff volume, esophageal and tracheal distortion, and mucosal pressures in the development of esophageal rupture.

By providing this information, it is hoped the awareness of the forensic community to the esophageal and pharyngeal injuries associated with use of the Combitube® and how they occur is raised. The authors stress the importance of thorough investigation of the perimortem events including review of resuscitation records/reports as they aid in defining the extent to which the injury contributes to the cause and manner of death. In addition, this work demonstrates the vital role the medical examiner/coroner plays in identifying existing or potential problems with current or emerging medical devices. By fulfilling this role, the medical examiner/coroner can provide clinicians and emergency medical personnel information that can be used to prevent similar injuries in the future.

Esophageal Rupture, Combitube®, Complications

G77 Determination of Time Since Death—Cardiac Troponin I

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This presentation will describe the development and utility of cardiac Troponin I (cTnI) as a time since death marker. Estimates of time since death in the early postmortem interval 0–7 days are currently performed using different temperature based methods and other physical parameters that lack the desired forensic reliability. The qualitative and semi-quantitative analysis of the degradation of cTnI as a time since death marker will be discussed using a bovine tissue model followed by postmortem human cardiac tissue samples.

The importance of determining the time since death is crucial to criminal, civil and forensic cases. Time since death markers have lagged behind the advances in technology of the past century. Knight explains, 'regrettably, the accuracy of estimating the postmortem interval (PMI) has by no means kept pace with the enormous strides made in technological sophistication.' Early documented works on time since death focused on temperature measurements postmortem and possible algorithms to model the behavior of postmortem cooling of the body. Current technology is based on postmortem temperature methods similar to those described back in the 1800s. Marshall, an expert in this area, best summarizes the general issues with temperature measurements as follows, 'It would seem that the timing of death by means of temperature can never be more than an approximation.' Biochemical markers investigated to estimate time since death include protein fractions, urea, creatinine, glucose, iron, potassium, calcium, enzymes, immunohistochemical detection of insulin in pancreatic β-cells, myo-albumin fraction and Strontium-90 calcium analogue levels. Postmortem muscle proteolysis has been researched to explain the muscle relaxation following rigor mortis. Temperature, as a time since death marker, remains a leading marker after many years of investigations and limitations.

Cardiac Troponin I emerged as the leading serum marker for myocardial infarction (heart attack) in both the U.S. and Europe in the mid 1990s. It has become the gold standard serum marker for cardiac damage. This research is focused on a technique exploiting the postmortem tissue degradation of cardiac Troponin I to determine the time since death.

The technique consists of isolating and separating troponin I and its proteolytic fragments from cardiac muscle tissue (myocardium). This is accomplished by using magnetic microparticles that capture this protein from a 1.0 g cardiac tissue homogenate extracted with a buffer that inhibits proteolytic activity. The capture microparticles are incubated for 1 hour and washed several times with extraction buffer. The proteins bound are eluted from the microparticles using a low pH buffer. The proteins are separated by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) and transferred to paper using a semi-dry Western blot protocol. The proteins transferred are probed with monoclonal antibodies specific for cardiac Troponin I. The blot is then incubated with goat anti-mouse antibody labeled with alkaline phosphatase (GAM-ALP). The blot is developed after incubating with a precipitating colored substrate. The bands of cTnI and most of its proteolytic degradation products that retain the antibody-binding region (epitope) are visualized by this technique. Digitization of the Western blot is performed using a scanner and software that can integrate the area of the peaks for qualitative and semi-quantitative analysis.

Cardiac troponin I exists as an intact protein when sampled from fresh human cardiac tissue. The experiments focused on a model of bovine cardiac tissue followed by human cardiac tissue with known time since death. The samples were frozen until the analysis was performed to avoid proteolysis during storage. The results indicate a consistent cTnI banding pattern amongst different human cadavers and a pseudo-linear relationship between percent cTnI degraded and the log of the time since death with a coefficient of correlation, $r > 0.95$. The unknown time since death degradation pattern can be qualitatively compared to a "reference heart" incubated under controlled conditions. The analysis matches the cTnI degradation pattern of the cadaver in question to the "reference heart" degradation pattern incubated at different time points. Thus, the extent of cTnI degradation serves to estimate time since death. Overall, this technique offers advantages over current methods such as wider postmortem interval, measurable degradation pattern and a temporal semi-quantitative relationship. In addition, at lower temperatures the postmortem prediction interval can be extended to provide a wider range. The degradation pattern of tissue cTnI is useful in the determination of the early postmortem interval (0 to 7 days), which is difficult to estimate with current technology.

Cardiac Troponin I, Time Since Death Marker, Postmortem Interval

G78 Quantitative Measurement of Ribonucleic Acid Degradation as a Possible Indicator of Postmortem Interval

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After attending this presentation the participant will understand that RNA degradation is time-dependent, can be quantified by reverse transcription and polymerase chain reaction and may serve as indicator of postmortem interval.

Ribonucleic acid (RNA) research is a major topic in molecular biology and medicine. RNA is less stable than DNA in vivo and in vitro and therefore is believed to undergo rapid postmortem degradation. This may be the reason why RNA analysis did not obtain significant attention in forensic science up to now. However, due to the nucleic acid structure small amounts of mRNA can be amplified by polymerase chain reaction after synthesis of complementary DNA (cDNA) by reverse transcription (RT-PCR). The poly-A-structure at the 3'end of most mRNAs allows exact imaging of the mRNA pattern by oligo(dT)-primed reverse transcription including differences in fragment size due to degradation. Primers designed for sequences near the 5'-end of the mRNA should provide weaker amplification results than primers located near the 3'-end in degraded samples because the average mRNA size is expected to be smaller after RNA degradation so that less full-size transcripts will be generated during reverse transcription.

The objective of this study was to investigate whether quantitative measurement of RNA degradation could be helpful in determining the time of death in bodies. Blood taken from healthy volunteers was stored under various conditions and for variable time periods. Blood from bodies with exactly known time of death was taken from the femoral vein. After counting leucocytes RNA and DNA were extracted using standardized protocols. For estimation of the degree of degradation the 260/280 nm UV absorption ratio and the ratio of 28S to 18S ribosomal RNA of the RNA samples were determined. To assess the integrity of messenger RNA competitive RT-PCR using an synthetic competitor mRNA, one-step duplex RT-PCR with simultaneous amplification of a short and long fragment of the same mRNA (ß-actin) , multiplex RT-PCR with amplification of four fragments located between the 3' and 5'-end of the mRNA (fatty acid synthetase, FAS) and comparative RT-PCR of house-keeping genes (glycerin aldehyde-3-phosphate dehydrogenase) were performed. The amplification products were visualized with agarose gels or automated capillary electrophoresis. For quantification the staining intensity in ethidium-bromide stained agarose gels or the peak area in electropherogramms generated with laser-induced fluorescent capillary electrophoresis were calculated.

The results show, that RNA degradation is gradually increasing up to 5-6 days postmortem depending on the ambient temperature. The in vitro as well as the postmortem assays demonstrate that the in vitro/postmortem time interval can be estimated by quantitative measurement of RNA degradation during the first week within a range of 1-2 days. Multiplex RT-PCR of the FAS-mRNA provided the most consistent results because the degradation of long (>4kb) mRNAs is measured showing a significant decrease of the amount of 5'-sequences that require full-size transcripts for detection relative to 3'-sequences which are close to the origin of reverse transcription.

Beside the forensic implications this study has high relevance for clinical and experimental RNA research because the exact time-course of postmortem or in-vitro RNA degradation is largely unknown. In forensic pathology quantitation of RNA degradation seems to close the gap between early postmortem interval (< 24 h) and the beginning of putrefaction. Further evaluation studies are currently performed with autopsy cases to enhance the significance of statistical calculations.

RNA Degradation, RT-PCR, Postmortem Interval

G79 Experimental Evaluation of Rigor Mortis: The Influence of the Breaking (Mechanical Solution) on the Development of Rigor Mortis

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The learning objective consists in presenting the influence of the breaking (mechanical solution) on the development of the intensity of rigor mortis

Although little is still known about its development over time, rigor mortis is routinely used to estimate the time since death. In order to further knowledge on this phenomenon the authors have developed a method for the objective measurement of the intensity of cadaver rigidity in rats.

The principle of the method is to determine the force required to cause a movement of small amplitude (4 mm) in the limb under examination. Since the movement doesn't break rigor mortis, serial measurements can be conducted. The apparatus measures the resistance caused by rigor mortis in the knee and hip joints of rats. This method was formerly used to evaluate the influence of several antemortem and postmortem factors (i.e. body weight, muscular mass, age, physical exercise, ambient temperature, various causes of death, electrocution) on the development of rigor mortis. Present investigations address a very poorly known phenomenon in the development of rigor mortis, which consists in the return of the rigidity after mechanical solution. In fact, observations on human cadavers have shown that if early rigor mortis is "broken" (by forcing a limb to bend), it may reappear. However information based on standardized experiments is lacking concerning this phenomenon.

Experimentation: Question addressed:
- reappearance
- intensity after reappearance
- rapidity of reappearance
- time limit of reappearance
- rigor mortis time span after reappearance

Animals: male albinos rats, approx. 300 g
Method to break rigor mortis: the paw is vigorously pulled twice in order to completely straighten the limb.
Breaking time points: 1, 2, 4, and 6 hours p ostmortem.
Measurement time points: 10 min, 1h, 2h, 3h, 4h, 5h, 6h, 8h, 12h, 16h, and 24 h postmortem.

Results: The maximal values of the intensity of rigor mortis are reached between 4 and 5 hours postmortem in the control group with a plateau of the intensity between 4 and 8 hours postmortem. If the breaking takes place at 1 hour postmortem, the curve representing the intensity of rigor mortis has the same shape, i.e., maximal values are attained at the same time, but values are significantly lower. A breaking point at 2 hours postmortem gives similar results: maximal values are obtained at the same time as in the control group but values are significantly lower. If breaking occurs after 4 or 6 hours no significant rigidity reappears.

Conclusion: Rigor mortis may reappear if it is broken during the early phase of its development, but its intensity is significantly lower. The time course of rigidity after breaking is the same as in the controls. If the breaking intervenes after the full development of rigor mortis, it doesn't reappear. These results offer a better understanding of the phenomenon of rigor mortis and, further, of the estimation of time since death, a fundamental element in forensic medicine.

Rigor Mortis, Breaking of Rigor Mortis, Development of Rigor Mortis

G80 Evaluation of a Putative Snuff Film

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The attendee will understand how to critically evaluate computer animation from a medicolegal perspective.

So-called "snuff films" are films, which purport to show an actual killing as entertainment. The killing is done for the purpose of the film, as distinguished, for instance from compilations of executions and killings from news reports or taken by observers. The existence of "real" snuff films or whether they are an urban myth is an occasional source of debate.

This is a case report of a putative snuff film that was presented to investigators as evidence of a possible homicide. In this animation, a young woman was tied to a chair and shot. The investigators were skeptical, and before expending resources to search for a body asked for an evaluation of the imagery. This presentation will detail some of the findings, and provide an approach to the evaluation of such imagery.

A copy of the data was provided to the Digital Image Processing Laboratory, and the cine was evaluated on a frame-by-frame basis. Analysis focused on two primary areas:

1. Internal inconsistencies (features in the image that were not appropriately constant), such as inappropriate optical flow, evidence of image manipulation, etc.
2. Factual inconsistencies (features which did not fit natural laws), such as inappropriate bloodstain patterns.

In this particular instance, a number of internal inconsistencies were found in the imagery, including inconstant positioning of the entrance wound, inappropriate firing of the weapon, inaccurate bloodstain patterning, and others. A computer search was performed to determine the provenance of the animation, and was successful. The film was traced to its original release on the internet a few years ago and to the production house that made it. A Canadian special-effects company that specializes in "fantasy violence" had made the film as a publicity effort.

A number of points can be made from this analysis, including the importance of a multidisciplinary approach to integrating scene and medical information, the effects of image quality and compression method, and the use of the internet as a source and repository for these kinds of films and resource for their investigation. In this particular case, the use of JPEG compression placed severe limitations on the analysis of optical flow, since the details necessary for such evaluation were obscured by the JPEG blocking effect, which becomes increasingly problematic if contrast enhancement is used.

As digital imagery becomes increasingly integrated into the current culture, forensic pathologists and physical anthropologists should expect to receive more and more images for medicolegal evaluation. The evaluation of these images requires both an understanding of the medical aspects of the scene being analyzed but also a comprehension of how to approach imagery and how to handle digital evidence. In cases of digital imagery, the media containing the data may well be itself a piece of physical evidence to be analyzed separately than the data contained therein. A number of groups, including the Scientific Working Group on Digital Evidence are promulgating guidelines for handling evidence that is provided in digital format, while other groups, such as the Scientific Working Group on Imaging Technologies in the U.S. and similar groups in the international arena are developing guidelines for the acquisition and evaluation of digital data. A short discussion of the handling of digital evidence and the place of the medical examiner in handling such evidence will be provided.

In this particular instance, a determination that this image was not of an actual killing was made rather quickly, and a more intense examination

was not necessary. Possible further approaches to evaluation will be discussed.

A short review of the snuff-film urban legend and its variants, and an introduction into some of the material easily available through modern distribution methods of imagery, including the internet, will be provided.

Video Analysis, Image Analysis, Snuff Film

G81 Analysis of Electric Injury Patterns in Human Skin by Magnetic Resonance Microscopy

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The goals of this presentation are to gain a greater understanding of emerging diagnostic technologies; to develop correlations between magnetic resonance microscopy and light microscopy for electrical injuries; and to better recognize the histopathology and pathophysiology of electrical damage to the skin.

Introduction: The pattern observed for an electric injury depends on the strength and frequency of the electric field, the path of the current, and the histoarchitecture of the tissues. Tissue trauma results from (a) electric field effects and (b) Joule heating due to the passage of electricity. To characterize the electric injury pattern in skin a variety of techniques, ranging from histology to scanning electron microscopy, have been applied. These techniques give detailed information about changes to cell morphology in sections taken at the site of the entrance and exit wounds, but provide little information about the extent of tissue damage in peripheral and deep tissues. Clinical MRI studies can provide some information about vessel patency and muscle necrosis, but the injury pattern is lost due to limited spatial resolution. In this work, MRM was used for the first time to characterize the microanatomy of an electric injury pattern in human skin.

Materials and Methods: Skin specimens, with visible epidermal lesions, were dissected from the left and right foot of a human cadaver that had received a fatal electric shock. Fixed skin samples were rehydrated in phosphate buffered saline prior to imaging. All experiments were performed on a Bruker Biospec spectrometer (Bruker Instruments, Inc. Billerica, MA) coupled to horizontal magnet operating at 7T (300 MHz for protons). Quantitative 2-D images had a slice thickness of 2 mm and an in-plane resolution of 120 mm. 3-D images were acquired with a RARE imaging sequence. The microanatomy of the resulting electric injury pattern was characterized by MRM and images were validated against histologic sections taken through the wound site.

Results and Discussion: On gross inspection, electric lesions were found to be composed of three zones: a central zone, an intermediate zone, and a peripheral zone. In the central zone the epidermal layer was completely destroyed and the underlying dermis was thermally damaged. In the intermediate zone, dermal necrosis was observed under the detached epidermis and in the peripheral zone there was little evidence of damage to cutaneous tissues.

Three-dimensional MRM images of formalin-fixed skin specimens were found to provide a complete view of the damaged tissues at the site of an electric injury as well as in neighboring tissues, consistent with histologic reports. The signal intensity of the dermal layer in the central zone was reduced due to thermal damage and increased in the intermediate zone because of cellular necrosis caused by the electric field. A subjacent blood vessel with extensive intravascular thrombosis supports the hypothesis that electricity traveled through the vascular system before arcing to ground. MRM images of intact skin samples confirm that the resulting electric injury pattern was comparable to that of a vascular lesion.

Forensic Science, Electric Injury, Magnetic Resonance Microscopy

G82 Coins as Intermediate Targets: Reconstructive Analysis With Body Models

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The attendee will learn about intermediate targets and body models in wound ballistics.

Introduction: The phenomenon of intermediate targets is well known in wound ballistics. Intermediate targets are materials that receive some kinetic energy from the striking bullet. The result is that the intermediate target may be set into motion and become a secondary projectile. The injury analysis involving intermediate targets is often difficult. Therefore in forensic science, models are used to reconstruct injury patterns to answer questions regarding the dynamic formation of unusual injuries. In ballistic research glycerin soap and ordnance gelatin have been well established as soft-tissue substitutes. Recently, based on previous experiences with artificial bone, a skull-brain model was developed. The goal of this study is to create and analyze a model-supported reconstruction of a real forensic case with a coin as an intermediate target. A man with multiple bullet wounds was admitted to the hospital, where they found, by computed topography of the head, two foreign bodies. The man died several hours after admission to the hospital. At autopsy two foreign bodies in the brain were identified: a .380 caliber Winchester Silvertip bullet and a deformed, 1970, Mexican 50-centavo coin. There was no evidence of close-range firing and a through-and through gunshot wound at the base of the left index finger suggesting that the bullet passed first through the hand, picking up the coin as secondary projectile before entering the head. Since it wasn't clear exactly how this unusual injury pattern came about, a reconstruction was attempted.

Materials and Methods: Gunshot experiments were made at the "Ballistic Missile Trauma Laboratory and Range" of the Armed Forces Medical Examiner at the Armed Forces Institute of Pathology, Washington D.C. For the first experimental set-up 10% gelatin blocks were used (size 36 x 15 x 15 cm) at 4° C. For the reconstruction of the ballistic process, a gelatin block with a thickness of 1.5 cm was used to represent the left index finger of the victim; a gelatin block of 0.5 cm was used to simulate the skin of the head. In some gelatin block experiments "Lauan Plywood" with a thickness of 6 mm (Home Depot, USA) was used to simulate the bony skull, which was placed between the finger and skin simulants. For the second experimental the artificial skull-brain-model was used (Thali, et al. *Forensic Science International* 125 (2002) 178-189). The artificial

skull is a layered polyurethane sphere 19 cm outside diameter and 6 mm thick) constructed in a specially designed form with a inner table, outer table and a porous diploe sandwiched in between. The brain itself is simulated with ordnance gelatin. Ammunition (Winchester 380 Automatic (85 GR) Silvertip Hollow point – muzzle velocity 1000 fps) similar to the real case was used. The bullets were fired by a Llama .380 pistol. As intermediate target 1970, 50- centavo Mexican coins were used. The coin was positioned between the simulated finger and the body simulant.

First the authors fired directly into three gelatin blocks, then fired into two "finger-coin-gelatin-block"-models, then into five "finger-coin-wood-gelatin- block"-models and finally into two skull-brain models. The gunshots were documented with a high-speed digital black and white camera PHANTOM V4.0 (Photo-Sonics, Burbank, CA) frame speed of up to 32,000 pictures per second. All gelatin blocks were examined by a digital mobile C- arm unit Compat 7600 (OCE, Salt Lake City) at the Office of the Armed Forces Medical Examiner in Rockville, MD. The CT scans of the head models were done at the National Naval Medical Center in Bethesda, MD with a GE Light Speed multi-slice helical scanner (General Electric Medical Systems, Milwaukee, WI). Using this cross-sectional modality 3D volumetric data was acquired which gave the possibility to do further post-processing with 3D virtual reconstructions (VoxelView, Vital Images, Inc., USA). After the radiological examination the gelatin blocks and the head models were dissected to analyze the bullets and the coin as an intermediate target.

Results and Discussion: With this model of an intermediate target simulation it was possible not only to demonstrate the "bullet-body (finger) interaction", but also to recreate the wound pattern found in the victim. It could be demonstrated that after the primary projectile has struck the simulation materials, that the bullet and the coin traveled through the tissue simulants.

This case demonstrates that using ballistic models and body-part substitutes can reproduce gunshot cases simply and economically, without conflicting with ethical guidelines.

Thus, model set ups with body-part substitutes, in many scenarios, are ideally suitable diagnostic aids for the purpose of solving reconstructive ballistic questions.

Forensic Science, Ballistic, Intermediate Target

G83 Two Gunshots to the Head: Suicide or Homicide? A Biomechanical Study

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This presentation will use of a finite element head model to demonstrate the lack of incapacitation following a shot with a .22 bullet, demonstrate the importance of crime scene elements, and discuss the consequence of three shots : one to the chest and two to the head.

A 20-year-old man was found dead in his bedroom by his younger brother, in the family house. Investigators found the body lying on the ground, near the bed, with a handgun and a box of bullets at his beside. Examination of the body showed three gunshot wounds: one to the chest and two to the head (between the eyes and above the right ear respectively). Entrance wounds were all contact wounds. The handgun was a single-shot revolver and the box of bullets contained "super x", .22 caliber bullets. Both the box of bullets and the handgun belonged to the victim who used to practice shooting in a club. Investigators found blood spots on the victim's bed aiming towards the cupboard where the deceased used to store his gun. Prior to autopsy, X-Ray examination of the body showed that Bullet A was stuck in the dorsum sellae, Bullet B in the left temporal bone, and Bullet C in the spine.

Bullet A penetrated the skull through the ethmoid, crossed the sphenoid sinus and ended in the Dorsum Sellae, close to the external part of the dura mater. This shot was associated with hemorrhage surrounding the two optic nerves. Bullet B penetrated the right temporal bone, crossed the brain and ended in the left temporal bone. Bullet C penetrated the sternum, touched the right side of the heart, crossed the aorta and the 11th dorsal vertebrae and ended in the medulla. Bullet A caused a blindness of the victim. Bullet B led to an immediate incapacitation of the victim. Bullet C caused an internal hemorrhage and a paraplegia. The possibility of a suicide was discussed. Bullet B leading to immediate incapacitation was certainly the last fired. Bullet C was possibly fired just before. But did bullet A led to an incapacitation of the victim or could he still rearm his weapon and shoot twice? The bullet did not penetrate the neurocranium, therefore there was no crush or stretch mechanism involved that could lead to incapacitation. But was a commotio cerebri generated? Commotio cerebri is a matter of sudden acceleration of the skull, which by means of inertia of the brain, results in wounding at coup and contrecoup. The .22 bullet has a mass of 2.5g, measures 5mm diameter and has a muzzle velocity of approximately 230 m/s. This results in an ultra short time span during which the projectile is acting upon the skull. Because of inertia, the skull will not essentially move during transfer of impulse. A high transfer of momentum and energy will result in perforation of the skull without acceleration of the head. To confirm this theoretical approach, a biomechanical study using a finite element model of the head and brain was done. The authors used the ULP model a validated finite element model developed in Strasbourg. The geometry of the inner and outer surfaces of the skull was digitized in the Strasbourg laboratory from a human adult male skull. The data given in an anatomical atlas by Ferner, et al. 1985 was used to mesh the human head using the Hypermesh code. The ULP model includes the main anatomical features: skull, falx, tentorium, subarachnoid space, scalp, cerebrum, cerebellum, and brain stem. Falx and tentorium have a layer of shell elements, skull is simulated by three-layered composite shell and the others were constituted by brick elements. This skull modeling permits simulation of the bone fracture introducing material discontinuity and then to analyze its effects on the head response in case of head impacts involving skull fracture.

The finite element mesh is continuous and represents an adult human head. The subarachnoid space was modeled between the brain and the skull to simulate the cerebral-spinal fluid. This space is constituted by a layer of brick elements and surrounds entirely the brain. The tentorium separates the cerebrum and cerebellum and the falx separates two hemispheres. A layer of brick element simulating the cerebral-spinal fluid surrounds theses membranes. The scalp was modeled by a layer of brick elements and surrounds the skull and facial bone. Globally, the present human head model consists of 11939 nodes and 13208 elements divided in 10395 bricks and 2813 shells. Its total mass is 4.5 kg.

This study shows a very slight movement of the head (less than 1mm) and no shearing injuries to the brain, providing no argument for an incapacitation of the victim following the shot of bullet A. The shot between the eyes could therefore have been the first, followed by a shot to the chest and a final shot to the head, the latter penetrating the two cerebral hemispheres and rapidly leading to death. The localization of blood spotting could be the consequence of a movement of the victim towards the cupboard to seek for his box of bullets to rearm his weapon. The victim was right handed. Important gunshot residues were found on both hands of the victim but mainly on the right hand. Investigators found that the victim was depressed because of personal and professional conflicts. The authors demonstrate that even if, initially, a homicide could be suspected, the possibility of a suicide cannot be excluded and is likely to be the manner of death in this case.

Head Model, Suicide, Incapacitation

G84 Application of Biomechanics to the Interpretation of Pathology Data

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The presentation will demonstrate how biomechanical analysis aids in the interpretation of pathology data resulting from a fatal fall.

A female university student was found dead in the early morning on the pavement four stories below her dormitory window. Both the university and the local police conducted investigations of the incident. An autopsy was performed. The autopsy report and photographs were provided to a consultant forensic pathologist in anticipation of wrongful death litigation. The complaint alleged that the student had accidentally fallen from a “loft” built by a third party and out of the bottom of the swung open window in the room. The “loft” was a bed raised upon two by fours, above the height of the window, to provide more floor space.

The body displayed multiple blunt trauma consistent with the fall, fractures of skull, spine, sternum and ribs with posterior displacement of the lumbar spine. Striated abrasions of the anterior inferior thorax and upper abdomen were prominent. The initial problem was how to correlate these injuries with egress from the window, the windowsill and a 30-inch concrete overhang located above the first story presumed by police as undisturbed.

A 3-dimensional mock-up of the loft and the window was created to investigate possible fall mechanisms. A subject with the same anthropometric characteristics as the deceased was labeled with reflective markers before testing began. Sagittal plane kinematic data were acquired and evaluated with a Peak Performance Technologies Motion Analysis System (Englewood, CO). The position of the whole body center of gravity (CG) was derived in the sagittal plane. There were no accidental fall scenarios that resulted in the CG extending beyond the window ledge; the only possible scenario involved the subject crawling over the ledge and out the opening. An evaluation of the fall trajectory was consistent with this latter scenario – there was no evidence of a push or other source of substantial horizontal velocity. The striated abrasions were consistent with the scenario supported by the biomechanical analysis. The fractures were also consistent with the fall distance.

In this case, the pathologist required further data than originally provided at autopsy to decipher the mechanisms of injury and death. The biomechanical analysis provided the necessary data to interpret the autopsy findings.

Biomechanical, Fall, Autopsy Interpretation

G85 Evaluation of Iron and Macrophages in Meninges of Infants Dying Suddenly and Unexpectedly

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The goals of this research project are to assess the significance of iron and macrophages in the leptomeninges and dura of infants and young children dying without evidence of head injury.

As potential pathological markers for occult head injury, the presence of iron and macrophages in the meninges of infants and young children who died of various causes and without evidence of head injury were evaluated. This preliminary study was conducted in order to develop criteria for assessing whether these markers are reliable indicators for head injury when identified microscopically in the leptomeninges and dura of infants dying suddenly and unexpectedly.

For this study the authors evaluated 18 deaths involving infants and young children ranging in age from 0 to 2 years old, with a mean age of 23 weeks. These included 4 deaths of Sudden Infant Death Syndrome (SIDS), 6 additional natural deaths, 2 unintentional deaths, 1 homicidal death, and 5 deaths due to undetermined causes. None of the cases had history or anatomic evidence of head injury. They selected 3 samples of leptomeninges from each infant and, in 12 of the 18 cases, one sample of dura. They examined tissue sections stained by hematoxylin and eosin (H&E), trichrome, an iron stain for hemosiderin, and an immunocytochemical stain for the macrophage marker, CD68. Under a 40x objective lens, they graded the microscopic features of each section semi-quantitatively for the presence and quantity of iron and macrophages. An "iron score" of 0 to 4 was ascribed to each section as follows: no staining for iron (score 0); occasional staining with most fields negative (score 1); focally abundant staining with most fields showing no staining (score 2); focally abundant staining with most fields showing positive staining (score 3); prominent staining throughout the section (score 4). Because there were 3 sections of leptomeninges examined, they calculated a "total leptomeningeal iron" score from 0 to 12 by simply adding the individual scores from each section of leptomeninges from the same case. As only one section of dura was examined, possible scores for the "total dural iron" ranged from 0 to 4. The "total macrophage" scores from both leptomeninges and dura were derived using the same procedures.

Eleven of the 18 cases showed a total leptomeningeal iron score of zero (of 12 possible); i.e., no iron was observed in any of the three sections. Four of the eighteen cases received a total iron score of 1/12; one case had a score of 2/12; one case had a score of 3/12; and one case had a score of 4/12. The dura (n=12) showed slightly higher total iron scores with only three of the 12 cases having total iron scores of 0 (0/4). Four of the cases had a score of 1/4; 3 cases had a score of 2/4; and one case each had scores of 3/4 and 4/4. All 18 cases had positive macrophage staining on all sections with individual section scores ranging from 2 to 4. The total leptomeningeal macrophage score was 8/12 on 2 of the 18 cases; 9/12 on 4 cases; 10/12 on 3 cases; 11/12 on 5 cases; and 12/12 on 4 cases. The dural macrophage score was also positive on all 12 cases, with scores ranging from 1 to 4. Three cases had a score of 1/4; 4 cases had a score of 2/4; 2 cases had a score of 3/4; and 3 case had a score of 4/4.

These data indicate that macrophages and small amounts of iron are a common finding in the leptomeninges and dura of infants and young children who have died suddenly and unexpectedly. However larger amounts of iron deposits may indicate either birth injury or occult traumatic brain injury. As a continuation of this preliminary study, we are evaluating additional cases of sudden infant deaths in order to establish a "normal" basis of iron and macrophages in the leptomeninges and dura of children with respect to age, birth history, and cause and manner of death. The ultimate outcome of these efforts is to develop objective criteria for markers of occult head injury.

Child Abuse, Traumatic Brain Injury, Meningeal Hemosiderin

G86 Extent and Distribution of Retinal Hemorrhages in Abusive and Non-Abusive Head Injury

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The goals of this presentation are to present the differences between the extent and the distribution of retinal hemorrhages found in abusive compared with non-abusive head injury.

Outcome: Attendees may know differences in retinal findings which can be used to help distinguish between abusive and non-abusive head injuries.

Observations from ocular examination of 80 head-injured infants and children identified a statistically significant greater extent and different distribution of retinal hemorrhages in those with abusive head injury compared with those with non-abusive head injury.

A prospective ocular and systemic study of infants and children was undertaken at the Southwestern Institute of Forensic Sciences between 1981 and 1989. The study group included 169 infants and children. Death was attributed to head injury in 80 of the children. Review of investigations, medical records, and follow-up investigations was used with gross and microscopic findings from autopsy examinations which included ocular examinations. Most of the deaths were attributed to abusive head injury, 62 cases, while 18 of the deaths were attributed to non-abusive injury. The latter included five children involved in motor vehicle collisions. Five more were run over by motor vehicles. One was thrown from a motorcycle. Four children fell: one went out a second story window to a concrete patio, one fell from stairs to a conglomerate patio, the third was standing on a washing machine and fell onto his head, the fourth was standing on tall bed above a concrete floor and fell onto his head. One child was riding on a bicycle with an adult who fell on top of her when the bike hit an obstacle. A child's stroller rolled downhill and collided with a wall; a respiratory tract infection contributed to that death. The eighteenth child suffered a gunshot wound of the head and the ipsilateral eye was examined; no hemorrhages were seen in that eye.

Retinal hemorrhages were found in nine of the eighteen children with non-abusive injuries (50%) compared with 53 of the 62 children with abusive head injuries (85%). The Yates-corrected p value was 0.004 with Greenland, Robbins 95% confidence limits 1.07 < Relative Risk <2.74. Looking at the presence of retinal hemorrhages at the retinal periphery, hemorrhages were found in three of the 18 with non-abusive injuries (17%) compared with 47 of the 62 with abusive injuries (76%). The p value was <0.001 with confidence limits of 1.60 < RR < 12.90. Hemorrhages at the macula were found in six of the eighteen children with non-abusive injuries (33%) while 48 of 62 with children abusive injuries (77%) had such hemorrhages. The p value was 0.001 with confidence limits of 1.19 < RR < 4.53. Posterior hemorrhages near the optic disk were found in nine of eighteen children with non-abusive injuries (50%) and 50 of 62 with abusive injuries (77%). The p value was 0.02 with confidence limits of 1.00 < RR < 2.60. Looking at the presence of hemorrhages in the superficial retina, hemorrhages were found in four of the 18 children with non-abusive head injuries (29%) while 47 of the 62 children with abusive head injuries (76%) had such hemorrhages. The p value was <0.001 with confidence limits of 1.42 < RR < 47.85.

Microscopic grading of the extent of retinal hemorrhages allowed further differentiation between the two groups. Hemorrhages of 4+ markedly distorted the retinal architecture, 3+ slightly distorted the retinal architecture, 2+ were visible at low power (20x), and 1+ were only visible at high power (100x). The distribution of the hemorrhages was described with reference to the ora serrata, the equator, the macula, and the posterior retina including the disk at the nasal and temporal sides of pupil-optic nerve sections of the eye. The hemorrhages were also described with respect to the superficial and deep retina as well as subretinal hemorrhages.

Only one child among non-abusive head injury group had as much as a 3+ hemorrhage and that in one eye only. It was found at the subinternal limiting membrane (superficial retina) at the temporal equator. The child was unrestrained sitting on the lap of a back-seat passenger in a car broad-sided in a motor vehicle collision. The child also had 2+ hemorrhages at the macula, the posterior, and both sides of the ora serrata. Two had more extensive 2+ hemorrhages. One of these children had 2+ hemorrhages extending from the posterior retina to the equator in one eye, the other eye was uninjured. A car rolled over this child's head at low speed. The other child with slightly more extensive hemorrhages had them present posteriorly and extending to the equators bilaterally; hemorrhages were also seen at the ora serrata in one eye. This child had an unwitnessed fall while playing on concrete stairs over a conglomerate patio. The patterned injuries from the conglomerate were helpful in reconstructing the event. All six of the other children with hemorrhages had 2+ hemorrhages in at least one area, usually the posterior or equatorial retina. The superficial retina was involved infrequently.

In contrast, children with abusive head injuries had more extensive retinal hemorrhages which more often were found in the superficial retina and the retinal periphery. Hemorrhages graded as 3+ and 4+ were found in 38 of the 62 children with abusive injuries (61%) as opposed to 1 of 18 of those with non-abusive injuries (6%). The children with at least 2+ hemorrhages tended to have them more widely distributed and to involve the superficial retina more than the children with non-abusive injuries. There was only one child with but a single microscopic 1+ posterior hemorrhage; nine had no hemorrhages.

The presence and extent of superficial and peripheral hemorrhages were good discriminators of abusive head injuries when present. No 4+ hemorrhages were seen in non-abusive head injuries in this population. Only one 3+ hemorrhage was seen in an uncontroverted non-abusive injury death. Only three children with non-abusive injuries had hemorrhages at the retinal periphery. Two were unrestrained back-seat passengers in motor vehicle collisions; the third fell from concrete stairs.

Extensive superficial and peripheral hemorrhages are part of the constellation of abusive head injuries. The absence of such hemorrhages increases the need to identify the other parts of the constellation before making a diagnosis of abusive head injuries.

Retinal Hemorrhages, Abusive Head Injury, Retinal Periphery

G87 Perimacular Retinal Folds and the Shaken Baby Syndrome: Critical Appraisal Testing of the Current Medical Literature

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The goals of this presentation are to discuss the limitations of the current medical literature regarding specificity and presumptive causal mechanism of perimacular retinal folds in Shaken Baby Syndrome.

Perimacular retinal folds accompanying retinal hemorrhages in childhood head trauma are considered virtually pathognomonic of Shaken Baby Syndrome by many ophthalmologists, pediatricians and forensic pathologists. The postulated mechanism is that these traumatic retinal findings result from vitreoretinal traction during cycles of acceleration-deceleration (shaking). Bilateral severe retinal hemorrhages and perimacular retinal folds observed clinically had been attributed to abusive head trauma in a 14-month-old child and a 7-month-old infant with severe acute intracranial injuries. Forensic autopsies confirmed the ocular findings but subsequent investigations concluded that the fatal injuries were non-intentional from static or quasi-static loading.

Design: Case reports, observational

Testing: Critical appraisal testing was performed on 35 medical journal articles and book chapters published from 1966-2001 that discussed presence, specificity and/or causal mechanism of perimacular retinal folds in abusive childhood head injuries.

Results: Publications discussing specificity or formative mechanism of perimacular retinal folds concomitant with retinal hemorrhages observed in childhood abusive head trauma consist of case reports (2), clinical and/or autopsy case series (8), unsystematic review articles (8),

and book chapters (2). Two case controlled studies were found; however, one exhibited bias in control selection and the other only discussed the postulated formative mechanism. The remainder of the publications indicated that perimacular retinal folds were present in some cases of childhood abusive head trauma.

Conclusions: Perimacular retinal folds accompanying retinal hemorrhages in childhood head trauma cannot be regarded as diagnostic of Shaken Baby Syndrome based on the current medical literature due to study type, design bias and lack of appropriately controlled studies. Well-designed clinical and autopsy studies with suitably matched controls must be done before causative mechanism and specificity can be assigned to perimacular retinal folds when observed in children with acute intra-cranial injuries.

Perimacular Retinal Folds, Shaken Baby Syndrome, Child Abuse

G88 Neuropathology of Abusive Head Injury

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The goals of this presentation are to 1) appreciate the differences between traumatic and hypoxic diffuse axonal injury; and 2) to understand the basis of traumatic unconsciousness.

This presentation will describe the neuropathology of a large series of abusive head injury in infants and young children as well as a group of control cases. The brains were examined by a forensic neuropathologist and subjected to a protocol for sectioning with sections from 16 sites including parasagittal white matter, 3 levels of corpus callosum, brain stem, cerebellum, distal optic nerves, and cervical spine. Sections were stained by H & E and β-amyloid precursor protein (βAPP) and graded for the presence of βAPP reactivity using a 4 grade classification. The abusive head injured children ranged from 3 weeks to 8 years old and the controls were of similar ages. Head injury is the most common cause of death in children dying from inflicted injuries. There is great interest in understanding the neuropathology in young children with abusive head injuries and correlating the pathology with the biomechanics of the injury. Clinically, these children most often present an immediate change in their level of conscious following injury which may consist of impact, shaking, or a combination of the two mechanisms. These mechanisms have been proposed to cause rotational or angular acceleration injuries of the brain accounting for the presence of thin layers of subdural hemorrhage, retinal hemorrhages, and brain swelling in those who survive some period. The question of whether traumatic diffuse axonal injury is the basis of the loss of consciousness (traumatic unconsciousness) and other findings in these children is an important issue. A recent study by Geddes (Geddes et al, Brain 2001, 124:1299-1306) reported that severe traumatic axonal damage is rather rare in infant abusive head injury unless there is considerable impact and that the diffuse brain damage responsible for loss of consciousness in most cases is hypoxic rather than traumatic. This presentation will demonstrate findings from a large series of abusive child head injuries which finds that traumatic diffuse axonal injury occurs more frequently than reported by Geddes. It is important to recognize hypoxic brain damage and to distinguish those changes from traumatic diffuse axonal injury as frequently the two findings occur together and these distinctions will be discussed. The study also found differences in the appearances of acute traumatic DAI and older injury as demonstrated by βAPP.

Abusive Head Injury, Traumatic Diffuse Axonal Injury, Child Abuse

G89 Pediatric Injury Evaluation: A Clinical Forensic Pathology Program in Georgia

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The goals of this presentation are to describe the authors' consultative experience in the evaluation of physical injury in children.

Child abuse is a common cause of physical injury in children. It is estimated to occur in one million children each year in the United States. The majority of cases of child abuse do not result in fatal injury. It frequently becomes the responsibility of a medical professional to recognize and accurately interpret the nature of injuries in suspected child abuse. An accurate diagnosis is critical in protecting the child and in providing medical-legal information. Thus, it is necessary to develop expertise in the field of child abuse through extensive experience or specific training in a forensic medicine program. The authors have established a child abuse investigative support center to address the critical need to accurately interpret injuries in children and to train more forensic pathologists in this field.

The Child Abuse Investigative Support Center (CAISC) is a clinical forensic medicine program at the Georgia Bureau of Investigation (GBI) Division of Forensic Sciences (DOFS) that was established in August 2000. The center was established to address the needs of agencies involved in investigations of child maltreatment. The center performs dual functions of providing consultative assistance and educational training throughout the state of Georgia. Physician members of the center consist of forensic pathologists of the GBI Medical Examiner's Office who possess expertise regarding injury causation. They are requested for expert consultation in suspected child abuse cases and are available for court testimony. An investigative division of the center provides consultations by criminal analysts who possess expertise in reference to crimes involving children. The center is also an integral part of the forensic pathology fellowship at the GBI and serves to train fellows in the field of child abuse and neglect. The center operates under state and federal grants and provides services free of charge to consulting agencies.

Since its inception, 103 cases (mean age 2.7 yrs; range 19 days to 16 yrs; 58M:45F) of pediatric, predominately non-fatal, injuries have been referred to the center for evaluation. Various law enforcement agencies presented the majority of the cases and the Department of Family and Children Services requested the center's service in 33% of the cases. The interpretation of injuries was based upon the evaluation of pertinent documents depicting and/or describing the injury. These included medical records, photographs, case files and radiographs. In four instances the object implicated as the source of the injury was evaluated and on two occasions the acutely injured child was evaluated while hospitalized.

A spectrum of injuries was represented in the cases we evaluated including bone fractures (35%), dermatologic injuries such as bruises and abrasions (31%), burns (24%) and cranial-cerebral injuries (22%). Only 3 cases involved injuries to regions involving or near the genitalia and were presented to evaluate for possible sexual abuse. Overall, 56% of the injuries were interpreted as abusive in nature. Nine cases were interpreted as representing discipline but not clearly abusive in nature and injury causation was inconclusive in eight cases. In the majority of cases a written consultation report was provided at the time of the evaluation. So far, courtroom testimony has been necessary in only three cases.

This review of the child abuse investigative center has yielded useful information. The authors identified that the service is particularly of value to rural areas that lack the resources and medical expertise that are typically available in large metropolitan areas. They recognized that

in many cases there is a long delay in the investigation and prosecution of child maltreatment. Their goal is to improve marketing of their services and to evaluate more acutely injured children. They have experienced difficulty in interpreting injuries on some occasions because of sub-optimal documentary material (i.e. photographs).

Overall, this study reveals that forensic consultative teams can perform several functions related to child abuse crimes: 1) provide expertise in evaluation of the injuries, 2) provide training opportunities in the field of child abuse, 3) provide expert court testimony.

Child Abuse, Clinical Forensic Medicine, Georgia Bureau of Investigation

G90 Physical Findings in Confessed Homicidal Suffocation of Children: A Case Series

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The goals of this presentation are to review the physical findings, and lack thereof, in homicidal suffocation of young children.

Investigation of death and injury in children requires attention to detail of subtle injury patterns and careful, thorough case history review and scene investigation. As seen in various individual anecdotal cases, intentional suffocation of children may have relatively few findings. To have a more comprehensive understanding of the physical findings in suffocation, the authors undertook a retrospective review of cases of confessed suffocations of children age 5 years or less in which the first author performed the post-mortem examination or a living forensic examination prior to the child's death. In all cases presented herein, a parent entered a guilty plea in criminal court. In four of the five events, the parent gave a formal confession to law enforcement, and later entered a guilty plea in criminal court. In the 5th event, the mother allegedly confessed to cellmates, and entered an Alford Plea in criminal court. The case series consists of 8 children age 5 or less who died at the hands of 5 perpetrators. In 2 of the events, multiple children were killed on the same night.

Event #1 - Fraternal twins, age 6 weeks were reportedly discovered dead in their crib by their parents one morning. Despite initial denial of the parents of use of the in-home apnea monitors, the investigators collected them at the time of the initial scene investigation. Post-mortem examination revealed no injuries whatsoever on the boy, and a small superficial abrasion on the eyelid of the girl. Downloading of the apnea monitors revealed a record of the double homicide. Confronted with the evidence, both parents confessed to suffocating the infants with pillows. The father told investigators that he did it because he "couldn't take" the continuous crying of both infants. Both entered guilty pleas and accepted "life" sentences. Interestingly, during a previous marriage five years earlier, the mother had "lost a baby to SIDS."

Event #2 - A previously healthy baby girl was admitted to the hospital for a reported apneic episode at 4 months of age. Over the next four months, she was repeatedly admitted to the hospital for recurrent apnea, and underwent a Nissn fundoplication in an attempt to alleviate GE reflux thought to be contributing to the apneic events. At eight months of age, the infant was admitted in full arrest following another in-home apneic event. At the request of the treating physicians and police, she was evaluated as a "forensic medicine" case at the time of the last admission. There were no injuries to the baby at the time of the final admission, and there had been no injuries documented on previous admissions for apnea. She did not recover, and died 2 weeks later. The immediate cause of death was hypoxic encephalopathy, but the underlying cause and manner remained unknown. Later, the mother (a juvenile) spontaneously came forward and admitted to repeatedly suffocating the baby, who was the alleged result of an incestuous event. The case was resolved in juvenile court.

Event #3 - A four-month-old infant was brought to the OCME as a "suspected SIDS" case after being found dead on a couch. At autopsy, findings included a faint abrasion surrounding the ala nasa, erythematous areas over the neck, and a geographic pattern of cutaneous petechiae involving the head, neck, and right upper extremity. The investigators re-interviewed the mother following the preliminary autopsy findings report. The mother, a teenager, admitted to suffocating the baby against her chest and shoulder to stop his incessant crying. She avoided a jury trial by pleading guilty to reckless homicide, and was sentenced to five years.

Event #4 - A two-year-old boy with diagnoses of hyperactivity and probable autism was found dead following a nap. His position at body discovery was described as prone, with his head "face down" in the pillow. The child had no petechial hemorrhages, no intraoral trauma, and no identifiable injuries to any body surface. The preliminary autopsy report listed "no anatomic cause of death." Two days later, investigators received a call from a relative claiming to be an eyewitness to the child's homicidal suffocation. The father admitted to suffocating the child by holding his face into the pillow "until he went to sleep." The case was adjudicated without a trial.

Event #5 - Three young girls (ages 5 years, 28 months, and 17 months) were allegedly discovered dead together in a standard adult bed. Complete autopsies and detailed scene investigation and case history review failed to reveal any natural disease, environmental hazard, or toxicologic substance to explain their deaths. All facial trauma was mild, and increased with the age of the child. But even the 5 year old displayed only small maxillary gingival contusions and abrasions, rare bulbar conjunctival petechial hemorrhages. The girls' baby sister (age 2 weeks) had died 4 ½ months earlier - death in that case was initially attributed to SIDS, although a disclaimer had been included in the final opinion, stating that the age was not "typical." The three older girls' deaths were attributed to suffocation, with the manner ascribed to homicide. Fifteen months after the deaths, the mother pleaded guilty to four counts of murder by means of an Alford Plea.

In reviewing cases of pediatric death, all aspects of the investigation must be integrated to draw conclusions regarding cause and manner of death. The physical findings of asphyxia (accidental or homicidal) are often subtle, and may range from no evidence of injury to minor facial trauma. Additional clues to the cause of death may be found in a careful case history review and integrated scene investigation. These findings may initially seem to be small details that seem "out of kilter," and thus direct the investigation further. In many cases however, because of the paucity of findings in these cases, only admission by the perpetrator will allow determination of a homicide.

Child, Suffocation, Homicide

G91 Escalated Homicide: Cultural Changes Produce a New Type of Child Death

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The goals of this presentation are to present results from a study of abuse related child deaths in Memphis, TN, using hospital records, Medical Examiner reports, homicide police investigation files, and court transcripts; to evaluate the validity of the battered child syndrome and the impulsive homicide as a framework of analysis for child abuse related fatalities; and to propose the additional analytical category of escalated homicide to the existing conceptual tools of analysis.

The clinical tableau of abuse leading to child death has traditionally been classified as either manifestations of the battered child syndrome, or as evidence of impulsive homicide. The battered child syndrome first described by Tardieu[1] in the 1860s in France, and again by Kempe[2] in the 1960s in the USA typically involves a long term pattern of physical abuse creating a series of injuries over time, often coupled with symptoms of deprivation and neglect. Impulse homicide is presented as a single event of lethal violence, most often from blunt trauma injuries, with little or no evidence of any sequence of severe prior injuries or deprivation[3] .

It is the contention of this paper that, although both types are valid and useful description of abuse, they do not provide an adequate explanation for all cases. As a result of the studies, the concept of escalated homicide is introduced as a tool for assessing, recognizing and describing the changing nature of patterns of child abuse.

Medical and forensic treatment of violence against children gives primacy to physical injuries, and is essential to the understanding, diagnosis and documentation of abuse. But looking at the tree should not hide the forest. Circumstances produce injuries, not vice versa. The physical injuries of child abuse occur in a social/cultural context, for the most part a household, or care facility, the structure, composition and function dependent upon larger social forces. They are places where complex and often dysfunctional interpersonal relationships are acted out. Unfortunately, these environments are also the first lines of failure under stress, and their weakest and most silent members often the first victims.

This study integrates the forensic and social findings in such a way as to allow for the discrimination of the social and cultural forces leading to the abusive event. Of the 30 cases reviewed as part of the initial study and drawn from a prior study of 1,451 child deaths investigated by the Medical Examiner in Memphis, TN, in the past ten years, 5 were categorized as impulse homicides, 6 as battered child cases, and 12 as escalated homicides. One case involving a 20 month-old girl abused separately by mother, showing battered child signs, and mother's boyfriend, killing the child as an escalated homicide was classified as a combination example. Finally 5 cases were atypical in regard to perpetrators and setting.

Of the 12 escalated homicides, eleven involved the victim being murdered by the victim's mother new paramour, and only in one case was the child killed by the biological father. Typically, the ultimate assault takes place within a fit of anger deceptively reminiscent of the impulsive homicide. The pathgnomonic differences are definite. What differs is the fact that in all cases there were premonitory and warning signs of abuse, ranging from observed behavioral responses of the young victim towards the aggressor, to unexplained bruises, bite marks, black eyes, and even unexplained and/or unobserved broken bones were present. Although escalated homicides reveal patterns of injuries over time, the motivation leading to the production of injuries differs because the relationships of authority vary between abused and abuser.

In a battered syndrome context, relations of authority are legitimate, or perceived as legitimate, and articulated in terms of parental rights. Typically a father takes over the task of disciplining a child either for the general purpose of "showing him the way," or for a specific purpose such as toilet training. Most often, physical punishment is not secretive, and the level of external interference limited. In instances of escalated homicide, boyfriends do not possess any legitimate authority over their girlfriends' kids, and are often being reminded so. Here, physical abuse is hidden and excuses are made to explain the injuries and scars. Most importantly though, beating the child has nothing to do with disciplining him, or teaching him to become a man. In most cases, it is a venting of anger, frustration, and resentment over the current living situation, and ill feelings towards their partners. This gradual escalation of frustration and anger, generated by household dynamics leads to repetitive acts of increasing violence eventually culminating in a deadly blow.

Recognizing variation in the behaviors that create child abuse is the first step in establishing profiles of perpetrators of violence against children. The forest is made up of a variety of trees.

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Battered Child Syndrome, Impulsive Homicide, Escalated Homicide

G92 Magnetic Resonance Microscopy as an Adjunct in The Evaluation of Infant Rib Fractures

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The purpose of this presentation is to explore the use of magnetic resonance microscopy in the evaluation of infant rib fractures, and to compare the findings with traditional anterior-posterior radiography, axial radiography, and histologic evaluation.

Following the second infant death in a family, the autopsy findings in the first infant death were reviewed at the request of the Naval Criminal Investigative Service (NCIS). Original autopsy radiographs from the first infant revealed multiple healing fractures that had previously been overlooked. Exhumation was recommended, and permission for exhumation ultimately granted. Re-interview of the mother, coordinated with the timing of the exhumation, prompted a confession as to how the children were killed.

The body of the first infant was exhumed, and healing posterior rib fractures were resected *en bloc* with the adjacent vertebral body and contralateral normal rib. Axial radiographs of each vertebra-rib pair were obtained. Magnetic resonance microscopy (MRM) was performed on each sample. Specimens were whole-mounted and cut in the axial plane for histology.

MRM provides microanatomic images of both hard and soft tissue. Images were acquired on a Bruker-Biospec system operating at 7 Tesla (300 MHz for ^{1}H). The 3-D images were acquired with a fast spin echo imaging sequence. The datasets were processed for visualization using the AVS/Express development environment, and 3-D images were rendered using a direct composite algorithm.

The ability to view and rotate the fractures in 3-D space allowed visualization of fracture morphology in ways unobtainable by standard radiography or histology. Fracture dimensions, the fracture line, the uninjured bony cortex, and the trabecular bony architecture were readily discernable by MRM. Histologic examination provided details of various aspects of bony healing that were not readily visible by MRM.

While MRM is currently an expensive imaging modality, limited to a few institutions and restricted to specimens of small size, it has great potential as an adjunct in the evaluation of healing fractures. With continued advances in technology and computing power, MRM will likely become widely available as an adjunct to, or perhaps a replacement for, histologic examination of some specimen types.

Infant, Magnetic Resonance Microscopy, Fracture

G93 Mother/Infant Co-Sleeping/Bed-Sharing and Sudden Infant Death Syndrome

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The goals of this presentation are to present to the forensic community a review of mother-infant co-sleeping and bed-sharing practices; to differentiate "safe" from "unsafe" co-sleeping conditions; to understand that, when done safely, bed-sharing/co-sleeping may actually be protective against death due to SIDS.

Deaths which remain unexplained after a thorough medicolegal death investigation can be the source of great frustration for forensic pathologists. Several categories of unexplained deaths are known within the forensic community, but for many, no category of deaths is as frustating as Sudden Infant Death Syndrome (SIDS) cases. SIDS remains one of the great mysteries within the world of medicolegal death investigation. As such, theories as to the underlying cause or causes of SIDS have been and remain plentiful. Many risk factors have been identified, but most forensic pathologists know of several cases of SIDS occuring in infants with no identifiable risk factors. Whether or not a particular risk factor actually plays a role in SIDS can be controversial, and the implied blame that can accompany the identification of a particular risk factor can lead to feelings of guilt in the parents or other caregivers.

Within the forensic community, one of the most widely acknowledged *potential* causes of a SIDS-like death is overlay, an accidental asphyxial death related to another person lying on top of or wedged against the infant. Consequently, whenever an infant death occurs where the infant is sleeping with or next to another individual, it is important to consider the possibility of death by overlay. Depending on the forensic pathologist certifying such a death, a case where overlay is a possibility (but not necessarily proven) may be certified as a death due to overlay, SIDS, undetermined causes, or some other variation.

Because of the potential risk for overlay, there has recently been a national campaign against "co-sleeping/bed-sharing" with infants. Although the prevention of overlay deaths is an appropriate and worthwhile goal, the unconditional implication that any form of adult-infant co-sleeping is harmful is inappropriate, untrue, and not supported by scientific research. Part of the problem clearly stems from a lack of understanding of the terminology used in this debate. For example, "bed-sharing" is a form of co-sleeping, but there are other forms of co-sleeping that do not involve bed-sharing.

Another very important factor that is frequently overlooked is the nature of the maternal-infant relationship, including whether or not the mother is breastfeeding her infant. With respect to maternal-infant wake/sleep patterns, maternal and infant attentiveness and response, and similar parameters, it is inappropriate to consider the breastfeeding mother-infant night-time relationship equivalent to a nonbreastfeeding mother-infant relationship. Add to the latter relationship such factors as maternal drug or alcohol use and inappropriate sleeping conditions (such as a sofa) and it becomes clear that there are two ends of a spectrum when it comes to co-sleeping (and bed-sharing). At one end, there are the breastfeeding mothers who tend to be very attentive to their babies' needs, while at the other end, there are the mothers who are not so attentive and may, in fact, be careless. In other words, there are unsafe ways in which to co-sleep/bed-share, and there are safe ways in which to co-sleep/bed-share. A categorical condemnation of every form of co-sleeping/bed-sharing may indeed prevent accidental overlay deaths in certain infants; however, such a policy might also adversely affect infants who are otherwise a part of a safe co-sleeping/bed-sharing relationship. Data from previously-reported and ongoing studies of mother-infant sleep patterns will be presented, showing that in otherwise safe sleeping conditions, co-sleeping/bed-sharing may actually protect against SIDS. As the debate continues within the forensic community about how to certify SIDS-like cases in the setting of co-sleeping/bed-sharing, it is important that forensic pathologists be aware of all available information regarding this topic.

Sudden Infant Death Syndrome, Co-Sleeping, Bed-Sharing

G94 Death Certification in Sudden Infant Death Syndrome and Related Infant Deaths

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Upon completion of this presentation, attendees will become familiar with a newly-proposed method for certifying SIDS and SIDS-like deaths and to become involved in the dialogue concerning certification of such deaths.

For an infant death to be considered due to "Sudden Infant Death Syndrome" (SIDS), a complete death investigation and autopsy, including toxicology, must be negative, and the infant must be less than 1-year-old. The "classic" SIDS scenario involves an infant, typically less than 6-months-old, who is found dead in his/her crib. Known risk factors include low socioeconomic status, parental smoking, prone sleeping position, formula-feeding, and a history of prematurity. Within the past 10 years, a campaign by public health agencies and pediatricians to advocate a supine sleeping position has purportedly resulted in fewer SIDS deaths. Amongst forensic pathologists, a trend has been noted that there are fewer and fewer "classic" SIDS cases. Whether this is related to the sleep position campaign, better information-gathering, different methods of death-certification, or a combination of these is not known. Be-that-as-it-may, many SIDS-like cases occur where certain known risk-factors are clearly identified. A potentially unsafe sleeping environment is a factor that is increasingly being recognized as a possible cause in some of these deaths. Ultimately, these and the other known risk factors for SIDS may cause potential interpretive difficulties for forensic pathologists, thus creating death certification dilemmas.

A recent proposal in the National Association of Medical Examiners' "A Guide For Manner of Death Classification" (in draft form) relates to the certification of SIDS and SIDS-like deaths. In this proposal, it is suggested that various items from the scene investigation/history which cause potential interpretive difficulties (such as bedsharing or being found face down on a soft pillow) should be listed in part II of the death certificate, with part I listing "Sudden Infant Death Syndrome" or "Findings consistent with SIDS." In this presentation, a series of cases will be presented, ranging from classic SIDS to accidental overlay, with many cases including one or more items causing interpretive difficulty. In each, the circumstances of death, the autopsy findings, and the death certification using the newly-proposed method will be presented. Discussion will include the potential controversies concerning which items/risk factors warrant inclusion in part II of death certificate; other options for relaying information about these items/risk factors will also be addressed. Through the presentation of a series of example cases, the authors hope to foster more discussion and dialogue about this very important issue.

Sudden Infant Death Syndrome, Death Certification, Cause of Death

G95 Pediatric Mortality in the Cook County Medical Examiner's Office, 1 to 4 Years: 2000-2001

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The goal of this presentation is to present statistical data on causes of death in the pediatric group between 1 and 4 years of age in the Cook County Medical Examiner's Office cases. The authors examined case records of the Cook County Medical Examiner's Office (CCMEO) over the two-year period from January 1, 2000 through December 31, 2001.

The number of deaths investigated by CCMEO between 1 to 4 years of age totaled 148 cases in the two-year period. Eighty-six cases involved males and sixty-two involved females. Specific causes of death were identified in 97% of all cases. Leading causes were accidental injuries, natural deaths and homicides. This report highlights the impact of violent death mortality in early age. Accidental injuries are related to automobile accidents, pedestrian injuries, drownings, asphyxias, house fires, falls and overdoses. In natural deaths, diseases of the heart and infection predominate. Infection includes bronchopneumonia, lobar pneumonia and sepsis. Homicides include blunt trauma injuries, gunshot wounds, stab wounds, drowings, suffocations, starvations and arson fires. The cause of death was undetermined in 3% (5/148) of the cases. By manner of death, there were 70 accidents, 42 naturals and 27 homicide cases, respectively. Undetermined manner is 6% (9/148) of all cases. Those that were of undetermined manner included two cases of fire and two cases of drowning, and 5 cases where the cause of death was undetermined.

Mortality, Cook County, Medical Examiner's Office

G96 Suicide in Children: A 12-Year Retrospective Study

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Ssuicide in pre-adolescent children (ages 6-12), although unusual, present unique causes, risk factors and potential prevention strategies which serve a specific public health need in the prevention of this unique form of violence.

Methodology: Case files for all deaths in children ages 6 to 12 ruled suicide or undetermined from the Milwaukee County Medical Examiner's computerized case records were reviewed from 1989 through June 2002. In addition, case files for all adolescent suicides reported in the corresponding time period were reviewed. Detailed demographic information, social history, behavioral history, and death scene investigation, autopsy findings, individual and family medical and psychiatric conditions and characteristics has been abstracted and analyzed. Review of the pertinent medical and psychiatric literature, including collaboration with a pediatric psychiatrist treating children and survivors of suicide attempts has been undertaken.

Results: The authors identified trends, frequently occurring factors and consistent findings within characteristics, and in doing so a way to observe the predictive indicators for suicide "prone-ness" in any or all cases. Specific factors will include behavioral factors such as previous suicide attempts, verbalization of suicidal ideation, the presence of depression, parental and family psychiatric history, impulse control history, history of abuse and other factors. Medical factors include: substance abuse disorders, attention deficit hyperactivity disorder, enuresis, parental and family medical history.

Discussion: The Milwaukee County Medical Examiner's office has identified an issue with suicide in children, ages 6-12 and has determined that this is a public health significance do to it being such an unusual phenomenon. Although suicide in the childhood age group is a rare phenomenon, it is encountered in normal practice of medical examiners and child psychiatrists. Characteristics of suicide in children are different than those found in the teenager age group. Identification of the risk factors, personality and behavioral characteristics in completed suicides will provide a framework for the development of prevention strategies. The barriers to consistent death certification and reporting across jurisdictions will also be evaluated, in an effort to develop strategies to increase consistency and improve data comparability and meta-analysis capacity across multiple jurisdictions.

Suicide, Childhood, Pediatric

Physical Anthropology

H1 Expressions of Handedness in the Vertebral Column

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The observer of this poster will learn the usefulness of a new technique to determine handedness from the seventh cervical, thoracic, and lumbar vertebrae.

The goal of this study is to evaluate a new approach to determining handedness by looking at laterality of the spinous processes of the vertebral column. The spinous process of the vertebra is a potential indicator of handedness as it is the attachment site for a number of muscles and ligaments associated with support and movement of the upper limb, and repetitive and preferential use of one arm over the other may be reflected in a deviation of the process to either the left or right of the midline. The major muscles of the vertebral column associated with positioning of the pectoral girdle and movement of the arm include the trapezius and latissimus dorsi. The trapezius muscle attaches to the spinous processes of C7-T12 and the latissimus dorsi T7-L5. This research specifically focuses on these vertebrae.

Previous anthropological research on handedness has traditionally concentrated on observable bone indicators of musculoskeletal stress such as humeral asymmetry (the robusticity of muscle attachment sites and long bone length), differences in the length of paired arm elements, clavicular length and robusticity, scapular joint surface changes, and metacarpal size differences. Additional relationships explored include bone density and trabecular patterning, jugular foramen size and humeral expressions of the intertubercular sulcus, and nutrient foramen. These relationships have been investigated by comparing the degree and/or size of traits as expressed in the paired right and left elements.

General observations on the deviation of the spinous processes from the midline have been made in both the chiropractic and clinical literature (Oliver and Middleditch, 1991). Chiropractic research by Redmond (1996) on unassociated and demographically unknown lumbar vertebra found the majority of spinous processes in his sample generally deviated to the right of the vertebral midline. He suggests this may be a consequence of unequal stress being applied to the processes from muscular strength differences associated with arm dominance. Additionally, the role handedness plays on the overall shape of the vertebral column has been clinically observed by Hollinshead (1982) who notes that some left-handed individuals display lateral curvature with the convexity of the curve to the left.

For the purpose of this research, vertebrae of both males and females from the William M. Bass Donated and Forensic Skeletal Collections were examined. These skeletons are of individuals with known handedness information. In human populations, the majority of individuals are right-handed, with preferential left-handedness ranging between 10-13% (see Steele 2000 for a review). The distribution of right- and left-handed individuals in this dataset is reflective of the distribution in the general population. Photographs were taken of the superior view of the vertebrae and a deviation of the spinous process from the vertebral midline was measured in degrees.

Preliminary results indicate a majority of individuals show an observable deviation from the midline of the spinous process to the right, an anticipated finding since the majority of individuals are right-handed. Further research may indicate the (f) utility of this technique in the determination of handedness for forensic applications.

Handedness, Spinous Process, Vertebral Column

H2 Skull vs. Postcranial Elements in Sex Determination

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This poster will provide participants with information, derived from the Forensic Anthropology Data Bank, enabling them to make informed choices about which skeletal elements provide the most reliable indicators of sex.

When performing a forensic anthropological analysis, sex estimation is one of the first and most important steps. A visual analysis of the pelvis is an excellent indicator of sex. However, not all forensic cases provide the luxury of a complete skeleton. If an individual is left exposed in an outdoor context, not all elements may be recovered due to various taphonomic processes. Some cases may only consist of a cranium, others just a few postcranial bones. What to use when only the skull and long bones are present, in the absence of the pelvis, is of some debate. Bass (1995) and Byers (2001) indicate that the skull is the second best area of sex determination, the pelvis being the most reliable. This perception persists despite evidence to the contrary (Berrizbeitia 1989, France 1998, Ousley 2001, Robling and Ubelaker 1997). France (1998), while noting that the cranium is still often presented as the second best indicator of sex, reviews evidence showing that postcranial estimates are generally superior.

The purpose of this study is: 1) to test the hypothesis that the skull is better than postcranial elements using a recent forensic sample, 2) establish a hierarchy of sexing reliability by element, and 3) investigate race variation in sexual dimorphism.

The Forensic Data Bank (FDB) is unique in the fact that it continues to store data from individuals derived from the populations for which it is used, and provides an opportunity to explore postcranial sex discrimination techniques. Samples used in this study are comprised of 360 adult individuals, 90 Black and 270 White, with post 1929 birth years. Standard measurements were obtained for these individuals, 24 cranial, 10 mandibular, and 44 post-cranial (Moore-Jansen, Ousley, and Jantz 1994). Mahalanobis distance, sectioning points, and expected classifications were computed for each individual measurement. A stepwise discriminant function analysis was performed on the cranium, mandible and each postcranial element in order to find the best subset of variables for a discriminant function. A MANOVA test was performed to test race variation in sexual dimorphism

The humerus, clavicle, femur, scapula, tibia, radius, and ulna, respectively provided higher classification rates than the cranium in Whites. In Blacks, the humerus, clavicle, innominate, femur, and scapula, respectively yield higher classification results than the cranium. The fibula, calcaneus, mandible, and sacrum all present lower classification results than the cranium for both Blacks and Whites. The innominate presents as the third best element for sexing in Blacks and ranks below the cranium in Whites. In addition, the tibia ranks above the cranium in Whites and below in Blacks. The MANOVA test indicates the only elements exhibiting race variation in sexual dimorphism are the mandible and radius. Discriminant functions provide better classification rates than the univariate methods, with the exception of the tibia in Whites and the calcaneus in Blacks. Models and classification rates are provided.

Sex Estimation, Sexual Dimorphism, Discriminant Function Analysis

H3 Race and Ethnicity in Subadult Crania: When Does Differentiation Occur?

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Poster attendees will learn about survey data solicited from practicing forensic anthropologists on the issue of when skeletal attributes develop sufficiently to assign "race" to a largely intact human cranium.

For at least the past few decades, the concept of "race" has been debated within the discipline of anthropology and professionals have taken various stances on whether or not "human races" exist. Regardless of the fact that the biological definition of race does not apply to humans, forensic anthropologists are nevertheless often able to classify skeletal remains to socially recognized racial or ethnic groups with a measure of accuracy. However, owing to the complexities of polygenic inheritance and increasing admixture, racial classification is often far more difficult than assigning stature, sex, or age, although standard references agree the skull is the obvious choice for attempting to make racial distinctions.

In discussions of methodologies utilized in racial assessments, whether anthroposcopic or morphometric, there appears to be an underlying assumption, seldom voiced, that these methods are applicable to the remains of adults and adults only. Few references even make mention of racial assessments in subadults, and those that do generally refer to differences in long bone growth, and indicate this inter-group variability as being primarily of exogenous rather than endogenous origin. Krogman and Iscan (1986) have a section devoted to "Racial Differences" in their chapter "Skeletal Age: Early Years," in which they conclude, "We see no valid reason to hold that there are any *racial* differences (their emphasis), in the sense that differences in sequence or time may be genetically entrenched and, hence, significant." However, they do indicate "This problem has not been systematically studied save for the possibility of differences in the first two decades of life, and even here studies have focused mainly on evidence gained from the hand and wrist…" The scant references to racial differences among subadults include Choi and Trotter's (1970) study of American fetal skeletons, and research conducted by Hauschild (1937) concerning skull differences in the third fetal month. It is curious that while differences have been postulated and studied in fetal remains, albeit meagerly, there has been no systematic or recent study of racial variation in children or adolescents.

With regard to the development of skeletal traits associated with sex, it is widely held that these features do not appear until puberty and are ultimately of genetic origins that result in the timed differential production and release of hormones. In fact, although they are influenced environmentally, all growth processes that eventually culminate in the adult body size and morphology are guided by genetic and hormonal influences. However, general somatic growth occurs both prior to and after puberty. Therefore, it does not necessarily follow that skeletal traits associated with racial differences would have any direct relationship with puberty. Certainly some discrete traits, including dental traits such as Carabelli's cusp or shoveling of incisors, appear dichotomously or discontinuously during the growth of an individual. However, morphometric racial traits, such as those in the cranium, are a function of differential growth among individuals of varying genetic backgrounds. Undoubtedly, these traits could be influenced to some extent by the same exogenous dietary, pathologic and socioeconomic factors that act upon long bone growth and development. However, because crania develop differently than long bones, it is possible they are not as markedly affected, or alternately, affected in different ways.

The first objective of this study was to canvass the forensic anthropologic community regarding at what point in skeletal maturation they consider documenting morphological differences in the cranium that are typically associated with race or ethnicity. In addition, the author began to collect skull photographs of subadults of various ages and ethnicities to possibly further and more directly address this issue.

In May of 2002, a total of 245 surveys were sent to the membership mailing list of the Physical Anthropology Section of the American Academy of Forensic Sciences (AAFS). As of the writing of this abstract, 85 of those surveys were returned to the author for a response rate of 34.7%. Of the 85 respondents, 30 were Fellows in the Academy, 20 were Members, 17 held the rank of Provisional Member, 15 were Student status, 2 were Trainee Affiliates, and 1 was a non-member. The greatest number of participants (n=27 or 31.8%) reported their years of experience at 5-15 years, while 18 (21.2%) reported 15-25 years of experience, and 14 (16.5%) reported 25 or more years of experience. Of the 85 respondents, 26 (29.4%) reported either 5 or less years of experience or that they did not typically practice on their own. The survey also asked each participant to report on their average number of human cases per year and the average number of cases involving subadult/immature remains in which they participate annually (averaging the past five years).

The key question in the survey was worded as follows: "What would be the lowest age-at-death at which you would typically feel 'professionally comfortable' assigning 'race' or 'biological affinity' to a largely intact human cranium?" The survey asked participants to choose only one of the following responses:

- "I do not advocate assigning 'race' to human remains, regardless of age.
- Only when skeletal maturation is totally complete (i.e., all epiphyses are fused).
- 20-25 years at time of death
- 15-20 years at time of death
- 10-15 years at time of death
- 5-10 years at time of death
- 0-5 years at time of death
- "I've never considered the question, and do not feel comfortable answering it."

Responses were tallied and then sorted by years of experience, cases per year, and other survey parameters.

Within the 85 responses, all of the above answers were selected by at least one survey participant. One individual (1.2%) did not advocate assigning race to human remains, regardless of age, and one other individual (1.2%) declined to answer the question. Six respondents (7.1%) had never considered the question or did not feel comfortable answering it. The most frequent response (n=29 or 34.1%) was from those who indicated they would "typically feel professionally comfortable assigning race" when an individual is in the 15-20 year range; 15 of 85 (17.6%) reported they would feel comfortable assigning race only when skeletal maturation is totally complete; another 15 of the 85 respondents (17.6%) indicated they would assign race in the 20-25 year range; 7 respondents (8.2%%) would assign race in the 0-5 year range; 6 (7.1%) answered they would assign race in the 5-10 year category; and 5 participants (5.9%) would consider 10-15 years at time of death as the lowest age at which they would assign race. (It is interesting to note that there was no obvious correlation between the answer to the above question and the respondents' membership category or years of experience.) In summary, of the 77 survey respondents who answered the question and indicated they do report race, 59 of those (76.6%) would not feel comfortable doing so until after age 15, an age that roughly correlates with the post-pubertal period in most subadults.

As previously suggested, there is no biological reason to assume that the continuous types of morphological racial variability seen, in the cranium or elsewhere, are related to hormonal changes that occur specifically during the mid-to-later teenage years. However, from the survey one can conclude that forensic anthropologists are reluctant to assign a race below age 15. It is hoped that this paper will be the basis of a research agenda that helps illustrate at what point anthropologists can or cannot differentiate race or ethnicity from the crania of subadults.

The presentation will provide a more thorough discussion of survey responses, as well as photographic evidence of subadult crania of various age and ethnic backgrounds. Future directions of study are to utilize

Fordisc on crania of various ages, particularly older children, to see if any ethnic distinctions emerge, since the race differences Fordisc keys in on are mostly based upon shape rather than size (R Jantz, personal communication). Additionally, radiographs and photographs of living children and adolescents will be utilized to examine at what age cranial variations begin to emerge among subadults of varying ages.

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Race, Subadults, Cranium

H4 An Examination of the Petrographic Technique in the Analysis of Cementum Increments for the Determination of Age and Seasonality in Human Teeth

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The purpose of this presentation is to provide preliminary findings regarding the accuracy of cementum increments in determining age and seasonality in adult human teeth through the use of the petrographic techniques.

The 1950s witnessed the development and refinement of microscopic techniques specifically focused towards the estimation of age in humans. Gustafson (1950) examined multiple points on thin sections of teeth and found that, with some degree of accuracy, one could attempt to estimate age for an individual through observable changes. Wildlife biologists began to use microscopic analysis on non-human teeth to examine the cementum. By counting the layers of cementum in a particular tooth, age as well as season of death (seasonality) of mammals could be determined. It was not until the 1980s that anthropologists would attempt age estimates based on examinations of cementum increments in human teeth. It would take twenty years before anyone published on the possibility of the determination of seasonality in human teeth.

Why is cementum incrementation important to or even necessary for anthropology? To answer this question, one need only look at a fragmentary burial to see that teeth are one of the most durable elements of the human body. The techniques that anthropologists use in estimating age are only as useful as the available remains. Pubic symphysis degeneration, auricular surface changes, rib end changes, all of these techniques will require elements that often suffer damage, scavenging, or are completely missing from a burial or skeletal recovery. It is the intent of this study to demonstrate that cementum increment analysis, through the use of hard sectioning (petrographic) techniques, can be a valuable tool for providing accurate data on age and season of death.

This study is a preliminary examination of the use of petrographic techniques to view cementum increments and via these increments, determine age and seasonality. Before any work is conducted, each tooth is cleaned and measurements are taken for general documentation including, tooth length and width, crown height, and root length. Each tooth is coded with a number letter combination (protecting the identity and information for each tooth) and embedded in epoxy. Once the epoxy hardens, the tooth is cut with a diamond-wafering saw. Longitudinal sections are chosen over cross sections so as to allow viewing of the entire tooth root. Each half of the tooth is affixed to a slide with epoxy, labeled with the code of the tooth, and sent through a diamond-wafering saw, further reducing the tooth. Sections not attached to slides are labeled and stored for future sectioning. After cutting is complete, each slide section is ground down on a glass plate with 600 grit silicon carbide until the section is thin enough for the cementum increments to be visible. Thickness of each section varies depending on the tooth and when clear visibility of the cementum increments is apparent.

When a section is ground down to an appropriate thickness, it is viewed under a microscope using transmitted cross-polarized light. The entire length of the tooth root is examined. Increments are counted at the location that offers the best visibility (this varies from tooth to tooth). Counting the opaque lines and adding that count to the eruption date of the tooth being examined establish band count. Seasonality is determined by observing the outermost cementum increment. According to available research, opaque bands tend to correlate to winter seasons or seasons of slow growth while translucent bands tend to correlate to summer seasons or seasons of accelerated growth.

Results of preliminary research demonstrate that cementum increments are visible in human teeth using the petrographic technique. Sections examined thus far seem to demonstrate a positive correlation between cementum increments and age for individuals between 18-60 years of age (correlation decreases as age increases); however, results for correlation with seasonality were not conclusive. More research is necessary. Larger samples of teeth from forensic and historic material, as well as dental extractions of known age and seasonality will be valuable in determining accuracy, correlation, and examining the factors that influence variation within cementum increments.

Age Determination, Cementum Increments, Season of Death

H5 A Test of the Auricular Surface Ageing Method Using a Modern Sample: The Effect of Observer Experience

Debra A. Komar, PhD, Office of the Medical Investigator, University of New Mexico, Albuquerque, NM; Tim Petersen, MA, Department of Anthropology, University of New Mexico, Albuquerque, NM; Suzzette Sturtevant, BSc, and Britny Moore, BSc, Office of the Medical Investigator, University of New Mexico, Albuquerque, NM*

This poster will present findings of a study to determine whether low accuracy rates using the auricular surface morphology ageing method are the result of observer error or methodological deficiencies.

The validity of ordinal estimation methods such as ageing techniques rely both on the inherent accuracy of the method as well as the proficiency and experience of the observer. When poor accuracy rates are obtained, the difficulty lies in differentiating whether the fault lies with the method or the observer. This study utilizes a modern forensic collection and observers ranging from experienced faculty to novice undergraduates to evaluate the accuracy of the auricular surface morphology ageing technique developed by Meindl and Lovejoy (1985, 1989). The technique requires observers to classify the auricular surface of an individual according to eight phases. Written descriptions and photographs provide users of the method with criteria for each phase. The research sample used in this study consisted of 146 individuals from the documented collection at the Maxwell Museum of Anthropology at the University of New Mexico. The sample contained only individuals who died recently (1984 to present) and whose demographic information was thoroughly documented, thereby providing accurate age and sex information. Age at death ranged from 18 to 101 years and both males and females were represented. The observers included a junior faculty member (DK) with over a decade of experience using this ageing method in hundred of forensic and archeological analyses; a Ph.D. candidate (TP) with four years of training and practical experience and two undergraduates (SS, BM) with solid backgrounds in anatomy but no prior experience or training in this ageing technique. Overall accuracy rates for the auricular surface method ranged

from 25% correct for the junior observers, to 40% for the graduate student, and 84% correct for the faculty member. Intraobserver tests (using the Kappa statistic) were conducted to evaluate how consistent each researcher was in their observations. Results ranged from 75% (junior authors) to 100% (faculty member), indicating a fair to excellent degree of consistency based largely on experience. Interobserver tests (again utilizing the Kappa statistic) revealed poor agreement among the observers. Researchers with less experience noted that, despite the descriptions and photographs, the method was difficult to understand and use. Poorly defined or overlapping phases and vague descriptions were among the chief complaints. For example, the written description differentiating phases one and two states "changes from the previous phase are not marked and are mostly reflected in slight to moderate loss of billowing." Phase 3 instructs the observer to "note smoothing of surface by replacement of billows with fine striae, but distinct retention of slight billowing." Even for observers familiar with the definitions and features of the technique, such standards are often confusing and insufficient. Overall, the results indicate that the accuracy rates obtained with the auricular surface method do rely on the experience and training of the observer. However, tests of a similar ageing method (the Suchey-Brooks pubic symphysis morphology technique) by the two senior authors resulted in accuracy rates of 98% (DK) and 93% (TP) using the same collection. The Suchey-Brooks method requires observers to score the pubic symphysis of an individual as one of six distinct phases using written descriptions, illustrations, and casts. The results using the Suchey-Brooks method, combined with the high intraobserver scores of the senior authors, suggests that the poor accuracy rates obtained using the auricular surface method may not be exclusively the result of observer error. Several factors warrant consideration. First, the use of casts, well-defined phases with clear written descriptions, and separate standards for males and females seen in the Suchey-Brooks method render the method more "user friendly." Second, the auricular surface method was originally created using the Hamman-Todd collection at the Cleveland Museum of Natural History, which contains individuals who died prior to 1940. The Suchey-Brooks method was developed on a modern forensic collection. Temporal changes as well as the application of standards developed on one population to alternate populations may constrain the successful use of the auricular surface method.

Physical Anthropology, Ageing Methods, Osteology

H6 Sex, Size, and Genetic Mistakes: Identifying Disorders of Sexual Differentiation in Human Skeletal Remains

Linda O'Connell, BM, MSc, Joy Steven, MSc*, and Margaret Cox, PhD*, School of Conservation Sciences, Bournemouth University, Poole, Dorset, United Kingdom*

This presentation will assess whether disorders of sexual differentiation can be identified in human skeletal remains and whether such changes affect the determination of sex. Results show that a number of skeletal manifestations associated with each of the disorders and that these may compromise the effectiveness of sex assignation.

One of the most fundamental demographic parameters to be ascertained as part of any forensic or biological anthropological analysis is that of sex determination. The term sex can be defined in one of five ways: chromosomal sex, gonadal sex, phenotypic sex, gender, and sexual orientation. However, when forensic and biological anthropologists refer to this term, they are alluding to the biological sex of an individual, which is fixed by the X- and Y-chromosomes, and dictated by morphological characteristics. The potential effects of disorders of sexual differentiation upon elucidation of this demographic parameter, (particularly with respect to the effects on the pelvis and skull) has not been considered within this context.

A desk-based assessment extensively reviewed five selected disorders of sexual differentiation - Turner's syndrome, Klinefelter's syndrome, congenital adrenal hyperplasia, testicular feminization, and true hermaphroditism. The pathogenesis, aetiology, epidemiology, clinical features, and treatments of these conditions were investigated, together with any other mimicking conditions.

Results showed that there are a number of skeletal manifestations associated with each of the disorders. Examination of these traits revealed that the normal expression of skeletal sexual dimorphism could be compromised as a result, with individuals being incorrectly assigned a sex.

Furnished with this knowledge, the forensic or biological anthropologist will be in a position to not only offer a potential diagnosis, but also to fully evaluate any effects that this may have on the features employed for sex determination.

Disorders of Sexual Differentiation, Sex Determination, Skeletal Analysis

H7 The Foot as a Forensic Tool

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The goals of this presentation are to inform the forensic community of the importance of foot related evidence and the ability to use such evidence effectively in criminal cases.

This poster will present information on how the forensic podiatrist uses his or her expertise in the analysis, comparison, and evaluation of barefoot impression and bare footprint evidence.

The team approach is important to the success of any endeavor, especially in law enforcement. The team for footwear/barefoot impressions may include the crime scene specialist, investigator, forensic tracker, footwear examiner, and forensic podiatrist. The forensic anthropologist, who may have some overlapping responsibilities, may also be involved in the case. The podiatrist should take all foot casts, weight bearing or non-weight-bearing, and fabricate the models in dental stone. Laboratory personnel, as needed, can do the photography, inked impressions, etc., but with the assistance/recommendations of the podiatrist, because the needs may vary from case to case. As part of this process, the podiatrist can perform a suspect evaluation to include foot typing, biomechanical evaluation, pathology, and gait evaluation with the fabrication of evidentiary materials, such as a dynamic gait pattern, depending on case needs.

The scene of the crime is a very important area that requires thorough evaluation. Discovery, documentation, and recovery are paramount and although most evidence is properly processed, for some reason, footprint evidence, unless it is quite obvious, is usually not. This is by no means is a slight on the job of criminal investigation personnel. However, there are many reasons for this trend, but due to the increase in the number of individuals working specifically in this field and increased education and training in the law-enforcement community, this trend is changing.

The foot is similar in all individuals because of basic physiologic and anatomic factors. Due to inherent differences in body proportions, genetic predispositions, pathologic states, functional or dynamic variances or influences, footwear constraints, environmental factors, occupational influences, and injuries, it is unique to that individual. This uniqueness allows for the ability to identify individuals to being linked to a crime scene or wearing footwear that were either left at that scene or evidence of such.

Foot related evidence includes bare or sock bloody footprints, impressions in a substrate such as dirt, sand, dust, or blood on floors. The foot image is often present on the sock liner of the shoe in both two and three-dimensional forms. The shoe will also show significant traits of the foot that it housed. Since a large percentage of the population has some type of foot problem, pathology present in the foot from a structural standpoint such as a bunion deformity, hammertoe deformity, digital

imbalance, Haglund's deformity, and many others will lead to a wear pattern in the shoe. Functional or biomechanical imbalance will lead to other wear patterns that can be observed in the upper shoe or on the outsole. The shoe may also leave impressions in dirt, mud, sand, and blood. The shoe is sometimes left at the scene or discarded nearby and the podiatrist is often asked if the wearer of the shoe can be identified. The shoe print is often discovered and not always conclusively identified.

The poster will show exemplars of the foot that are used for comparisons and proper procedure for obtaining them, and for the footwear pertinent to the case. The foot zones as well as foot identification contours will be presented and their application to the identification process. The morphology of the foot and what can be ascertained regarding a "profile" of the individual who made the bloody footprint, for example, will be shown through various means.

A case study will be presented to show the attendee the protocol and procedures used to come to a valid conclusion utilizing different forms of foot related evidence.

Forensic Podiatry, Barefoot Morphology, Footprint/Impression Evidence

H8 Back to the Basics: Anatomical Siding of Fragmentary Skeletal Elements From Victims of the World Trade Center Disaster

Eric J. Bartelink, MA, Jason M. Wiersema, MA, and Maria Parks, MA, Department of Anthropology, Texas A & M University, College Station, TX; Gaille MacKinnon, BA, MSc, Department of Conservation Sciences, University of Bournemouth, Bournemouth, United Kingdom; and Amy Zelson Mundorff, MA, Office of Chief Medical Examiner, New York City, 520 First Avenue, New York, NY*

After attending this poster presentation, participants will learn: (1) methods used for the identification and anatomical siding of human remains from victims of the World Trade Center; (2) the practical utility of having visual and comparative reference material readily available when identifying fragmentary skeletal elements; and (3) the value of physical anthropologists in the mass disaster setting for identifying fragmentary, burned, and commingled remains. This presentation will further provide hands-on opportunity for participants to assess various methods (published and unpublished) used for the anatomical siding of fragmentary skeletal elements.

The identification of skeletal elements employs the absolute basics of human osteological methods used in the laboratory and field setting, and generally precedes assessments of sex, age, ancestry, stature, and identifying characteristics. When dealing with a single individual, identification of skeletal elements is straightforward, although taphonomic factors may complicate analyses. However, for mass disasters the death toll is high and may involve a long process of identification for remains that are in a heavily fragmented state.

Human osteological training provides the basic skills needed for the identification and anatomical siding of skeletal elements, as well as a comprehensive understanding of their orientation within the body. When more detailed methods are needed for assessing highly fragmentary and/or burned remains, closer attention to skeletal anatomy together with use of comparative material is often necessary in order to accurately identify and side elements.

The terrorist attacks of September 11, 2001, resulted in the deaths of 2,823 victims at the World Trade Center (WTC) in lower Manhattan, representing the worst mass fatality in U.S. history, and producing nearly 20,000 individual body parts with varying levels of fragmentation and decomposition. After the initial search for survivors, the daunting task of recovering human remains from the site was undertaken. A multidisciplinary team comprising pathologists, anthropologists, odontologists, fingerprint and DNA specialists, and identification staff was established to facilitate the identification process at the Office of the Chief Medical Examiner in Manhattan (OCME). Human remains were recovered from September 2001 through July 2002 from the WTC site, with a simultaneous secondary recovery effort at the Staten Island Landfill where debris was brought from the site to be sifted and screened for further remains. The fact that thousands of remains arrived at the OCME over a ten month period in a highly fragmented state, and were in many cases, incompletely recovered, prevented calculations of the minimum number of individuals (MNI) represented.

The unusual circumstances of two hijacked commercial airliners, fully loaded with jet fuel, impacting the 110-story North and South WTC towers, followed by their subsequent collapse and the collapse of five other adjacent commercial buildings, introduced a multitude of taphonomic factors that complicated the positive identification of individuals. These included the mutilation, fragmentation, and amputation of body parts, extensive decomposition and natural mummification, commingling, the effects of fire destruction, and further damage incurred through the use of earth-moving machinery during the recovery effort.

The extent to which remains were fragmented, burned, and/or decomposed hindered efforts to identify and anatomically side body parts, and further complicated interpretations of commingling. Because of the high incidence of commingling resulting from the collapse of the WTC complex and from recovery efforts to remove more than 1.6 million tons of debris from the site, the accurate siding of fragmentary remains proved to be an important component of the identification process. In the process of anthropological verification of remains following their original assessment, every attempt was made to identify and side fragmentary and burned remains through the use of comparative skeletal material, osteology textbooks, and methods developed throughout the course of the identification process.

A variety of texts provide excellent detailed information for the anatomical siding of fragmentary skeletal remains using a variety of methods (e.g., Bass 1995, White 1991; Steele 1989). However, these sources may not be practical or readily available in the mass disaster setting, where time is often the greatest constraint and accuracy is the most important goal. The degree to which remains were fragmented, burned, or decomposed, along with the sheer number of individual cases assessed, presented practical problems for attempting to side fragmentary remains. This was particularly evident when common anatomical features typically used in identification were either missing, difficult to assess due to the presence of soft tissue, or were heavily charred or calcined. This presentation will focus on several methods used for the anatomical siding of fragmentary remains as part of the anthropological verification protocol for the WTC disaster, and will further discuss practical applications in forensic anthropology.

Forensic Anthropology, Human Identification, Mass Disaster

H9 The William M. Bass Donated Collection at the University of Tennessee - Knoxville

Helen E. Bassett, MA, M. Katherine Spradley, MA, and Lee Meadows Jantz, PhD, Department of Anthropology, University of Tennessee, 250 South Stadium Hall, Knoxville, TN*

The attendee will be provided with an overview of the demographic information as well as some pathological information on the human remains available for study in the William M. Bass Donated Collection.

The William M. Bass Donated Collection is housed at the Forensic Anthropology Center, University of Tennessee, Knoxville, and contains the remains of over 425 individuals. Since 1981, body donations have been accepted for anthropological research. In most cases, the donations are received immediately after death and are used in various on-going human decomposition studies at the Anthropological Research Facility. Medical and other biological information is received through contact

between Forensic Anthropology Center faculty and the individual prior to death and/or the individual's family after their death. The purpose of this poster is to provide an overview of the demographic information about the donated collection and a brief look into some pathological conditions seen in the collection.

The majority of the donated individuals are from Tennessee and the surrounding states, although some have come from as far away as Texas and Pennsylvania, with dates of birth ranging from the 189's to 1974. The remains represent a 20th Century American sample continuing in time where the Terry and Hammann Todd collections end. A small number of individuals with early dates of birth result in overlap between these collections. Manners of death for the donated individuals include natural, accidental, suicide, and homicide, resulting in a wide age range. Additionally, the collection contains 27 infants and stillborns. Approximately 100 of the individuals have been autopsied prior to placement at the Anthropological Research Facility.

Ancestry and sex are two important demographic variables to consider. More males than females are represented in the collection, and the majority of the individuals are of European descent. Other racial groups represented include African Americans, Hispanic, Mexican, and American Indian.

Traumatic episodes are evident in the skeletal remains of the individuals. Many exhibit healed antemortem fractures, and some individuals have had limb amputations. Additionally, perimortem trauma (Meadows Jantz and Schneider, 1999) is present.

Finally, many pathological conditions are seen in the individuals such as: osteoarthritis, eburnation, amputation, spondylolysis, and diffuse idiopathic skeletal hyperostosis (DISH).

While osteological studies have been conducted using the collection, the increasing number of individuals available for study warrants a renewed interest and further analysis of the remains. The critical feature of the William M. Bass Donated Collection is that it is the largest collection of *modern* individuals available for anthropological study.

Meadows Jantz, Lee and Kennan L. Schneider
1999 Trauma Patterns in the William M. Bass Skeletal Collection. Proceedings AAFS, Annual Meeting, Orlando, Florida Vol. 5:215.

Anthropology, William M. Bass Donated Collection, Demographics

H10 The Hyoid Bone as a Sex Discriminator

Michael Finnegan, PhD, Department of Sociology, Anthropology and Social Work, Kansas State University, Manhattan, KS*

The purpose of this study was to assess whether the hyoid bone is a practical and reliable indicator of sex dimorphism.

With an ever-increasing number of archaeological and forensic cases involving fewer and fewer recovered remains, the suite of methods to ascertain the sex of the remains diminishes. In this eventuality, more and varied techniques are requisite for the accurate estimation of skeletal sex. Encouraged by positive results of recent radiographic analyses of sex dimorphism in the hyoid bone (Reesink et al. 1998), the author started collecting metric data on macerate specimens of the hyoid bone.

The hyoid bone is part of the cranium. It is positioned at the base of the tongue, suspended from the styloid processes of the temporal bones. It consists of a corpus, two greater cornua which articulate laterally, and two lesser cornua which articulate at the superior-lateral margins.

The choice of dimensional criteria was based on a review of the literature and on the measurements taken by Reesink et al. (1998) and Papadopoulos et al. (1989). Based on their earlier multivariate analysis of 13 traits, three traits appeared to be most useful in the radiographic analysis of sex dimorphism. The traits of choice are 1) the maximal height of the corpus (MMH); 2) the anterior posterior thickness of the corpus (ATP); and 3) the maximal transverse diameter of the corpus (MMH). . The chosen traits are also those that are most easily taken.

Data were taken on 52 hyoid bones (38 male and 14 female) from past forensic cases, cadaver materials and archaeological remains where the sex was either known or was judged from a combination of pelvic morphology and discriminant functions. All measurements were taken to 0.1 mm. Hyoid bones with obvious pathology or trauma were excluded. Those hyoid bones that showed cornu-corpus fusion, to the extent of obliterating the measuring points, were omitted. Approximately 5% of the selected hyoid bones could not be measured, usually due to fusion of one or more greater cornu with the corpus. The classification formula is 0.56(MMH)+1.92(ATP)+2.46(MTD)-73.2, with male assigned to positive values and female assigned to negative values.

In males, 32 of 38, or 84.2%, were correctly classified. In females, 9 of 14, or 64.3%, were correctly classified. Overall 41 of 52 or 78.9% were correctly classified. Both combined and male classifications were a few percent better than Reesink et al. (1998) radiographic technique, while female classification was not as good. These results may be an artifact due to the rather larger male sample and to a lesser extent the racial mixture, which has not been considered in this sample. Determination of sex based on the individual hyoid measurements is not significant. However, the overall correct classification is significantly higher than apriori probability and thus may be a useful technique in sex determination. Further verification of this technique on larger, racially separate samples is suggested before these hyoid measurements are added to the stable of reliable sex discriminators.

Hyoid Bone, Sex Determination, Discriminant Function

H11 The Estimation of Sex From the Proximal Ulna

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This paper's objective is to present the findings of a metric analysis quantifying the degree of sexual dimorphism of the proximal ulna and to assess its value in estimating sex.

The estimation of sex based on measurements of long bones has been a useful tool to the forensic anthropologist and skeletal biologist for years. These techniques are particularly effective when one is confronted with analyzing fragmentary remains. Much of the research available has focused on analysis of the lower limb bones, with the humerus receiving slightly less attention. Fewer studies have been conducted using bones of the forearm, with most utilizing non-U.S. collections.

The present study utilizes a discriminant function analysis of two measurements taken from the proximal ulna to estimate sex. The first measures the length of the semilunar and radial notches while the second measures the width of the proximal rim of the olecranon.

White and Black male and female samples were taken from the William M. Bass Donated Skeletal Collection (n=113), the Smithsonian's Terry Collection (n=98), and from U.S. Army Central Identification Laboratory, Hawaii (CILHI) cases (n=5). The Bass sample consisted of 78 White males, 15 White females, 17 Black males, and 2 Black females, with ages ranging from 18-89 years. From the Terry Collection, measurements were taken from 8 White males, 51 White females, 7 Black males, and 33 Black females. The ages of this sample ranged from 17-54 years. For the CILHI sample, 4 males (2 White and 2 Black) and 1 female (White) were utilized, with ages ranging from 19-38 years.

All of the ulnae were measured using a GPM sliding caliper with measurements taken to the nearest 0.5 millimeter. Whenever possible, the left ulna was chosen over the right, and only those ulnae free of pathological insult were measured.

Discriminant function analyses were run on the data, with separate examinations conducted to control for any possible racial differences.

Results (using both measurements) indicate that White males and females were correctly sexed with 93.2% and 95.5% accuracy (respectively), while Black males and females were correctly sexed 92.6% and 97.1% of the time (respectively). An analysis was also conducted to determine whether there was a significant secular trend between the Terry and Bass samples. The results of this latter test proved negative.

The results of this study demonstrate that the proximal ulna is highly dimorphic. Sex estimation using two dimensions of the proximal ulna yields correct sex classification as high as any other postcranial element, and exceeds correct classification rates normally obtained from the skull. The proximal ulna has obvious application to sex estimation in mass disasters, where remains may be fragmented, but should also be given considerable weight in sex estimation of complete remains.

Ulna, Sex Estimation, Sexual Dimorphism

H12 The Utility of Nonmetric Cranial Traits in Ancestry Determination - Part II

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The primary goal of the current study is to provide the audience with an overview of the state of nonmetric trait analysis in ancestry determination, and to test the utility of five traits in the classification of unidentified human crania.

The determination of ancestry is extremely useful for limiting the number of antemortem record searches during the forensic investigation of unidentified human remains. Most often, this determination – almost exclusively using the cranium – relies upon the combination of the assessment of a number of unique morphological features (nonmetric traits) and metric analysis of the shape of the skull. Evaluations utilizing nonmetric traits may be effective for predicting ancestry but relies on the observer's experience. Furthermore, the frequency of many of these traits among populations has not been examined in full and the range in variation of these traits is often not considered in ancestry prediction studies resulting in the loss of existing gradations that are observed (Brues 1991).

Considering this deficiency in the existing body of data, 17 nonmetric cranial traits were documented for 762 individuals from 20 populations throughout the world (European, n = 185; Asian, n = 156; American Indian, n = 241; African, n = 180) curated at the National Museum of Natural History, Smithsonian Institution. Last year (Hefner 2002) five of these traits were discussed: inferior nasal aperture, nasal bone structure, nasal aperture width, interorbital breadth, and post-bregmatic depression. These five traits were shown to have only a minimal predictive value for ancestry. In this presentation, discussion will focus on the morphological variation and frequency distribution of five additional cranial traits. The traits include anterior nasal spine prominence, zygomaticomaxillary suture shape, transverse palatine suture shape, posterior zygomatic tubercle, and malar tubercle.

First, each trait was examined and character states were defined, or, when appropriate, trait values from previous studies were utilized. Next, new anatomical terms and definitions were developed for character states not previously described. If possible, each trait was scored on a four or five-level scale, thus permitting the inclusion of intermediate morphologies. In this manner, each trait was scored progressively (i.e., Posterior Zygomatic Tubercle: 0 = absent; 1 = weak; 2 = incipient; 3 = medium; and 4 = strong). Finally, in an attempt to properly quantify the morphological variability, standard frequency distributions for each of the character states were calculated. In addition, polychoric correlations were computed for all traits to determine inter– and intra-population variability.

Ancestry determination from nonmetric traits classically relies on assessing whether a particular skull exhibits trait values that are believed to be representative of a given ancestral population (e.g., 'angled' zygomaticomaxillary suture in Asian and Native American individuals). In the current study, individuals possessing all five expected trait values ranged from 10.24% (13/127) for European individuals to 12.21% (21/172) for African individuals. Frequency distributions for most traits do not show significant differences between ancestral groups, with the possible exception of the transverse palatine suture. In this sample, 34.8% (64/184) of the Europeans possessed a "bulging" (asymmetrical) transverse palatine suture, 54.5% (90/165) of the Asian sample possessed a "straight" transverse palatine suture, 64.3% (207/322) of the Native American population possessed a "straight" transverse palatine suture, and 46.7% (64/184) of the African sample possessed an "anterior bulging" (symmetrical) transverse palatine suture. This agrees, to some degree, with the published results of Gill (1998). Polychoric correlations were statistically insignificant for all five traits in the current study. This lack of strength in association tentatively suggests that these traits may not be useful for clustering in ancestry prediction studies.

These data appear to undercut the predictive value of these traits. Further research is necessary for the traits currently used by forensic anthropologists in making a determination of ancestry. The production of detailed, anatomically based descriptions that record the variability in trait expression, and recording the frequencies of these traits among populations, will greatly enhance the forensic anthropologist's ability to determine ancestry through visual means.

Ancestry, Nonmetric Traits, Human Identification

H13 Forensic Anthropology, Repatriation, and the "Mongoloid" Problem

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After attending this presentation, the participant will understand: 1) discriminant function analysis (DFA) is a powerful tool for estimating ancestry from skeletal remains, 2) DFA using interlandmark distances (ILDs) can distinguish between Asian groups and American Indians very well, 3) morphometric relationships within and among Asian and Native American groups undermines the "Mongoloid" label and grouping, and 4) an appreciation of population histories is important in analyzing modern human remains.

Establishing the cultural affiliation of human remains is a vital part of the Native American Grave Protection and Repatriation Act (NAGPRA), which mandates the evaluation and repatriation of human remains to the appropriate Native American tribes. Often, the decision whether to repatriate and to whom is primarily based on biological data. Native American remains are a concern for forensic scientists and museum personnel, who need to distinguish between Native American remains and those from other groups (Pickering and Jantz 1994). The illegal sale of human remains is also a NAGPRA violation if the remains are those of an American Indian.

The estimation of ancestry is more complicated if one tries to discriminate among closely related groups. Native Americans and Asian groups share a more recent common ancestor and have traditionally been grouped under the "Mongoloid" label. "Mongoloids" are supposed to share a variety of soft tissue and skeletal traits (such as anterior zygomatic projection, brachycephaly, and shovel-shaped incisors) though the trait frequencies rarely have been tabulated. Hefner (2002) analyzed a large sample and found that certain nonmetric traits used to distinguish "Mongoloids" were unreliable. Brace (1996), in analyzing craniometrics, found that the Mongols were the most divergent of the "Mongoloid" groups he examined. The morphometric differences among Asian groups and Native Americans are not well established.

Ousley (2000), Ousley and McKeown (2001), and Mann and Ousley (2001) have shown that DFA of ILDs calculated from cranial landmark coordinates recorded with a three-dimensional digitizer is a quick and non-destructive method of recording overall morphology and determining the ancestry of complete or incomplete remains with accuracy and precision. The main advantages of using ILDs are that the forensic anthropologist only needs sliding and spreading calipers to collect ILDs, DFA can be easily used, including stepwise DFA to select the best variables to use, and partial remains can be more easily assessed. These advantages are naturally contingent on the appropriate populations being sampled.

Using a three-dimensional digitizer, cranial landmark data from over 400 Asians and over 500 Native Americans at the National Museum of Natural History, Smithsonian Institution, were collected. Seventy-eight landmark coordinates were recorded on each cranium, representing over 3,000 ILDs that could be calculated, but analysis centered on Type 1 landmarks, those located at the intersection of sutures. The continental groups were comprised of Mongolians (100), East Asians (Japanese, Chinese, Korean, Buriat, Chukchi), Alaskan (Aleut, Eskimo, Indian) and Plains, Western, and Southern Native Americans. Interestingly enough, one museum cranium labeled "Chinese" was an outlier and was determined to be of European descent based on DFA of ILDs from Chinese and 19th Century American Whites (posterior probability = .99).

The results show promise for use in forensic (especially Repatriation) situations where ancestry may be Asian as opposed to Native American. Mongolians were found to be the most divergent Asian group and were clearly distinct from East Asians and Native Americans. DFA classifies all three groups 94% correctly. One remarkable feature of the Mongolians is their extreme hyperbrachycephaly, probably among the highest in the world. East Asians showed greater similarity to Native Americans, especially Alaskan Native Americans, than to Mongolians, but could be separated from Alaskans 93% correctly using 25 variables in DFA. The similarity between East Asians and Alaskans is likely due to relatively recent gene flow across the Bering Strait.

Our results remind the forensic anthropologist that ancestry will reflect population histories, and that terms such as "Mongoloid" may be misleading both biologically, because they tend to mask underlying variation, and taxonomically, because in this case Mongolians are quite divergent from East Asians and Native Americans.

The use of ILDs continues to show great promise for use in forensic laboratories and museums where human remains are analyzed in terms of ancestry.

Craniometrics, Discriminant Function Analysis, Mongoloids

H14 A Strategy for Age Determination Combining a Dental Method (Lamendin) and an Anthropological Method (Iscan)

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The goals of this presentation are to improve the accuracy of age determination by combining the results of two methods, Lamendin and Iscan method.

Estimating the age of non-identified individuals at death is a difficult task in forensic practice, because no method has proven to be accurate. The ideal method for age determination must be simple, reliable, and precise. Most of the authors recommend use of the many age indicators available.

A few years ago, the authors proposed a method, the Two Step Strategy (TSS), combining the Schey-Brook system and the Lamendin method. The two step strategy consisted of looking first at the pubic bone to determine sex and phase and then to determine estimated age from the SBS alone when the individual showed phase I, II, or III morphology or from the Lamendin method alone if phase IV, V or VI morphology existed. The objective of this project was to try to improve the accuracy of age determination by combining the results of two methods.

The Iscan method is widely used and considered simple (especially with the help of pubic casts) and reliable. This method is based on the interpretation of the sternal articulation aspect of the forth rib. Unfortunately, in individuals over 40 (phase VI, VII, VIII) this method is not precise enough (SD over 10 years). Interestingly it is only in individuals under 40 that the Lamendin method shows SD over 10 years. This method is based on the measurement of translucence and periodontosis heights of an intact monoradicular tooth (preferably an upper incisor).

The goal was to assess which was the best way to combine these methods in order to improve the age estimation accuracy without decreasing reliability.

Samples of 39 Caucasians males (16 to 64 year of age) for whom the forth rib and an upper incisor were both available comprised the study. An estimate was considered correct when actual age determination from the rib fell within the mean +/- 1 SD of the Iscan phase and from the tooth within the estimated age +/- 1 SD of the decade. The «combination» of results gave an estimation using the age interval common to the Iscan and the Lamendin method (which very often resulted in a more "precise" estimation). The results will be developed and discussed.

Results observed (1):

	Total sample	<40 years	>40 years
N	39	28	11
Correct aging	%	%	%
Iscan	64	57	54,5
Lamendin	69	68	72
Combining method	69	68	72

Results observed two:

	Total sample	<40 years	>40 years
N	39	28	11
Correct aging	%	%	%
Iscan	71	75	63,6
Lamendin	69	68	72
Combining method	74,5	75	72

Physical Anthropology, Forensic Odontology, Age Determination

H15 Introducing *Daubert* to the Balkans

Richard J. Harrington, PhD, International Commission on Missing Persons, Alipasina 45a, Sarajevo; Benjamin Swift, MBChB, Division of Forensic Pathology, Robert Kilpatrick Clinical Sciences Building, Leicester Royal Infirmary, Leicester, United Kingdom; and Edwin F. Huffine, MS, International Commission on Missing Persons, Alipasina 45a, Sarajevo*

The goal of this presentation is to review the impact of recent technological advances¾most notably, DNA analysis and physiochemical testing, as integrated with traditional forensic anthropological and archaeological approaches¾on legal decisions made by local courts and commissions in the former Yugoslavia.

The conflicts of the 1990s in the former Yugoslavia left perhaps 30,000-40,000 missing, with most presumed dead. Since 1996, vast resources have been committed by international organizations to the

recovery, examination, and repatriation of mortal remains in this region. Much of this effort has been conducted under the auspices of organizations such as the International Criminal Tribunal for the former Yugoslavia (ICTY), which focuses on exhumations of mass graves for the purpose of war crimes investigations. However, two important considerations are that (1) ICTY is not responsible for the systematic personal identification process of the recovered mortal remains, and (2) ICTY is required by the international community to operate in accordance with accepted international standards of evidence collection, analysis, and legal presentation. By presenting such evidence before an international court, ICTY can effectively bypass local laws and customs.

The International Commission on Missing Persons (ICMP), in contrast, assists in the systematic personal identification process and promotes cooperation and coordination among local commissions, courts, and exhumation teams. Although the mandate is different, the overall philosophy of the ICMP to promote adherence to the highest possible standards is in line with other international organizations. From the perspective of cultural relativism, this is equivalent to the promotion of "Western" standards.

"Western" forensic science, as practiced in the U.S., is increasingly scrutinized within the context of the 1993 U.S. Supreme Court ruling on *Daubert v. Merrell Dow Pharmaceuticals, Inc*. Even among laypersons (and experts) who have never heard of *Daubert*, there appears to be an ever-increasing recognition that expert opinion presented in courtroom testimony should be based on objective science that passes validity and reliability tests.

The introduction of so-called "Western science" into a tradition-bound Eastern European region has been accelerated by the remarkable surge in DNA-led identifications in this region in the year 2002. The success of the ICMP DNA Program has led to a complete rethinking of how to approach the personal identification process in the former Yugoslavia. To the extent that the DNA-led approach to the identification process is assimilated culturally and legally in the region, it can be stated that *Daubert* has *de facto* gained a toehold in the Balkans.

However, this successful introduction was not accomplished at the expense of traditional forensic sciences; rather, it required the integration of multiple lines of evidence, to include forensic/archaeological context analysis, biological (skeletal) profiling by anthropologists, and evidence review by police investigators and forensic pathologists. This has quickly led to the refinement of standard operating procedures for "routine" cases, and therefore has not (at least at the time of this writing) required the intervention of local courts to resolve disputes pitting "old" against "new" techniques.

Several exceptional cases have been presented to ICMP that cannot necessarily be resolved by DNA matching or traditional approaches alone. During the course of recovery operations, skeletal remains that could predate the 1990s conflict are commonly encountered. Occasionally, intense public debate is generated over cases where former warring parties disagree over whether a set of remains does or does not date to the war period. Samples from some of these cases have been submitted for both DNA testing at ICMP labs and physiochemical testing for postmortem interval, dietary history, and geographic origins testing at the Division of Forensic Pathology, University of Leicester. Results of these tests are expected during the late summer of 2002, and these results, along with results of traditional analysis of evidence, will be presented to the appropriate local commissions and courts for review. This paper will provide an account of the impact of the *Daubert*-influenced "integrated approach" (i.e., traditional approaches combined with new-but-accepted and experimental-but-verifiable-and-reliable approaches) on local commission and court rulings.

Forensic Sciences, Human Identification, *Daubert*

H16 Dirty Secrets: Identification of Older Crime Scenes in the Former Yugoslavia Through Blood Protein and Volatile Fatty Acid Soil Analysis

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The goals of this presentation are to present to the forensic community evidence validating the analysis of soil deposits by CIEP, GC, and MS in the identification of older crime scenes.

Those who commit murder regularly attempt to hide or destroy evidence to avoid prosecution. Murder scenes are cleaned up and bodies removed and concealed by the guilty party. After hiding the body, the murderer, rethinking his disposal plan, may even retrieve the body and attempt to hide it in a different, more secretive, location or destroy it in some manner, further confounding investigations. Identifying and documenting a crime scene, especially an older one, in the absence of a credible witness, a body, or other physical evidence is near impossible. However, the absence of observable evidence, while an obstacle, is not necessarily an end to the investigation. Despite removal, the body may have left behind microbiological evidence that can be collected and analyzed. Human blood proteins and volatile fatty acids (VFAs) deposited in soil at murder scenes and concealment/burial sites may remain stable over long periods of time; sophisticated soils analyses may be used to detect them.

The same detection methods used by archaeologists for ancient artifact examination and criminologists in recent murder cases were used in this study to examine older soil deposits sampled from three sites investigated by the International Criminal Tribunal for the Former Yugoslavia (ICTY): an execution site, four individual graves in a cemetery, and a mass grave.

An immunological test, crossover immunoelectrophoresis (CIEP), was used to identify blood proteins as independent evidence of an execution near Stutica, Kosovo. The passage of time between residue deposit and testing was an important element in this study. Forensic investigators rarely test soils for blood residue if the event in question is more than a few months old on the assumption that predatory microorganisms would degrade deposited residue beyond the ability to identify them. The Stutica blood proteins were deposited in soil approximately a year-and-a-half prior to analysis. In spite of the blood protein's lengthy exposure to the soil, from a total of 72 samples, 44 returned positive results for human blood proteins.

Similarly, VFAs in soils collected from cemetery graves in Duz, Kosovo and a mass grave in Knin, Croatia, were identified using a microFAST GC^2 (a field portable gas chromatograph) and a HP 5890 Series II GC with a 5971 mass selective detector Mass Spectrometer (MS). Six samples were removed from four graves in the Duz cemetery for testing. Prior to exhumation and soil sampling, bodies laid in the graves approximately one-and-a-half-years. GC results from the cemetery revealed the presence of iso-butyric and valeric water soluble VFAs in one sample. MS examination of the samples was inconclusive. From a six-year-old mass grave in Knin, three soil samples were analyzed in the same manner. GC and MS analysis revealed the presence of iso-butyric and iso-valeric water soluble VFAs in two of the three remaining samples. In addition, MS analysis revealed the following non-water soluble VFAs in all three samples: capric, lauric, myristic, palmitic, stearic, and oleic. Possible causes for inconsistent results between the cemetery graves and the mass grave may be attributed to the differences in burial styles, soil moisture, and clay content.

The positive findings of blood proteins and VFAs in the Kosovar and Croatian soils validate CIEP, GC, and MS analysis of older site soils. In the absence of bodies or other physical evidence, investigators are encouraged to use these methods of identifying and documenting sites to support their evaluation of suspected crime scenes. Demonstrating that

murder scenes, execution sites, and individual and mass graves can never be completely cleaned—that evidence of past criminal activity can never be completely erased—may help to deter murder and human rights abuses in the future.

Soil Analysis, Blood Protein, Volatile Fatty Acids

H17 Exhumations in Bosnia and Herzegovina: Unique Challenges in the Recovery From Cavern Sites

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The purpose of this paper is to present an account of the challenges faced by forensic experts in recovery operations from deep caverns in Bosnia and Herzegovina.

Three and half years of war in Bosnia and Herzegovina in the 1990s left about 250,000 dead and more then 30,000 missing, most of whom are presumed dead. The majority of missing persons are Muslims ("Bosniaks") who were killed during so-called "ethnic cleansing" operations during the spring and summer of 1992 and in July of 1995 after the fall of Srebrenica. Their bodies were buried in a seemingly endless number of clandestine mass graves, dumped into rivers, wells, septic tanks, and caverns, or simply left unburied in fields, meadows, and forests.

One of the most difficult kinds of exhumation sites is the underground cave (cavern). Bosnia and Herzegovina, with its mountainous configuration, has thousands of natural caves, caverns, crevices, and pits. During the conflict, many of them became convenient dumping grounds, soon filled with bodies from mass executions.

From the time when the Lanište cavern containing remains of 188 women, men, and children was discovered and exhumed in October 1996, the Bosniak State Commission for Tracing Missing Persons found 18 natural caverns from which remains of 585 individuals were recovered, while dozens of other caverns were carefully inspected for the presence of human remains. Eight caverns were discovered in southwest part of the country in Herzegovina, seven in the northwestern region of Bosnia known as the Krajina, and four in eastern Bosnia.

Recovery of remains from the caverns can be difficult and dangerous. Caverns can be deep (the deepest so far being 80 meters) and entrances can be as narrow as one meter. In addition to the dangers posed by natural threats (such as falling during ascent and descent), many caverns also contain a variety of explosive devices. To date, the remains recovered from caverns are generally skeletonized due to the length of time that has passed since bodies were dumped into them. However, in the Paklenik cavern that was exhumed in the summer of 2000 there were saponified remains of Bosniaks who were dropped in after reportedly being executed in the summer of 1992. In this case, deep layers of rocks and animal bones from a nearby slaughterhouse covering the bodies inhibited the natural process of decomposition.

With or without such concealment or site tampering, such as damage by grenade explosions after the bodies are dropped in, there are numerous technical and practical problems in the recovery of remains from cavern floors. Over time, as bodies decompose and bones disarticulate, skeletal elements separate and slide out of the clothing. Often those bones either commingle with bones of other individuals or they slide down to the bottom of the cavern. After the cavern floor becomes covered with bones, virtually no space is left for maneuvering by recovery team members, who are forced to work from suspended platforms or by hanging from ladders and ropes. Limited space also prevents the full complement of team members from effectively working simultaneously. Creative approaches are necessary to allow for proper mapping and excavation of the remains from cavern floors.

Forensic Anthropology, Exhumations, Mass Graves

H18 Resolution of Large-Scale Commingling Issues: Lessons From CILHI and ICMP

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The goal of this presentation is to introduce a new method of osteometric sorting of commingled skeletal remains.

Commingling of human skeletal remains can obstruct the process of forensic identification, especially when dealing with large numbers of deceased individuals. As the methods of forensic anthropology routinely require the compilation of information gleaned from multiple elements of the individual skeleton, commingling complicates the analysis. Furthermore, for humanitarian reasons alone it is the role of forensic experts to attempt to re-associate the largest amount of remains as possible for disposition to the next of kin.

Anthropologists at the U.S. Army Central Identification Laboratory, Hawaii (CILHI) routinely encounter commingled skeletal remains, as from aircraft crashes and battleground mass graves. Likewise, anthropologists of the International Commission on Missing Persons (ICMP) working in the former Yugoslavia are faced with identifying several thousand sets of remains, a large portion of which are commingled to some degree. Scientists of the two organizations are collaborating to develop innovative new approaches to solving this recurring problem. Solutions to the commingling problems at CILHI and ICMP involve the disciplined application of traditional anthropological methods (e.g., pair-matching and articulation), the development of new anthropological methods (e.g., osteometric sorting), and the judicious use of DNA sampling and profiling interpretation. Aside from these purely scientific considerations, solutions to the commingling problem at the scale encountered by these organizations must include the development of a laboratory operational plan that incorporates the latest methods while simultaneously overcoming a number of serious constraints (e.g., limited numbers of personnel, high personnel turnover, limited space, limited time, etc.). In some situations the large quantity of remains precludes the ability of analysts to visually assess all of the bones at one time, and a "virtual" analysis is proposed to assist in the re-association procedure.

A key component of the solution to the commingling problem advocated here is the method of osteometric sorting, a technique that has been developed by Byrd and Adams. Osteometric sorting works by testing the null hypothesis that two bones are of the correct size to have originated in the same individual. The linear statistical models employed are currently derived from a large reference data set developed by the CILHI. Since these data were taken from primarily American skeletons, existing models were tested against intact skeletal remains recovered in the former Yugoslavia. Test results confirm the applicability of the method to both populations. As a result, the data collected from the former Yugoslavia have been incorporated into the CILHI reference data set and new models are being generated for application by CILHI and ICMP anthropologists. Details concerning the resolution of commingling issues, including the incorporation of osteometric sorting into the laboratory operations at CILHI and ICMP, are presented.

Measurements, Commingling, Human Identification

H19 Reassociation of Skeletal Remains Recovered From Graves in Bosnia and Herzegovina

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The goal of this presentation is to familiarize the forensic community with the application of traditional forensic anthropology to the evaluation of commingled skeletal assemblages recovered from mass graves dating to the recent conflicts in Bosnia and Herzegovina. DNA testing is used to confirm the anthropological assessment of re-association in several cases.

Three and half years of war in Bosnia and Herzegovina took the lives of about quarter of million people. Approximately 30,000 of them as still reported as missing. The main purpose of those exhumations was—and still is—the identification of the deceased and return of their remains to the grieving families for proper burial. Unfortunately, exhumed remains are often either incomplete or commingled. Therefore all exhumed remains should be first carefully checked, inventoried, re-fitted if broken, and then re-associated (if possible) before the final examination and identification process.

A wide variety of recovery sites are encountered in Bosnia and Herzegovina. Mortal remains may be buried in mass graves or clandestine isolated graves, dropped into caverns and wells, incinerated in houses, hidden in garbage dumps, or scattered through meadows, forests, or agricultural fields. Both primary and secondary graves are routinely exhumed, and the site formation processes and post-depositional disturbances (deliberate and otherwise) at both types of sites can lead to commingling or separation. The recovery process itself, as well as post-recovery examination, can introduce commingling or other disassociation if done hurriedly or by improperly trained workers.

Unfortunately, there are no widely accepted scientific standards that are uniformly applied to the evaluation of commingled and disassociated remains. Forensic anthropologists with considerable experience with skeletal assemblages rely heavily on visual inspection of morphological traits. These experts review general shape and size of bones; shape, size, and location of articulating surfaces; discoloration of bones; pattern of ligament attachment; size and location of nutrient foramina; pattern of osteoarthritic lipping; deformation and remodeling of neighboring bones; pattern of changes in vertebral bodies, and age estimation in cases of re-associated upper and lower parts of the skeleton or skulls.

Metric analysis has traditionally been limited to long bone length comparisons and comparisons of humeral and femoral head dimensions. More comprehensive osteometric analysis is being explored as a means of re-association, but this has yet to gain wide acceptance. However, rapid advances in DNA technology now make it more feasible and cost-effective to make bone-to-bone comparisons in the re-association effort.

In addition to presenting an overview of the usefulness of traditional morphological trait analysis in assessing a Bosnian skeletal population, this paper will present the results of a limited number of bone-to-bone DNA comparisons to independently verify the forensic scientists' expert opinions.

Forensic Anthropology, Commingling, Human Identification

H20 The Influence of Large-Scale DNA Testing on the Traditional Anthropological Approach to Human Identification: The Experience in Bosnia and Herzegovina

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The purpose of this presentation is to review the impact of large-scale DNA testing on the practice of forensic anthropology in Bosnia and Herzegovina. The attendee will learn about the approaches adapted by forensic anthropologists in this region as they gain "instant feedback" from the DNA results and use the information to refine their techniques.

The identification of the mortal remains of thousands of individuals who disappeared during the 1992-1995 war in Bosnia and Herzegovina (BiH) represents the most ambitious project of its kind. Since its creation in 1996, the International Commission on Missing Persons (ICMP) has worked in close cooperation with local commissions established in the Bosnian Federation and the Serbian Republic of Bosnia to recover and identify the missing, and bring closure for the loved ones of the missing.

A large database for mortal remains recovered from mass graves and other sites has been created using traditional approaches in anthropology, pathology, and police investigations. However, despite the fact that thousands of remains have been recovered since 1996, and intensive efforts to identify these persons have been attempted, only a limited number of positive (as opposed to circumstantial) identifications had been achieved until recently. As ICMP DNA laboratories became fully operational in 2002, the sudden increase in DNA matches leading to positive identifications has created new roles and opportunities for forensic anthropologists.

One misconception regarding DNA-led identifications is that once a DNA match is made, then a positive identification automatically follows. This is far from true: it is imperative that traditional forensic scientists review the tentatively identified remains and related evidence to ensure that the match is valid.

With large-scale DNA matching for skeletal remains, the anthropologist receives a wealth of feedback on many cases in a short period. In reviewing the DNA evidence along with the biological profile (age, sex, stature, etc.) generated during the postmortem examination, the anthropologist is also receiving feedback on his or her own abilities to assess the human skeleton. This allows for improving one's skills in creating biological profiles, but appropriate measures must be in place to ensure that circular reasoning and unconscious bias are eliminated. This is particularly important for age-at-death assessments, which can be highly subjective. By having more than one forensic expert review each case and by using multiple lines of evidence, proper safeguards are introduced to ensure that the traditional forensic techniques and the DNA results are properly integrated to ensure the highest degree of confidence in the identification process.

Forensic Anthropology, Human Identification, DNA

H21 Age-Related Changes in the Adult Male Vertebral Column

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This paper introduces a method for improving age-at-death estimates in the adult human male skeleton using progressive morphological changes in the vertebral column. Results of a preliminary descriptive analysis of 100 adult male skeletons of known ages for changes in three vertebral traits will be presented.

Although there are currently many methods of age assessment available to forensic anthropologists, limited research has been conducted on the systematic changes in the vertebral column (e.g., Albert and Maples 1995). To the extent that such studies have been conducted, the focus has typically been on stages of vertebral ring epiphyseal union, and is therefore restricted to younger individuals.

During the course of postmortem examinations of victims of recent conflicts in Bosnia and Herzegovina, it was noted that (1) pubic symphysis metamorphosis was less reliable for age assessment of individuals over about age 40, and (2) other age-related changes in the vertebral column aside from ring fusion seemed to be sufficiently widespread and progressive to warrant further documentation.

Already well known to forensic anthropologists is that three aspects of vertebral morphology undergo noticeable change with age. First, the vertebral secondary centers, including the epiphyseal ring, appear during puberty and fuse to the centrum between about ages 17-25 (Bass 1972); second, the inferior and superior aspects progress from a well-organized, ridged configuration in younger individuals to an amorphous, often porotic appearance in older individuals; and third, the inferior and superior rims transition from "straight" to "wavy" (undulating) to sharply lipped with age.

Also well known to forensic anthropologists is that morphological changes in the vertebral column are highly influenced by biomechanical stress and pathological conditions, and therefore can be highly individualized due to different individual life histories. These factors have limited the usefulness of the vertebral column in age assessments of adults in genetically and culturally diverse populations.

However, in Bosnia and Herzegovina lower genetic diversity and greater similarity in lifestyles than in, say, the U.S., may contribute to more predictable rates of change in the vertebrae that allow for greater confidence in its relevance for age assessment. Although even in this population the contribution of vertebral morphological analysis to age estimation is relatively modest, it appears to be sufficient to warrant further research.

Aging Technique, Human Identification, Forensic Anthropology

H22 Lamendin's and Prince's Dental Aging Methods Applied to a Bosnian Population

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This presentation will evaluate the application of simple dental aging techniques to a Bosnian population. This research project tests the accuracy of Lamendin's aging method and Prince's modification of the Lamendin method as applied to a Bosnian population. The sample consists of 400 teeth (incisors and canines) from 100 males of known age.

Identification of skeletal remains benefits from the use of accurate aging techniques. One of the more promising of recently developed techniques is the Lamendin method for age determination of adults from single-rooted teeth (Lamendin et al 1992), as derived from a French population. The primary components of this method are measurements of periodontosis and transparency of the root. Lamendin proposed the following simple equation for age assessment: $A = 0.18 \times P + 0.42 \times T + 25.53$ (where: A = age in years, P = periodontosis height / root height x 100 and T = transparency height / root height x 100).

While other, traditional aging techniques have limited accuracy for aging remains of older individuals, several studies have shown that Lamendin's method yields very good results, especially for individuals between ages 40 – 70.

Prince (2002) modified Lamendin's method by adding root height (RH) to the equations for white and black males and females. The equation for white males is: $A = 0.15 \times (RH) + 0.29 \times P + 0.39 \times T + 23.17$. Prince clamed that inclusion of root height reduced the mean difference and therefore improved accuracy.

Skeletal remains found in mass graves in Bosnia and Herzegovina present additional problems that can be addressed with improved age determination techniques. The remains are often commingled or incomplete, with skulls often separated from the rest of the skeleton. Therefore simple, quick, and accurate dental aging methods may facilitate the re-association of crania and mandibles to postcranial elements.

This research conducted on Bosnian remains from the recent war (1992 – 1995) might be helpful not only in the identification of the missing from the war, but for new forensic cases in Bosnia and Herzegovina as well.

Forensic Anthropology, Human Identification, Dental Aging Technique

H23 Impact of Heat and Chemical Maceration on DNA Recovery and Cut Mark Analysis

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The goals of this presentation are to educate forensic anthropologists and pathologists about the impact of common maceration techniques on the interpretation of tool marks and recovery of DNA from human bone.

Molecular genetics is a powerful tool in the forensic sciences, with bones increasingly utilized as sources of both genomic and mitochondrial DNA. Thus, anthropologists must be extraordinarily cognizant of how skeletal materials are handled and chemically treated while in their custody. Few jurisdictions require bone samples to be extracted prior to anthropological analysis, and there are instances in which a case review at a later point in time may require molecular identification. Although chemical preservatives, such as polyvinyl acetate (PVA), are no longer in wide usage among forensic anthropologists because of the deleterious affects on DNA quality, there are no studies known to the authors that examine the impact of an even more widespread anthropological protocol – maceration. Anthropologists employ a varying array of chemicals and temperatures in maceration protocols but the affects on DNA quality and quantity are currently unknown. In addition, the anthropologist must always be concerned about the impact of soft tissue maceration on the subtle signs of sharp trauma. Since sharp trauma may leave only superficial marks in bone, it is possible that chemical stripping of the periosteum may compromise the appearance of incisions and/or create postmortem damage that may complicate anthropological analysis. Therefore, the purpose of this study is to evaluate the affects of common maceration techniques on DNA degradation and cut mark integrity.

In order to quantify the amount of mitochondrial and genomic DNA from both cortical and spongy bone, fresh pig (*Sus scrofa*) rib cage sections and upper forelimbs were utilized. Bone samples were taken for DNA analysis before and after maceration. To test cut mark integrity, a single researcher stabbed each set of remains twice and marked the end of the cut bone with a notch for later reference. The remains were macerated using a control of warm water (90°C) and multiple experimental procedures found in published and non-published sources, including: bleach solution, dish soap, and meat tenderizer, EDTA and papain, hydrogen peroxide solution, and alternative heating methods such as an incubator and microwave oven. Nonmetal tools and soft toothbrushes were used to gently remove loose tissue during the maceration process. Observations were taken of the texture of the meat and bones, odor, duration of procedure (in hours), and bone condition. The bones were allowed to air dry prior to examination.

A number of variables were scored for each experiment, including the time to complete maceration, ease of maceration, overall bone quality, and integrity of the cut mark. DNA recovery was quantified by initial

spectrophotometry (A230, A260/280), followed by fluorescence-activated quantification based upon the DNA amount per bone sample. Briefly, the DNA pools from each bone sample were labeled with the fluorescent intercalating agent SYBR gold (Molecular Probes, Eugene, Oregon) and overall amount of DNA was quantified using a FLA3500 PhosphorImaging System (Fujifilm, Tokyo, Japan). While the extraction of any amount of DNA from bone is quite significant, the isolation of intact DNA is the ultimate goal. To address this vital point, two experimental methods were utilized to detect the quality of DNA in each bone sample, agarose gel electrophoresis and PCR amplification. Following extraction, intact genomic DNA will run as a single band on an agarose gel. The presence of multiple bands or smears on the gel signifies degraded DNA. PCR amplification using primers designed to two gene loci, one nuclear and one mitochondrial, were then used to confirm the quality of the extracted DNA.

The results indicate that the type of maceration technique had little affect on sharp trauma observations (though bleach was problematic) but that the DNA recovery rate was negatively influenced by excessive heat and a number of chemical treatments. The most effective maceration methods that preserved DNA also proved to be the most economical. It is recommended that forensic anthropologists use conservative, non-aggressive maceration protocols in the likely event that the bones will be utilized as a source of molecular information.

DNA, Sharp Trauma, Maceration

H24 Two Miles and Nine Years From Home: The Taphonomy of Aqueous Environments

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The goal of this case study is to provide insight into how taphonomic factors can produce unusual wear patterns on human remains.

The recovery of human remains from aqueous environments remains a complex topic due to the dynamic nature of the environment. Important to the interpretation of the trauma on the bones is having information regarding: spatial orientation, water temperatures, pH levels, water currents, and abrasiveness of the submerged environment. Various taphonomic forces that affect human remains in water are only beginning to be understood, especially with regard to the estimation of the post-mortem interval and bone erosion patterns.

On January 4, 2002, Louisiana State University Forensic Anthropology and Computer Enhancement Services (FACES) lab personnel were called to a small pond near a road in East Baton Rouge Parish. A concerned citizen observed what appeared to be the tail end of a car in the pond and phoned the police. Though various people had noticed the metal protruding from the water over the years, until that day, no one had informed law enforcement. Upon retrieval of the mud-filled car from the pond, human remains were found inside the mangled vehicle. The visible remains were taken to the LSU forensic anthropology laboratory for analysis. A few days later, LSU FACES lab personnel traveled to a local wrecker yard, the location of the retrieved car, in search of any additional remains. Due to the distorted nature of the vehicle, a thorough search of the car was impossible. Using the "jaws of life," local firemen removed the top of the vehicle. This provided the FACES lab personnel complete access to the interior of the car. Additional human remains and personal items were recovered. Through analysis and 19-year-old dental radiographs, which were provided by a retired orthodontist, the remains were positively identified as a man who had disappeared almost nine years earlier.

Other than one right intermediate phalanx of the foot, all bones below the waist were recovered. This was due to the spatial orientation of the lower legs. Various bones of the upper body were recovered. Since the windshield was destroyed, the elements of the body that were not present in the vehicle could have been lost through the windshield opening at the time of the accident or upon removal of the car from the pond. The dynamic environment of the pond also could have displaced some of the elements.

Spatial orientation enhances or impedes taphonomic agents from affecting particular bone surfaces. In this case, the lower legs were protected from abrasive agents in the water by the leather boots the decedent was wearing. The boots were too short to protect the proximal tibiae and fibulae. The proximal ends of the fibulae were completely worn down symmetrically. Both tibiae also exhibited an interesting wear pattern. Each tibial plateau was completely worn away with the exception of a small lateral portion of the plateau. Symmetrical erosion was also evident on the innominates. The innominates were both worn completely away from the iliac crest down to the iliac pillar. Both ischiopubic ramii were also missing. Symmetrical erosion of these elements was caused by a combination of abrasion and spatial orientation. Abrasive agents in the water moving through the vehicle over a period of almost nine years attributed to this phenomenon. Another possible factor in the symmetrical abrasion of the innominates was the spatial orientation of the bones rubbing against the fabric of the car seat.

All human remains recovered from the vehicle exhibited varying degrees of wear and erosion from the aqueous environment. The unique erosion that occurred in this case was a result of abrasion, spatial orientation, and dissolution. This case study demonstrates how an aqueous environment can uniquely alter bone. By understanding the effects that aqueous environments can have on human remains, the forensic anthropologist is able to more accurately interpret the trauma that is evident on bones. This microenvironment provides a distinctive look at the taphonomy that can affect remains in a submerged vehicle.

Taphonomy, Aqueous Environments, Forensic Anthropology

H25 Dissolving Dentition: The Effects of Corrosive and Caustic Agents on Teeth

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By attending this poster presentation, the participant will become familiar with the chemicals that can be used to erode or dissolve the tissues of the dentition. This research provides an explanation of the chemical break down of the dentition in relation to masking identity.

With the evolution of forensic technology, methods for positive identification are becoming increasingly accurate. New methods allow for a corpse to be identified at almost any point of decomposition. The new technology and methodology has led to a more creative and resourceful criminal, and as criminals become more forensically aware their methods of disposal change. Although few cases have been documented where chemicals are the mode of body disposal, this method provides a seemingly fool proof and effective approach to disposal. Several household chemicals contain harmful agents that when used can result in the masking of identity. The purpose of this pilot study is to indicate which chemicals can be used in order to erode or dissolve the dentition, and what type of damage each chemical causes to dentition.

A local oral surgeon provided 20 adult human anterior and posterior teeth. Quantitative measurements of weight (g), crown width (mm), and tooth length (mm) were obtained for each tooth. Qualitative observations were recorded using digital imaging as well as photographs under a stereoscopic microscope. A small hole was drilled through the root of each tooth to allow for a wire to be inserted through the tooth. The five chemicals used in this project were muriatic acid (hydrochloric acid), sulfuric acid, potassium hydroxide, and two concentrations of sodium hydroxide, purchased through a local home improvement store and Fisher Scientific.

The molar concentration of the chemicals purchased through Fisher Scientific (potassium hydroxide, sodium hydroxide and sulfuric acid) was similar to the concentrations found in common household cleaning products. Eighty milliliters of each chemical was poured into a 100 ml beaker and assigned a letter. Four teeth were submerged into each beaker, with the chemical solution only covering the enamel portion of the tooth, thereby mimicking the surfaces that would normally be exposed had the teeth remained in the alveoli. To quantify and record the corrosive effects of the chemicals, measurements and images of the dentition were taken at two-hour intervals for a total of 8 hours. During this time the chemical solutions were not replenished.

Although all the chemicals tested demonstrated some level of dental destruction, the muriatic acid (hydrochloric acid) proved to be the most effective chemical in this experiment. Interestingly, the dentition submerged in muriatic acid showed a dramatic decrease in weight during the first two measurement periods. The authors hypothesize that this decrease in weight slowed as the chemical reaction subsided and the chemical degraded due to air contact and evaporation, suggesting that the most damage occurs during the first part of contact. After two hours of submersion the enamel of the dentition exposed to muriatic acid had dissolved, leaving the exposed dentin to slough off in sheets with only the organic component remaining. The dentition submerged in sulfuric acid showed some etching on the enamel surface, and at the end of the experiment the enamel surface had a white, powdery appearance (most likely the result of the breakdown of inorganic components of the enamel). The dentition exposed to the potassium and sodium hydroxide solutions showed minimal to no damage. Of all the chemicals tested in this pilot project the dentition exposed to muriatic acid left distinguishing marks and unique pattern on the dentition. With further investigation and analysis it may be possible to specifically isolate these characteristics as being unique to muriatic acid as well as other concentrations of hydrochloric acid.

Corrosive Substances, Dentition, Masking Identity

H26 Rituals Among the Santeria: Contextual Clues and Forensic Implications

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The purpose of this paper is to present contextual and taphonomic evidence to identify the ritualistic use of human skeletal remains and other artifacts found in association with Santeria shrines. In addition, information regarding the geographic distribution and historic beginnings of the Santeria religion are presented.

Originating in Cuba, the Santeria religion has been operationally defined as a syncretic fusion of Afro-Caribbean religions and Roman Catholicism. Development of the Santeria religion began in Cuba during the early 16th century when Spanish colonialists forcefully acquired slaves from Nigeria, the Congo, the Dominican Republic, and Haiti. In particular, slaves originating from the Yoruba region of Nigeria and to a lesser extent the Bantu from the Congo are considered to have been the major carriers of the African religious beliefs and practices that contributed to the Santeria religion.

Non-practitioners often describe the Santeria religion as a religion that is primarily based upon oral traditions, rituals, and animal sacrifices. Yet, growing conservatism among the Santeria has shown that many regard themselves as Catholic, having a belief system that is in line with "the ethical principles of Christianity" (Lefever 1996:2). Nevertheless, practitioners still seek Santeria priests (*santero*) in order to receive relief from physical pain, mental anguish, and protection from evil. The type of ceremony performed by the *santero* depends upon the type of problem to be solved: minor problems may be handled through the use of ritual objects, music, movement, and even esoteric words. Conversely, major problems require the invocation of the most important deities, necessitating additional propitiation including animals, rum, food, cigars, and water (Wetli and Martinez 1981). *Paleros* or *mayomberos* who perform rituals that stem from the black magic sect of the Santeria (the *Palo Mayombe*) are said to invoke injuries and deaths. Such rituals require the use of human skeletal remains.

According to González-Whippler (1994) skeletal elements from different ancestral groups are associated with special abilities. In particular, the crania of Whites and Asians are thought to invoke special powers. These associations suggest that certain skeletal material may be more desirable and should have a different frequency if the practitioners are truly able to select skeletal material for its magical powers.

Since the Mariel boatlift in 1980, the numbers of Santeria practitioners in the U.S. has increased. Researchers have estimated that as many as 300,000 practitioners live in New York City and nearly 70,000 practitioners live in Florida (particularly Miami and Tampa) with clusters of Santeria practitioners noted in Detroit, Chicago, Atlanta, Gary (Indiana), Savannah, and several cities in California (Lefever 1996). As such, medical examiners and law enforcement agencies may encounter Santeria shrines and their attendant problems regarding the origin and identification of the human remains with increasing frequency. Therefore, illustrative cases from the C.A. Pound Human Identification Laboratory (CAPHIL) and the Florida District 11 Office of the Medical Examiner are presented in order to shed light on the associated contextual data that can be used to determine whether the human remains used in religious ritual settings are of contemporary medico-legal significance. Beginning with casework conducted by Drs. Wetli and Martinez (1981), cases presented in the seminal article were reexamined, supplemented by at least thirty additional cases from the District 11 Office of the Medical Examiner and CAPHIL. Specifically, each specimen was examined for taphonomic clues of their origin and cataloged associated artifacts when the information was made available.

The skulls, crania, and occasional postcranial bones were recovered from a variety of contexts, including cemeteries, wooded areas, and homes. In some instances the human bones were found in association with black iron caldrons (called *nganga*) or wrapped in cloth or burlap bags and as centerpieces of altars. Artifacts in association with the skeletal material included knives, chains, locks, nails, beads, seashells, coins, candle wax, and mercury. The most commonly associated nonhuman bones included bird (chicken, parrot, and pigeon), bat, lizard, cat, turtle, fish, deer, pig, sheep and goat. Chicken feathers and blood were also noted on many of the bones and artifacts. No pattern was found in the application of chicken blood and feathers to any of these ritual items. Many of the human bones were acquired through grave robberies or biological and/or teaching specimens.

Citations:

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Santeria, Skeletal Remains, Artifacts

H27 Frozen Human Bone: A Histological Investigation

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The goal of this presentation is to determine the histological effects of freezing on human bone.

A plethora of research has been produced concerning the fate of human bone when it has been exposed to various external stressors. These include taphonomic processes such as natural weathering, decomposition, and burning studies. Each study attempts to aid an investigator by trying to determine, for example, what exactly a human skeleton would look like after it had been exposed to an accelerated fire for thirty minutes. The result of this type of research may afford an investigator the opportunity to analyze the evidence at the crime scene and compare it to the research in order to draw educated conclusions about the actual evidence. This is not to imply that all of the questions of investigators have been answered. Rather, each new case brings more questions and more variables that need to be taken into consideration.

One such question asks if there is a way to decipher whether a body or body parts have been previously frozen by looking at the skeletal elements. The circumstances that surround this question suggest that the victim would have been frozen for some time and was taken out of the freezing element and was allowed to thaw and decompose to the state of skeletonization. Would it be possible at this point to determine whether or not this body had indeed been frozen? Or, at a more basic level, does freezing damage the histological integrity of bone to prevent osteon aging ability.

Few studies incorporate both the variable of low temperatures and human remains. However, two such studies focus on the decomposition of the soft tissue after a freeze thaw event, but none have focused on the bone itself. While there is no evidence that freezing can change the gross morphology, there has been no research concerning whether or not the microscopic structure of the bone would be altered as a result of the freezing process. This research will attempt to determine whether bone that has been previously frozen would be histologically distinguishable by looking for a patterned anomaly, such as patterned cracking.

It is possible that the microscopic structure may indicate some changes due to the blood vessels, which run throughout the bone allowing for communication and nutrient flow between bone cells, undergoing the freezing process. Freezing allows for the expansion of fluids (including bodily fluids) and possibly for the forced increase in vessel diameter that may be evident, microscopically, in a section of frozen bone as small fractures in the bone microstructure.

In order to determine whether the freezing can be identified within the bone microstructure, it is necessary to freeze several human bone sections. After the sections have been frozen for twenty-one days, they are allowed to thaw in accordance with the circumstances surrounding the question. The samples are thin sectioned in order to view their microstructure. This analysis affords the opportunity to look for changes in the microstructure that may be indicative of the freezing process.

Statistically, the results of the microscopic analysis did not demonstrate significant differences in the histology of frozen and non-frozen human bone. The changes that were noted in the test samples (C samples) do indicate that some fracturing may occur due to the freezing process, although this fracturing may not be patterned nor may it occur systematically throughout the frozen bone. While this evidence of physical changes caused by liquid expansion is encouraging to note, the cracking was not consistently present throughout the sample set, nor, when found in a section of bone, was the cracking present around each of the haversian canals within the section.

Even though there is not a consistent pattern to the fractures noted in the sample set, this should not rule out some histologically identifiable changes associated with freezing. It is clear that it is quite possible that bone sections may undergo noticeable changes due to the freezing process, although this experiment was unable to ascertain such information using light microscopy. The second part of this experiment is to view the specimens under a scanning electron microscope to analyze the bone surface for evidence of freezing.

Bone Histology, Freezing Process, Microscopy

H28 The Effect of Heat Associated With Maceration on DNA Preservation in Skeletal Remains

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The goal of this presentation is to present to the forensic anthropological community the differences in skeletal CNA preservation before and after exposure to heat by maceration of soft tissue.

Genetic analysis is becoming an important aspect of the individual identification process in the field of forensic science. The discovery that DNA can be extracted from skeletal remains is becoming significant to forensic anthropologists because it complements identification by osteological analysis. The maceration of soft tissue is an important step in skeletal analysis because the removal of soft tissue makes signs of trauma and individualizing characteristics easier to see. However, the same taphonomic forces that affect bone preservation also affect the preservation of the DNA contained within the skeletal material. Heat is a factor that is known to increase the degradation process by accelerating the rate of the chemical reactions responsible for human decomposition. This poster will present the differences in skeletal DNA preservation before and after the process of removing soft tissue by boiling, and show whether these differences are significant in obtaining the amount of DNA needed for genetic analysis.

For genetic analysis, 15 *Sus scrofa* (pig) femora were sampled before and after 6 hours of simmering in water, 70 ml of Borax and 100 ml of bleach at 95°C. An additional 13 pig femora were sampled for genetic analysis before and after 10 hours of simmering in water, 70 ml of Borax and 100 ml of bleach at 95°C. Water was periodically added to keep the bones submerged. Two time spans were chosen in order to investigate a wider range of heat exposure. The femora were collected from pigs displaying varying stages of natural decomposition, ranging from 1 month to 1 year of surface exposure, which would be similar to the condition of skeletal remains that a forensic anthropologist would receive for analysis. Pig remains were chosen because the decomposition process and bone microstructural make-up are similar to that of humans, and because specimens are easily obtained for forensic studies.

A pig specific DNA probe was used to determine DNA quantification by luminescent detection using CDP-Star chemiluminescent techniques. Chemiluminescent detection relies on probes designed to bind to the DNA region of interest. Primers for a pig specific DNA sequence of 374 base pairs in length, a portion of the Pre-1 porcine short interspersed nuclear element, were designed to allow abundant amplification of the target DNA sequence. Short and long interspersed nuclear elements comprise over a third of the genome in higher eukaryotes and are common target sites for PCR based genetic fingerprinting. The Pre-1 porcine short interspersed nuclear element is found on several pig chromosomes at a relatively high copy number, and provides a tool for indirectly quantifying DNA recovered from pig bones. The Pre-1 DNA probe was produced by PCR amplification of DNA isolated from the white blood cells of freshly drawn pig blood obtained from a local veterinarian. The PCR product was crosslinked to an alkaline phosphatase enzyme that converts a dioxetane phosphate substrate to a dioxetane product. This conversion emits photons of light, which are captured on X-Ray film and used to determine the

amount of DNA in the sample. A greater luminescent intensity indicates a larger amount of DNA. Known amounts of DNA from the pig white blood cells were quantified and used to construct a standard curve by slot blot analysis. The skeletal DNA samples were then quantified by slot blot analysis and compared to the standard curve for analysis.

Temperature increases are known to accelerate the degradation rate of DNA by destabilizing hydrogen bonds, and increase the probability of strand breaks and cross-link formation. Comparing the amount of DNA obtained before and after maceration is of value to forensic anthropologists in demonstrating if the heat generated by the boiling of skeletal remains is great enough to affect the amount of skeletal DNA available for future genetic analysis.

Skeletal DNA, Maceration, Genetic Analysis

H29 Using Restriction Enzymes to Reduce the Inhibitory Properties of Bacterial DNA on PCR Amplification of Human DNA Sequences

Janene Curtis, BS, Archeology and Forensics Laboratory, and Christine M. Turk, BS, and Mary K. Ritke, PhD, Biology Department, University of Indianapolis, 1400 East Hanna Avenue, Indianapolis, IN*

This presentation suggests a protocol to successfully amplify a human DNA sequence (huTh01) from historic skeletal DNA samples that previously produced little or no Polymerase Chain Reaction (PCR) amplification. The results of this study demonstrate the potent inhibitory effects of DNA, obtained from a mixed population of soil microorganisms, on PCR amplification of huTH 01 (a short tandem repeat or STR) from human skeletal DNA. However, the PCR-inhibitory properties of soil microbial DNA was reduced by hydrolysis with a restriction enzyme.

When DNA is recovered from bone samples, PCR amplification of specific informative DNA sequences is often inhibited. Difficulties in amplification of DNA may be due to diffusible inhibitors from the soil and surrounding burial environment (that co-purify with the skeletal DNA) or non-diffusible inhibition (due to covalent modification of the template DNA). One hypothesized source of diffusible inhibition is non-human DNA contamination whose source is predominantly the bacteria that colonized the bone during decomposition. The circular bacterial DNA chromosome is less prone to degradation than linear human chromosomal DNA, and from bone samples is usually purified in great excess compared to human DNA. The physical presence of the abundant bacterial DNA could conceivably interfere with PCR amplification by 1) reducing the ability of a human-specific primer to anneal to its complementary sequence (mispriming on the abundant bacterial DNA); and 2) saturating the active sites of the Taq DNA polymerase making little or no enzyme available for binding to the minute amounts of human DNA present.

DNA extracted and purified from a mixed population of soil microorganisms (predominantly bacteria) was added to contemporary human DNA in a series of graduated ratios: 0.76 - 9.5 mg bacterial DNA was added to 0.112 mg of human DNA. The combined human and bacterial DNA samples were then PCR amplified using a primer pair designed to select for amplification of the short tandem repeat, TH 01 (huTH 01). PCR products were resolved by electrophoresis through a 10% poly acrylamide gel and visualized by ethidium bromide staining. The results indicated that DNA from a mixed population of soil bacteria was a potent inhibitor of PCR amplification from human DNA templates. All masses of bacterial DNA tested resulted in complete inhibition of PCR amplification of huTH 01.

In an attempt to remove the inhibitory effects of the bacterial DNA on the PCR amplification of huTH 01, the restriction enzyme *Pst 1* was used to hydrolyze the bacterial DNA before adding it to human DNA in the pre-PCR reaction cocktail. Aliquots of human DNA were combined with different amounts of either hydrolyzed bacterial DNA and or intact bacterial DNA. At a ratio of 2.7:1 (mg: mg) of hydrolyzed bacterial DNA to human DNA, amplification of hu TH 01 was not inhibited. At this same ratio, intact bacterial DNA was inhibitory to huTH 01 amplification. When bacterial DNA: human DNA ratios fell below 1.3:1 (mg: mg), the bacterial DNA did not inhibit PCR amplification of huTH 01 whether hydrolyzed or intact. When bacterial DNA to human DNA ratios of 11.4:1 (mg: mg) were tested, both hydrolyzed and intact bacterial DNA inhibited PCR amplification of huTH 01. Thus, there is a window at which hydrolysis of the bacterial DNA with *Pst 1* will enable PCR amplification to occur.

To test the potential of pretreatment of historic DNA templates with restriction enzyme, human DNA from three different historic bone samples was hydrolyzed using *Pst 1* restriction enzyme. This DNA, along with control bone DNA not treated with *Pst 1*, was subjected to PCR amplification of huTH 01. Amplification occurred for all three samples of bone DNA samples tested; however, more huTH 01 was amplified after pretreatment of the bone DNA with *Pst 1*.

These results have a practical application. Often when specific, informative DNA sequences cannot be amplified using bone DNA as a template, the amount of DNA used in the PCR reaction is decreased, to try to reduce or eliminate inhibitory effects of diffusible inhibitors such as foreign DNA. However, this method also dilutes the already limited amount of human DNA that can be amplified; if the human DNA is highly degraded to begin with (as is the case with historic samples) dilution may reduce the templates below the lower limit needed for PCR amplification. Attempts to separate the abundant bacterial DNA from the pg quantities of human DNA introduce the risk of contamination with contemporary DNA (from additional handling of samples) or the loss of the historic human DNA. However, results suggest that with the use of restriction enzymes, the original amount of bone DNA may be maintained or even increased; therefore a better chance of amplification and/or a higher yield of PCR product may be obtained.

Historic DNA, DNA Profiling, PCR Inhibitors

H30 Fire Scene Management Strategies for the Recovery of Human Remains From Severe Vehicle Fires

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This presentation proposes operational guidelines for scene management and recovery of victims of fatal vehicle fires.

Fatal vehicle fires pose unique challenges to fire investigators, medical examiners, anthropologists, odontologists, and law enforcement personnel. The presenters strongly endorse initiating this investigative function as a multidisciplinary team approach. This presentation proposes operational guidelines for scene management and recovery of victims of fatal vehicle fires. The key to all fire death investigations is the preservation of the scene and the documentation of evidence associated with the causation of the fire. Prior to conducting the removal process of fire victims, it is vitally important to remember that the fire may have been ignited to conceal elements of a crime or to make the death appear accidental. Suicide by incineration is an uncommon modality of self-destruction but there are documented instances of victims who prepare the scene to give the appearance of an accidental death. Death investigators are encouraged to approach all fire related deaths as homicides until they prove otherwise. These guidelines are presented to minimize postmortem trauma that may occur during the removal of a decedent from within the confines of a vehicle. Additionally, these steps are outlined to increase the accuracy of determining cause and manner of death, the origin of the

vehicle fire and significantly contribute to the identification of the vehicle's occupant(s). The following guidelines are proposed to outline procedures for recovering fatally burned victims of vehicle fires.

1. Quality scene maintenance begins with appropriate fire suppression. A fog or mist water application is suggested, rather than a powerful full stream of water. This is highly likely to reduce the amount of postmortem trauma to victim(s) inside the vehicle. Educate fire departments that if there is an obviously deceased individual(s) grossly burned in a vehicle fire, use the minimum amount of low-pressure water to extinguish the fire.

2. Subsequent to fire suppression a vehicle should be allowed to cool, and collected moisture should be permitted to drain from the vehicles interior. Fumes from burnt plastics, vinyls, paint and other chemicals should be given an opportunity to dissipate. This reduces the potential hazard of investigatory personnel inhaling toxic fumes.

3. The presenters have discovered that moving burnt vehicles to a secure environment, while the victim(s) remained inside, has produced considerable destruction of evidence and postmortem trauma to the victim(s). If the vehicle is in a location where it can be left for a brief period of time, it is highly recommended that the vehicle not be moved, but a large tarp be placed over the vehicle and a guard or police officer stationed to maintain scene integrity.

4. As in most investigations comprehensive quality photography of the scene is paramount. Every step of the recovery process should be photographed. Photographs taken with a wide-angle lens may yield clear evidence of a burn pattern as well as other details as to the fires origin.

5. Leave victim(s) in place, and have fire personnel cut away the side or both sides of the vehicle. This allows safe access for personnel removing victims and reduces postmortem destruction to the victim(s) body while being removed.

6. Notify a forensic anthropologist as soon as possible and request that they respond to the scene to assist in the recovery and removal of the victim(s). This is a crucial step in the recovery process, since severely charred human remains may be very difficult to distinguish from the various burnt debris from inside a vehicle.

7. Before anything is actually removed from the vehicle being examined, collect carpet and seat material samples from around the body of each victim. If any of the victim's clothing remains, samples should be collected and tested for the presence of accelerates. Liquids flow to the lowest level and ignitable liquids may "pool" in the clothing or matrix directly under the body. All samples from fatal vehicle fires should be placed in a glass jar, which is then placed into a clean, airtight metal container. A container should never be more than half full as a vapor space is vital to analysis.

8. If victim(s) have been fused, or are adhering to the seat cushions or spring structure of the vehicle seats, cut the seats loose with the victim still in place. The seat can be removed and transported to the medical examiner's office without disarticulating the victims.

9. Human remains should not be placed into body bags after removal. They can be placed on a sheet of plywood sheet covered with a clean, white sheet. Placing victims in conventional body bags after removal is likely to produce additional postmortem damage to the skeletal structure of the victim. Every effort should be made to transport the victim(s) to the medical examiner's office in the least disturbed condition possible.

10. Each decedent from a vehicle fire should undergo full-body X-Rays. This is necessary to assess whether elements of a crime may exist, such as bullets or shotgun pellets for example. Additionally, jewelry or body artifacts that might confirm the identity of the individual(s) may remain undetectable without the assistance of radiological examination.

11. Since most victims of extreme vehicle fires are identified solely by their dentition, extra caution should be exercised to preserve a victim's dental structure. The integrity of exposed teeth can somewhat be safeguarded by applying an aerosol adhesive.

12. After the fire victims have been removed, the vehicle should then continue to be checked by fire investigators to confirm the cause and origin of the fire.

13. Every effort should be made not to process vehicle fires with human remains inside at night unless it is absolutely imperative. Fragments of bone, jewelry artifacts, as well as other significant evidence is likely to be overlooked due to inadequate lighting.

Both presenters feel strongly that the above-mentioned guidelines will facilitate higher quality, more comprehensive fatal fire investigations. Fire department education as to fire suppression strategies where there are fatalities present is imperative, as well as establishing written procedural guidelines outlining the management of vehicle fire fatalities. It is suggested that a multi disciplinary approach to the scene management, victim recovery and identification of victims be initiated. It is also recommended that all entities involved in these types of investigations be made aware of the importance of a forensic anthropologist in the recovery process of human remains.

Forensic Anthropology, Fire Suppression, Suicide by Incineration

H31 Peculiar Marine Taphonomy Findings: Preservation of Human Remains as a Result of Submersion in Sequestered Environments

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The purpose of this presentation is to present, by means of text and photographs, the taphonomic model of decomposition observed in 52 human remains after 7 months at 800 meters underwater.

Due to a growing need for information the taphonomic study of human remains recovered from the sea in order to interpret perimortem and postmortem modifications and to estimate time since death has emerged. Forensic goals that may be advanced by determining individual identity, place of death, and cause of death, need a model of decompositional changes or of preservation and a theoretical understanding of marine ecology specific to the environmental context where the remains were found. A search for marine death data including human remains and their recovery yielded very few studies or case reports in literature. This presentation reports the findings of medical examinations of 52 human bodies recovered in October 1997, after seven months spent 800 meters underwater in the Adriatic Sea. Victims of the Kater I. Radez, the boat-people sank following a collision with an Italian Navy warship that was patrolling the Italian sea-frontiers (March 1997). In 1999, during the AAFS annual meeting (abstract G78), the authors discussed the model for the organization and operations that were used by the medical examiner's team to recover the bodies and establish personal ID of all the victims. The environmental conditions were: temperature 4°C, a sandy and muddy seabed, high pressure (81 ata), salinity 35%, oxygen 0.5 ml/l, darkness, current running from north-east to south-west (velocity: 10-15 cm/second). The bodies were found in each of four holds of the wreck: 8 in the steering-compartment, 24 in the bow, 9 in the stern, 10 in the middle hold, 1 in the engine room. In addition, 1 completely skeletonized cadaver was recovered outside the wreck, on the sea-bottom. All the victims were wearing winter clothing when the ship was engulfed but their heads and hands were uncovered. The human remains were scored for regional presence of soft tissue, exposure of bone, and disarticulation to determine the general decomposition pattern. The regions scored were the head, neck, hands, forearms, upper arms, feet, legs, pelvic girdle, and trunk. Initial adipocere formation (soft with a greasy consistency) appeared on covered areas of all the bodies. The head and hands were skeletonized in 57% of the cases, the hand-bones being disarticulated in 30% of these. The internal organs were in place and showed nearly normal coloration but demonstrated extensive softening and autolysis. The mechanism of soft tissue destruction in the skeletonized areas was the result of the feeding

activity of marine scavengers such as small size fish and molluscs: clusters of *Xylophaga dorsalis* and *Adula Simpsoni* used the clothing and wooden supports of the wreck as a substrate for attachment. Some very unusual findings featured square or snowflake shaped crystals attached on the skin surface in covered areas. In conclusion, the pattern and sequence of decomposition observed have to be considered unusual for human remains lying in a marine context for several months: they appear to be related to submersion of the bodies inside a sequestered environments like the holds of a wreck.

Marine Taphonomy, Human Remains, Decomposition

H32 The Landscape's Role in Dumped and Scattered Remains

Mary H. Manhein, MA, Ginesse Listi, MA, and Michael Leitner, PhD, Department of Geography and Anthropology, Louisiana State University, 227 Howe-Russell, Baton Rouge, LA*

The goals of this presentation are to assess and understand the relationship between the landscape and dumped bodies.

In February, 1987, at the American Academy of Forensic Sciences Annual Meeting in San Diego, Dr. Milton Newton, a geographer in the Department of Geography and Anthropology at Louisiana State University (LSU), co-authored and presented a paper in the Criminalistics Section entitled "Geoforensic Analysis of Localized Serial Murder: The Hillside Stranglers Located." In that groundbreaking paper, Newton used spatial analysis without computer technology to demonstrate that geography can be a valuable forensic tool to aid in capturing serial killers. In his words, "The classification of serial murderers as to 'type' becomes important when we consider the geographical need to map phenomena according to kind." Newton's work is just one example of the ways in which he and others have applied such mapping techniques to a wide variety of different spatial activities. Since the 80s, advances in modern computer technology have allowed various researchers to more quickly, efficiently and easily manipulate geographical data to demonstrate the impact of the landscape and environment on human activities. Additionally, forensic scientists have taken advantage of such powerful techniques. Computerized mapping assists law enforcement agencies in strategic planning, crime analysis, and other operations. In the past, the applications have ranged from simple pin maps, or other mapping analyses, to the organization of information in usable databases.

In this research project, the authors have combined the modern technology of the Global Positioning System (GPS), Geographic Information Systems (GIS), and Spatial Analysis (SA) with remotely sensed data, including Digital Orthophoto Quarter Quadrangle (DOQQ) images, to evaluate and analyze deposition sites of human remains from across Louisiana. The LSU Forensic Anthropology and Computer Enhancement Services Laboratory (FACES Lab) analyzed 100 for commonalities using GIS, GPS, DOQQ's, and SA. These cases included those delivered to the FACES Laboratory and a subset of 32 cases retrieved in the field by FACES Lab personnel.

In analyses of the larger data set, the landscape played a vital role in the ultimate location of the body. Also, the local taphonomic processes impacted the body's discovery and recovery. Variables considered in these analyses included season of the year, setting (urban, rural, or suburban), vegetation cover, easiest access to site, natural or manmade barriers, and the effect of scavenging animals.

The results of various statistical tests and spatial analysis on the subset of 32 cases demonstrate no statistically significant relationship between time since death and dispersal distance. Also, analysis shows that the circular variance, i.e., the direction of dispersal around the original dumpsite, appears to be random with respect to postmortem interval. On the other hand, a significant negative relationship exists between circular variance and distance, but, due to a small sample size, this result needs to be interpreted with caution.

To summarize, the results of this research clearly show that modern technology can provide forensic scientists with the tools needed to more accurately and efficiently interpret the landscape's role in the investigation of dumpsites.

Dumped Bodies, Geographic Analysis, Anthropology

H33 The Role of Textiles in Determination of Postmortem Interval

Kellie M. Gordon, BA, and Mary H. Manhein, MA, Department of Geography and Anthropology, Louisiana State University, 227 Howe Russell Geoscience Complex, Baton Rouge, LA*

The goal of this presentation is to assess the deterioration of a decedent's clothing to assist in determining postmortem interval (PMI) of a forensic case. Preliminary results have provided 88% accuracy in PMI estimation.

One of the most critical problems to be solved in the medicolegal field of forensic science is time since death, or postmortem interval (PMI). Determination of PMI typically falls upon the forensic pathologist, but in advanced cases of decomposition, a forensic anthropologist is often consulted. Accurate assessment of PMI is important because investigators can narrow the time frame of events for a case, a crucial step for law enforcement in forensic analysis. However, as PMI increases, the accuracy of determination of PMI often decreases. Rarely in a forensic case can PMI be determined based on one taphonomic variable. Yet, an investigator can aspire to having a basic understanding of the various effects that each variable may bring to the deterioration rate of a body to form a more comprehensive evaluation of PMI. This study offers forensic investigators another reliable method of determining PMI by analyzing the deterioration rates of various fabric types associated with actual forensic cases.

An analysis was completed based on a comparative evaluation of clothing curated by the Louisiana State University Forensic Anthropology and Computer Enhancement Services (FACES) Lab. A total of 17 forensic cases were examined. The clothing from each case is stored separately from the associated skeletal remains; therefore, assessments of PMI were based solely on a visual evaluation of the fabric and not on skeletal evidence. Also, the estimations were made without any previous knowledge of the history of the case, including the environment in which the decedent was found.

Only items of cotton, polyester/cotton blend, or polyester were examined. Shoes, belts, and leather goods were not considered. On some items, the tag on the clothing could still be read and the exact fabric composition was recorded. In cases where no tag was present, estimation was made as to the composition of the clothing based on its appearance, weave pattern, and texture. As the items were examined, a number of recurring characteristics presented themselves. Items with extensive insect activity, series of small (1-2) mm holes as well as the presence of larva cases, were generally assessed to be associated with a longer PMI than items with little or no evidence of insect activity. Overall insect activity was judged on the percentage of the item's surface area that featured evidence of such activity. Fading of the materials, as well as relative stiffness or fragility, was attributed to cases with longer perceived exposure to the elements. Polyester/cotton blends exhibited vertically aligned runs in the fabric and transparency, both becoming more prevalent with increased deterioration. The presence of adipocere was also considered in forming an estimation of PMI.

Once all of the clothing was evaluated in this blind test and a PMI estimation was made for each case, the official case files were then examined to determine the accuracy of the estimations. In 15 of the 17

cases considered, the PMI estimation either fell into the range previously assessed by the forensic anthropologist or hit exactly on the actual PMI of the case, providing 88% accuracy. Overall, an accuracy of 88% shows promise in the evaluation of the deterioration of clothing in relation to determining PMI of a forensic case. In addition, coupled with the analysis of the human remains, a more accurate assessment of PMI will be made.

Postmortem Interval, Fabrics, Forensic Anthropology

H34 It Came Out of the Sky: Cremains as an Aerial Hazard

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The goals of this presentation are to present to forensic anthropologists and others a unique situation involving human cremains as a destructive force.

Shortly before the end of 2001 a homeowner in the city of Grand Forks, North Dakota discovered a large hole in his backyard deck. Inside the hole were a ruptured paper bag and a whitish granular material. The material was subsequently identified as human cremains. The origin of the cremains remained a mystery for several months. An attorney eventually contacted the parties involved and related that family members had arranged to have the cremains of a relative spread over the city. The family of the deceased refused to provide any information regarding the deceased or the events surrounding the "dumping" of the cremains.

A shop vacuum was used to recover the cremains from under the deck surface. In doing so a large quantity of "pea gravel" was recovered as well. This gravel was manually sorted from the cremains. The cremains were then sorted by size into three categories: large 2-17 mm, small ca 1-2 mm, and dust. Respectively these weighed 1029 grams, 332.6 grams, and 1090.8 grams, for a total weight of 2452.4 grams (5.4 lbs). Not all the cremains could be economically or practically recovered (some cremains were scattered under the deck beyond reach). A rough estimate of 10% loss places the actual weight at around 2700 grams (5.9 lbs).

Many of the larger pieces had a visible red stain. Under microscopic examination this stain had a glass-like appearance and was fused to the bone surface, an artifact of the cremation process. The larger pieces also retained an intact periosteal surface. No fragments were large enough to identify. Otherwise the cremains are unremarkable. Various non-organic items were sorted out from the cremains. These are primarily metallic and represent clothing items or fasteners associated with the box within which the body was contained during the cremation (grommets, staples, twisted wire).

The deck that was struck by the bag of cremains was of standard construction using green treated lumber, 1 x 6 decking on two foot joist centers. The deck is approximately square measuring 5.5 m (18 feet) by 6.2 m (20 feet). The opening is ovoid 30.5 cm by 60.9 cm with the long axis running parallel to decking centered between two joists.

The terminal velocity of the bag of cremains was calculated to be between 31and 49 m/s (102 - 160 f/s) which would have been attained within 3 to 5 seconds after release at a minimum distance of between 49 and 122 m (160 - 400 feet). This yielded a kinetic energy at terminal velocity of between 1297 J and 3241 J (949 - 2371lbf).

Cremains, Kinetic Energy, Forensic Anthropology

H35 The Effect of Human Body Mass on the Rate of Decomposition

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The attendee can expect to come away from this presentation understanding: 1) differences in soft tissue removal rates for varying body compositions, 2) during which stage of decomposition there is a significant reduction in body mass, and 3) the relationship between internal body temperature and ambient air temperature relative to body mass.

All vertebrate organisms, given equal opportunity at death, will proceed through the same stages of decomposition. However, the rate at which individual organisms move through the stages of soft tissue and osseous destruction is dependent on a myriad of variables, including body mass. Previous studies examining the relationship between body mass and rate of decomposition are few. Hewadikaram and Goff (1991), using two domestic pig carcasses (*Sus scrofa L.*), provide the only systematic analysis of the effect of body mass, as well as the patterns of insect succession on the rate of decomposition. The authors found that there was a difference in the rate of decomposition, but not in insect succession, relative to the size of the carcasses. Their study showed that a greater number of adult flies were attracted to the larger carcass (15.1 kg. Vs. 8.4kg) resulting in larger maggot masses and more rapid removal of soft tissue.

Ongoing experiments in body mass and rate of decomposition are being conducted at the Anthropological Research Facility (ARF) located at the University of Tennessee using donated human bodies. To estimate relative body fat, skinfold measurements are recorded for each donated specimen upon arrival at ARF. Body mass, gross morphological changes, internal body temperature, external ambient temperature, and humidity are recorded daily for 30 days, followed by every third day for two weeks. Linear regression analysis is employed to measure the association between body mass, time, and temperature. Preliminary observations show that in the warmer months the most significant reductions in body mass occur during the bloat stage, and that a specimen can lose up to one quarter of its mass within a 24-hour period. Additionally, while specimens of various body compositions may lose up to a quarter of their mass in one day, those with greater relative body fat measures (i.e., greater fat mass) tend to lose mass more rapidly. However, further research is needed to confirm and expand initial results.

Previous studies documenting rates of decomposition in relation to body mass are few. This presentation will provide baseline regional information on rates of human soft tissue removal relative to body mass. Additionally, data derived from this project may aid the forensic anthropologist and forensic pathologist in estimates of time since death in the early stages of the postmortem interval.

Hewadikaram, Kamani A., and M. Lee Goff (1991) Effect of Carcass Size on the Rate of Decomposition and Anthropod Succession Patterns. *The American Journal of Forensic Medicine and Pathology.* 12(3):235-240.

Body Mass, Decomposition, Forensic Anthropology

H36 Understanding Rib Fracture Patterns

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During this presentation the dynamics of rib fractures will be discussed while introducing a new method for accurately describing the location of rib fractures. The ultimate goal is to test the predictive value of blunt force rib fractures.

Anthropologists face three challenges when analyzing blunt force rib fractures: first, understanding the mechanics of rib fractures; second,

describing the location of the fracture; and third, estimating the direction of the impact force. Galloway[1] states that rib fractures rarely occur at the point of compression. This behavior is seen because the rib is a single component in a closed system, which includes the paired ribs, vertebra, sternum, and costal cartilage. Force applied at any position or direction to the system is transmitted throughout the system. As the stresses are distributed through the system the weakest point fractures, which is not necessarily the point of impact.

Structural variation found within the rib further complicates rib fracture mechanics. The head of the rib is formed by relatively thick cortical bone. By comparison the sternal end is primarily composed of trabecular bone bound by a very thin shell of cortical bone. As a result the head of the rib fractures in both oblique and butterfly patterns, failing in tension before compression, while the sternal end of the rib often buckles, failing in compression before tension. Furthermore, the medial portion of the shaft often fractures in a transverse pattern that fails to indicate the direction of tension and compression forces. The first goal of this study is to understand the vast variation of rib fracture morphology and organize this variation into standardized categories.

White[2] identifies eight landmarks on the rib: head, neck, tubercle, angle, shaft, sternal end, costal groove, and cranial edge. Most of these landmarks are located in the posterior region of the rib enabling precise description of fracture location. However, the majority of the rib is identified as the shaft, creating a large wasteland of nondescript area. This lack of features makes communicating the location of a fracture difficult. In light of this, the second goal is to develop a method to accurately locate fracture lines throughout the rib. Conceptualizing the rib as one segment of a circle lends to viewing the system as a clock face. This enables breaking the cross sectioned thorax into twelve segments. Several numbers of the clock are assigned to landmarks and the nondescript areas between are divided in to segments by the numbers between those assigned. The method can be used to quickly and relatively accurately describe the fracture location.

The ultimate goal of the study is to determine the predictability of rib fracture patterns. This is accomplished through a database using the fracture patterns of victims when the direction of the traumatic force was known. The fracture patterns are coded and statistically compared for regularity. The final step of the study is a blind comparison of rib fracture patterns to the database in order to estimate the direction of force.

The extensive bone trauma evidence archived at the Regional Forensic Center, Memphis is used in this study. The bone is harvested during autopsy and retained for medico-legal purposes. The evidence includes males and females of all ages.

1. Galloway, A fracture pattern and skeletal morphology: the axial skeleton. In: Alison Galloway editor Broken Bones: Anthropological Analysis of Blunt Force Trauma. Illinois. Charles C Thomas 2000, 81-112.
2. White TD. Human Osteology. New York. Academic Press. 2000.

Forensic Anthropology, Rib Fractures, Blunt Force Trauma

H37 Features of Preexisting Trauma and Burned Cranial Bone

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After this presentation, the attendee will be able to: 1) recognize problems associated with analyzing burned human cranial remains, 2) establish expectations of normal artifacts from fire trauma, and 3) identification of aberrant features that may indicate preexisting trauma.

The majority of accidental fire deaths occur in homes or vehicles, but some are set to intentionally obliterate homicidal acts, personal identity, or incriminating evidence. Recognizing these is compounded when burning destroys the soft and hard tissues of the human body. With respect to the head, identity and injuries are readily obscured because of its structural vulnerability as protective layers of skin and muscle are quickly burned away, exposing bone to rapid organic degradation from heat. Absence of organic components leaves thin cranial bone fragile and susceptible to additional heat fracturing, mechanical fractures, deformation, and delamination (separation of tables). Within limits, these are expected to occur in thermally stressed cranial bone, but the danger lies when they either mimic or obscure antecedent traumatic features.

This problem is explored using a sample of 15 unembalmed human heads from anatomical gift donations, fully fleshed and preserved by freezing. Prior to and following placement of known trauma, each head was documented with lateral and anterior-posterior radiographs. Once fracture patterns and sites of impact were visualized on X-ray, each head was burned under controlled conditions while photographically recording soft tissue reactions of traumatized areas, followed by burn patterns in cranial bone. Experiments varied from partial to full cremation in order to appreciate the range of thermal degradation of traumatic stigmata and identifying characteristics. The fragmentary cranial remains were recovered, processed, and reconstructed to differentiate between trauma and the expected alterations of thermal destruction. In addition, known cases of homicide-related fires with trauma to the head were included in the study. All specimens were examined grossly and microscopically for patterns associated with trauma.

It is important to recognize the expected heat-related fractures in cranial bone prior to discussion of traumatic characteristics. Fleshed human crania burn according to the anatomically distributed insulative covering of soft tissue. Usually the superficial bony areas under the thin uniform scalp and forehead burn first followed by the thick muscular areas of the lower face. Heat dehydrates, shrinks and splits the to expose underlying muscle and bone. Heat destroys the organic composition, expressed through a progressive color range of buff (initial organic degradation), black (carbonized organic destruction), and white/gray (calcined inorganic structure). Aggressive interactions among rapid heating, vigorous shrinking of soft tissue including periosteum, and organic loss from the bone are responsible for initial creation of heat fractures in all stages of color, especially calcination.

A multitude of these may be present in the external table as small surface tensile cracks or superficial sites of delamination where the outer layer shrinks, separates and exposes the diploe. In several experimental crania, this produces a beveled appearance mimicking ballistic and blunt trauma. Advanced incineration or impacts while burning may produce fractures extending into the inner table. In calcined bone, sites such as these or open sutures may have a deep black outline around the breach from pressurized venting of organic materials within the vault. Examination of this feature is important since it was present in both known traumatized and non-traumatized (sutures and full thickness heat fractures) sites of the skull.

Linear fractures seen in a burned skull initially fall into a gray area since they have features of either heat or pre-existent trauma. These can occur during the earliest stage of burning as organic material undergoes destruction causing shrinking and splitting of bone. In areas of prolonged heat exposure, they may also radiate out from charred black areas into buff-colored bone freshly undergoing initial thermal alteration. However, they should not extend into green (unburned bone), as this is a feature of a preexisting fracture. Deep linear fractures sectioning all tables of cranial bone should be examined for morphologies along corresponding margins. Well-defined sharp margins are incurred in advanced calcined bone from thermal or mechanical fractures, possibly accompanied with deformation and shrinkage. Traumatic fractures have blunted deformed or even warped margins from thermal alteration. The difference becomes obvious following reconstruction, since heat fractures communicate more perfectly than traumatic fractures distorted by heat.

Features of traumatic injuries were easily evaluated during early stages of burning. Any compromise in skin integrity over the cranium

prematurely exposed bone to thermal destruction. Sites of cut marks or lacerations opened quickly and accelerated damage much like the effects of advanced decomposition around an open perimortem injury. Partial incineration provided an opportunity to observe the progressive effects of heat on the blunt, sharp, and ballistic trauma in cranial bone. Pre-existent linear fractures undergo little change through the ranges of unburned, initial buff, charred; calcined fractures become difficult to assess as margins gradually become beveled, ragged, blunted, or deformed. Suspected features should be closely examined and visually compared with a multiplicity of known dry postmortem heat or mechanical fractures surrounding the area.

Several distinct characteristics of blunt, ballistic, and sharp trauma do survive varying degrees of thermal destruction. With careful recovery and reconstruction techniques areas of inwardly crushed bone, ballistic and blunt beveling, features of impact sites, and sharp margins from edged weapons are preserved. Unfortunately dynamics of the burning environment, extinguishment methods, collapse of debris, and improper or incomplete recovery techniques can destroy these features. Therefore the likelihood of finding obvious signatures diminishes and less discernible than in unburned bone. Exercise extreme caution when looking for preexisting trauma and strive to use multiple indicators as supportive evidence. A variety of traumatic and non-traumatic features in burned cranial bone will be illustrated along with their forensic applications for evaluating burned bodies and bones.

Skeletal Trauma, Burned Bone, Fire investigation

H38 Burning Extremities: Patterns of Arms, Legs, and Preexisting Trauma

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After viewing this presentation, the attendee will be able to: 1) recognize soft tissue changes of fleshed arms and legs, 2) understand of the dynamics of pugilistic posture, 3) observe the progression of burning evidenced by color and heat-induced fractures in bone, and 4) identify effects of preexisting trauma.

Analysis of burned victims begins long after dramatic events of burning occur to soft and hard tissues of the body. What is seen at the medical examiner's office is an arrested phase of extremely dynamic processes involving heat, combustion, organic degradation and alteration of the body position. Little attention has been given to understanding processes creating burned trauma simply because it has not been directly observed. There are many clinically based theories about what happens to a burning body, and these misconceptions even make their way into well accepted forensic texts until disproved experimentally

A sample of 16 fully fleshed unembalmed human arms, legs, and torsos from anatomical gift donations were used in order to document changes during burning events. Several limbs were completely disarticulated at the humeral and femoral mid shafts while others remained anatomically intact. Conditions and activities of each experiment were documented with written notes, digital pyrometer, 35mm slide film, and digital camera based on timed intervals. These methods identified predictable sequences of burning for unobstructed extremities of the body, delineated phases of the pugilistic posture and established burning patterns for soft and skeletal tissue through all stages of burning events illustrated below.

Once placed in the context of heat, skin becomes waxy, glossy, tightens, blackens from charring, and begins to split into transverse, longitudinal, and stellate patterns. These windows expose underlying musculature, tendons, and finally bone. Shortening of tissues causes curling and abduction of fingers and toes, sequentially followed by gradual flexion of the wrist and ankles, contraction of elbow and knee, and finally localized tightening of the hip and shoulder. Bones become predictably exposed on the distal phalanxes, metacarpals, ulna, and radius as skin splits and burns away. Muscles and tendons from the proximal wrist quickly burn, disarticulate, mushroom at the margin, and recede distally to join the collective mass of tissue around the anterior surface of the elbow, while posterior effects expose the ulna, radius, and humerus. This is followed by gradual antero-medial rotation of the shoulder positioning the arm over the chest. Toes mimic fingers, splay and curl around the ball of the foot, while the ankle rotates medially, followed by a slow contraction of the knee and finally hip into the pugilistic posture. Superficial soft tissue protection around the knee and shin quickly expose bone followed by gradual destruction of musculature along the shaft. Unconfined arms and legs react in a sequential fashion as heat increases the severity of damage in direct proportion to time and temperature.

Prior to burning, several of the long bones were subjects of surgical practices and exhibited a variety of artifacts such as screws, plates, steel rod implants, and surgical cuts to skin and bone. All were easily identifiable during the post burn analysis, but observation revealed their influence in soft tissue and bone during the burning process. Superficial incisions in the skin were instantly affected by heat, tightening skin, with additional tensile forces from contracting muscle. Cut or traumatized soft tissues bulge and mushroom initially through surgical openings, resulting in premature exposure of underlying bone as soft tissue contracts and burns away. In a forensic setting, these results may indicate perimortem trauma to soft tissue or bone.

After bone is exposed, direct application of heat destroys the organic composition, expressed through progressive color changes of buff (exposure margin of initial organic degradation), black (charred bone undergoing organic destruction), and white/gray (calcined inorganic structure). Interpretation of these colors accurately reconstructs location, direction and extent of burning activity. Absence of color in advanced stages of incineration indicates complete loss of organic material, leaving stress signatures of longitudinal, transverse, curved transverse, and crazing heat-induced fractures in calcined bone. A variety of these may be present and by aiding interpretation of how and where soft tissue reduction occurred, help reconstruct events. One unique heat fracture identifies tissue regression as muscle tightens and pulls away, leaving a curving transverse defect as a watermark of gradual burning. Correlation of soft tissue burning and post fire fracture analysis further illustrates how tissue regression fractures are indicative of orientation and progression of burning in fleshed remains. The same is true for articular surfaces protected by soft tissue and cartilage, where stacked arcs of curved transverse fractures permanently illustrate the progression in burning and soft tissue reduction.

Fractured, cut, or compromised bone exhibits interesting patterns during the burning phases of soft and hard tissues. For example, one of the fleshed lower legs had been transected across the proximal mid shaft of the tibia and fibula with minimal surgical invasion in the overlying soft tissue on the posterior surface. Early in the firing, the powerful contraction of the leg muscles shortened and pulled the bone wide apart like a hinge; splitting skin, exposing muscle, and finally bone along the anterior surface, long before the knee drew up into the pugilistic posture. Post burn analysis of this specimen demonstrated the prolonged thermal effects due to the early exposure and even the calcined bone retained tool marks at sectioned surfaces and drill holes. These characteristics should be considered indicative of preexisting trauma since the mid shaft is an abnormal site for early burning to occur in most long bones. All features described above will be illustrated during this presentation.

Skeletal Trauma, Burned Bone, Fire Investigation

H39 The Influence of Behavior on Free Fall Injury Patterns: Possible Implications for Forensic Anthropological Investigations

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The goal of this presentation is to present the forensic community the results of an investigation into the influence of behavioral response (or lack thereof) on skeletal injury patterns in cases of falls from heights.

Victims of falls from heights tend to sustain a pattern of injury that is predictably different from injuries associated with other types of blunt trauma. Many studies have examined resulting injury patterns (particularly skeletal fractures) in attempts to reveal relationships between these patterns and various other factors such as body position, height of the fall, age, pre-existing medical conditions, etc. However, few have pondered the possibility of an association between skeletal injury pattern and cause or motivation of the fall.

Motivation or circumstances of a fall from a height can be a key piece of information in forensic contexts where it may be useful in assessing whether a victim's death resulted from a suicide, an accidental fall, a homicidal push, or whether death occurred prior to the fall. The patterns of skeletal injury may be of particular importance in cases where bodies are not discovered until some later time and soft tissue injuries are no longer observable, leaving a skeletal trauma analysis the only means of arriving at clues regarding the manner of death.

A key difference in these cases is the mental state of the deceased before and during the fall and their resulting behavioral response (or lack thereof). Victims of accidental falls and homicidal pushes do not consciously want the falling action to occur and will spontaneously, as a defense mechanism, attempt to interfere with and manipulate the physical forces acting upon them. They will attempt to protect their heads from impact with the ground, and/or extend appendages to brace themselves for impact. Suicidal persons, on the other hand, initiate purposeful action and may actually enjoy and welcome the fall, resulting in less preparation for impact. Studies indicate, in fact, that suicidal, psychotic, and inebriated individuals (who have been termed "abnormally relaxed") have a disproportionate survival rate among free falls of extreme distances as a result of their relaxed state. Similarly, severely incapacitated individuals or dead bodies (the extreme cases of "abnormally relaxed") would have no defensive response to the fall and impending impact. They are thus subject exclusively to the physical forces acting upon them.

This study examines the effect of these mechanical forces on the human body form in free fall in the absence of interference by human behavioral response. The hypothesis is that "abnormally relaxed" individuals will fall in a predictably different fashion than alert individuals due to the absence of a behavioral defense response, and that this will result in a distinct pattern of orientation at impact. Indeed, a review of case studies of free fall injuries indicated that most falls from heights result in lower extremity, pelvic and vertebral fractures, due largely to the fact victims of accidental falls tend to land in a feet-first orientation, a pattern that is notably different from studies of suicidal jumpers in which horizontal impacts and associated thoracic injuries and rib fractures are predominant. The investigation was undertaken by observing experimental free fall drops of an anthropomorphic dummy (representing the "abnormally relaxed" state) from a height of about 75 feet. Nine total drops were performed, using three different starting orientations; three falls began in a feet-first orientation, three began in a horizontal orientation, and three began in a headfirst orientation. All nine drops resulted in impact orientations that were roughly horizontal. Even over this relatively short fall, there was a distinct tendency for the dummy to rotate toward (or maintain) a horizontal orientation.

These results suggest that in the absence of a behavioral response, physical laws naturally orient the human form horizontally, probably because this is more stable position, maximizing drag forces. In light of these results, a review of a case study of a possible suicidal jump from 100 feet investigated by the University of Tennessee Forensic Anthropology Center was reanalyzed in an attempt to elucidate the possible circumstances of the fall. The pattern of skeletal injuries, which were primarily thoracic and axial, suggests a victim in a relaxed state at the time of the fall, lending support to suspicions that the victim was suicidal. The pattern of feet first injuries so pronounced in case studies could therefore be a result of the instinctive reaction of conscious humans to attempt to prepare for or resist impact. This information could be applied in forensic contexts by providing potential insight into the circumstances of a fall, particularly where skeletal fracture patterns are among the only clues.

Forensic Science, Forensic Anthropology, Falls From Heights

H40 Numerical Simulation of Fracture Propagation in a Test of Cantilevered Tubular Bone

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The objective of this paper is to present a new method for computing the geometry of fracture surfaces of bone.

Anthropologists recognize and use the fact that tubular bone fractures in a predictable way when cantilevered. Fracture orientation and surface morphology provides a means of establishing the mechanics involved in its production. The fracture typically propagates toward the cantilevered end, and a breakaway spur forms on the compression side of the cantilevered end. Although this pattern is recognized, the physics responsible for its production has never been demonstrated. A clear understanding of the physics involved in simple fracture production, as presented here, is an essential first-step toward the understanding of the factors affecting the formation of more complex fractures in tubular as well as flat bone.

This paper discusses the application of engineering fracture mechanics to the analysis of fracture formation in tubular bone specimens. The immediate objective is to present a new approach for the study of bone fracture—the Element-Free-Galerkin method coupled with a J-integral based crack propagation criteria. The Element-Free-Galerkin method was first introduced ca. 1994 by Belytschko, et al. The method is based on a generalization of the finite element method commonly used to compute the stress and deformation states in mechanical and human skeletal systems. The numerical method is general in scope and can be applied in principle to other bone morphologies.

In 1995, Belytschko applied the Element-Free-Galerkin method to the analysis of two-dimensional static and dynamic fracture problems. All of the problems considered by Belytschko used linear elastic fracture mechanics theory and concerned crack propagation in flat plates. It was shown that the Element-Free-Galerkin method was uniquely suited to crack propagation calculations because it is not necessary to regenerate the computational mesh as the crack propagates. Methods that require the regeneration of the computational meshes are computationally intensive, inherently slow, and often require user interaction. This first application of the Element-Free-Galerkin method to crack propagation was limited to linear materials that are brittle in nature and experience only small amounts of "blunting" (i.e., permanent deformation) at the crack tip. Cast iron is an example of an engineering material that demonstrates these properties.

In this study, the Element-Free-Galerkin method is extended to the fracture of tubular bone. A non-linear fracture mechanics approach, based on the J-integral fracture parameter, is used to control the crack growth rate and propagation direction. The J-integral was initially developed for

elastic-plastic materials, but has been shown to work well with other non-linear materials. The ultimate goal of this research is to develop a computer program that can compute fracture surface geometry based on bone morphology and loading data. For this study, the fracture morphology commonly seen in the fracture of cantilevered tubular bone (i.e., an angled fracture with a breakaway spur) is compared to simulation results. Areas in which the simulation results agree/disagree with the experimental data are discussed. The results of this study contribute significantly to the understanding of how engineering fracture mechanics theories and computational methods can be used to explain specific fractures. Eventually, virtual models of various bones in three-dimension may be used to facilitate an understanding of the mechanics involved in the production of butterfly, spiral and other fractures commonly seen in tubular bone. In addition, the affects of the cross-sectional shape of bone (e.g., femur versus tibia) and bone buttressing on fracture morphology may be examined with this approach. This approach will also allow the investigation of varying intrinsic qualities (e.g., bone brittleness and elasticity), as well as extrinsic factors (e.g., rate of loading, area of application, and impulse).

Although the methods used in this study are highly mathematical and use advanced simulation methods, the purpose of this paper is to provide the forensic community with an overview of a new simulation method and the results of a research study without dwelling on the mathematical detail. Computer generated images and graphs will enable the results to be understood.

Bone Trauma, Finite Elements, Fracture Mechanics

H41 An Evaluation of the Relationship Between Human Pelvic Size and Shape and the Distribution, Type, and Severity of Vertebral Degenerative Disease in Archaeological Material

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The goal of this presentation is to determine if there is association between pelvic size and shape and the distribution, type and severity of vertebral degenerative disease. The latter included osteophytosis, osteoarthritis, and intervertebral disc degeneration. Initial analysis of the data has confirmed current concepts regarding differences in size and shape of the female and male pelvic girdles. Evaluation of the effects of the pelvis on the site, severity, and distribution of vertebral degenerative disease are currently being undertaken and it is hoped that the results of this analysis will be presented.

In order to adopt an efficient bipedal posture and method of locomotion, the human skeleton has evolved a curved vertebral column and a stable, compact male pelvic girdle. The adaptive vertebral curves are most marked in the areas of C4-C6, T8-T10, and L3-L5 and the habitual force of gravity upon this configuration renders it susceptible to injury and degenerative disorders, such as osteophytosis, osteoarthritis, and intervertebral disc degeneration.

This research aimed to determine if there is any association between pelvic size and shape and the distribution, type, and severity of vertebral degenerative disease. As a compromise has been reached between efficient upright posture/bipedal locomotion and the size and shape of the female pelvis in relation to its role in parturition, a difference between the rates of degenerative disease was expected between the two sexes. Very little research to date has been conducted on the pelvic girdle and its relationship with other anthropological and palaeopathological parameters, so it is hoped that this study will help establish whether the actual size and shape of the pelvis alone bears any relation to the distribution of degenerative disease in the vertebral column.

A total of 103 documented individuals were examined form four British archaeological sites, spanning the 17th to the 19th century. The sites comprised, Christ Church, Spitalfields, London; St. Brides, Fleet Street, London; Kingston Quaker Burial Ground, Kingston Upon Thames, London; and St. Nicholas, Sevenoaks, Kent. The sex and age of these individuals is known from associated documented biographical data, and the sample represented a northwest European, middle class, population. The sample consisted of 62 females (aged 17-87 years, mean = 52.08, SD = 18.24) and 41 males (25-75 years, mean = 52.66, SD = 14.77).

Collected were 62 measurements from the pelvic girdle and its separate components were collected, together with an assessment of pelvic shape. A working system for recording the distribution and degree of severity of degenerative change in the vertebral column was established for 24 vertebrae (7 cervical, 12 thoracic, and 5 lumbar) in addition to the first sacral vertebra and occipital condyles. Recognized recording standards were adopted, and in the case of osteophytosis and osteoarthritis, included detailed assessment of osteophytes, extent of circumference affected by lipping, degree of surface porosity, extent of surface affected by porosity, degree of eburnation, and extent of surface affected by eburnation. These attributes were also ascribed, when present, to the costal facets in the case of the thoracic vertebrae.

Schmorl's nodes were described according to four parameters: their status, position, greatest depth, and shape. Aside from noting the presence or absence of a node, there exists no standardized method for recording these entities. A scheme for indicating the position of a node on the vertebral surface has been published in the literature and this approach was adopted for documentation of this parameter. Measurement of the greatest depth was achieved by employment of the depth measurer on the digital sliding calipers. New strategies were developed to allow status and shape of the node to be recorded.

Initial analysis of the data has confirmed current concepts regarding differences in size and shape of the female and male pelvic girdles. Age was found to have no significant effect upon the measurements recorded. Strong correlations have also been identified between certain individual measurements and reasons for this have been suggested. Evaluation of the effects of the pelvis on the site, severity and distribution of vertebral degenerative disease are currently being undertaken and it is hoped that the results of this analysis will be presented. Final results should enhance understanding of this particular pathological process and the factors responsible for its development, thus determining whether pelvic shape and size does play a role in its occurrence.

Bipedal Adaptation, Pelvic Shape, Pelvic Dimensions

H42 Assessment of Muscular-Skeletal Robusticity in Personal Identification of Human Remains

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The goal of this presentation is to present to the forensic community a critique of various morphometric procedures used by forensic anthropologists in measuring degrees of muscular-skeletal development in human remains.

This study adds to the standard protocol used by forensic anthropologists in determining personal identification of human remains: the assessment of degrees of muscular-skeletal robusticity. In cases where anatomical soft tissue structures are taphonomically degraded, as at scenes of mass disasters or under certain conditions of interment, the investigator may be able to reconstruct the massiveness of the skeleton which is a measure of the degree of strengthening or structural buttressing of bones by augmentation of osseous tissue ¾ a response to high mechanical loading. This condition, called "robusticity," has the potential to supplement other morphometric data by providing a profile of general

body form in life and specific characteristics of bones for reconstruction of those agents conducive to varying intensities of muscular-skeletal development. Gracile body forms and skeletal elements reflect reduction of factors contributing to robusticity, but are equally relevant to positive identifications of individuals.

Two questions are addressed: (1) how has muscular-skeletai robusticity been accounted for by anthropologists and anatomists? and, (2) how can this variable be measured?

Answers to the first issue invoke agents played by genetic inheritance, climatic conditions, and changes, geography with an emphasis upon latitudes, lifeways and individual behavior patterns. The latter category would involve skeletal changes related to markers of occupational stress (MOS), athletic activities, demands of different socioeconomic patterns, and stresses imposed upon locomotion by the terrain. Geographical and climatic explanations favor hypotheses that in hot tropical regions muscular-skeletal robusticity is low or absent in the postcranial skeleton (but not necessarily in cranial structures) and body builds are linear; in regions of cold stress conditions, more massive body forms are accompanied by high muscular-skeletal robusticity.

The present investigator proposes that no single cause accounts for degrees of muscular-skeletal robusticity found in ancient and modern populations or individuals. This was tested by comparing values of the "Robusticity Index" (ratios of femoral lengths of mid-diaphyseal diameters or circumferences) in three human skeletal samples (modem South Asians, Mesolithic South Asians, a modem series from France). Bivariate and multivariate statistical analyses indicate that comparative values of the Robusticity Index are insignificant given the slight differences between them. The high degree of robusticity represented in the prehistoric Indian series was exhibited in their femora, as well as in their other postcranial bones, by pronounced markers of occupational stress. Parallel markers of occupational stress were present in the French sample where individuals gave evidence of labor-intensive lifeways.

It is concluded that hypertrophy of MOS, rather than the Index of Robusticity, is a superior measure for reconstructing degrees of muscular-skeletal robusticity in the postcranial skeleton. Thus forensic anthropologists stand to gain a new approach to their practice of personal identification of human skeletal remains.

Definitions of Muscular-Skeletal Robusticity, Personal Identification of Human Remains, Methodologies in Forensic Anthropology

H43 Body Weight Estimation in Forensic Anthropology

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The goals of this presentation are to explore the role of body weight prediction in the biological profile and to examine techniques of body weight prediction from skeletal remains.

Although estimates of stature, age, ancestry, and sex are assumed components of the biological profile, estimation of body weight is not. Investigators at a crime scene will ask for body weight but this author has never formally addressed the request within the report of the osteological examination. Searches of the forensic literature reveal very few references to body weight estimation. The purpose of this presentation is to explore the role body weight estimation has in the biological profile, if any, and to examine techniques for estimating body weight.

Body weight has several features that make it an undesirable component for a biological profile. The purpose of the biological profile is to recover details from the skeletonized decedent that can be compared to a persistent record, such as photographs, identification cards, and medical records and films. In American society body weight is recorded in medical records and more infrequently for identification cards, so the possibility of identification is dependent on limited records. Weight is such a sensitive issue that, like stature, it is broadly subject to inaccuracy when self-reported. Weight differs from stature in that a witness might easily reconstruct the latter by comparing an individual to his or her height, but be reluctant to perform the same analysis for weight with any precision. The most detracting feature is that weight defies record keeping by being capable of dramatic change over relatively short periods.

Despite that body weight is a component of the identity of the deceased, the handicaps make it seem inappropriate for analysis. Yet at the very least the anthropologist would be providing information that helps the investigator refine a search image. Also, while the relationship between body weight and biological parameters such as life span or feeding behavior is understood on the species level for many animals, its effect on individual humans in a forensic context is not well explored. Knowledge of individual body weight could inform patterns of degenerative joint disease and cardiovascular disease, body transport and disposal and other taphonomic processes. The objection that weight is too nebulous to define is countered with the fact that given sufficient skeletal material (a restriction that applies to all components of the biological profile) a minimum range of weights would be obtainable simply from standards of weight for height. Then additional observations may be applied, such as clothing size if available, the trend to gain weight with age, or the circumstances of body disposal, to suggest an upper limit.

If body weight is included in the biological profile, how can it be reconstructed from human skeletal remains? Several options, most derived from palaeoanthropology, seem available. Palaeoanthropology and forensic anthropology both cope with the winnowing effect time and nature have on skeletal material, but the former subfield's focus on reconstructing the biology of extinct species has generated a larger toolkit for estimating body weight. However only a few of the techniques are applicable to modern humans. An early study by Baker and Newman (1957)[1] suggested dried bone weight be used to estimate body weight, but arriving at a standardized level of bone dryness made this technique difficult to apply. For measurements of several long bones and vertebrae McHenry (1992)[2] and Hartwig-Scherer (1994)[3] showed strong relationships (suggesting good predictive power) to body weight for modern humans. Aiello and Wood (1994)[4] and Gauld (1996)[5] have shown similarly strong relationships between measurements of the cranium and body weight. This study will focus on the cranial studies in order to illustrate the considerations involved in estimating body weight from skeletal measurements.

Aiello and Wood and Gauld both demonstrated high ($r > .90$) correlations between some cranial measurements and body weight in mixed primate (human and nonhuman) samples. Aiello and Wood focused on external measurements of the face and vault, while Gauld used vault thickness measurements. In addition to having a mixed primate sample these authors also relied on predictions for specimens not having recorded weights. Results were not reported for the strictly human parts of their samples, so this author designed a study with applicability to modern humans. One hundred forty-seven adults of recorded body weight (100 drawn from the Terry collection at the Smithsonian National Museum of Natural History and 47 from recent autopsies) were sampled for nine ectocranial and seven cranial vault thickness measurements. No prior effort was made to exclude emaciated individuals from the Terry collection; rather individuals were sorted during the analysis. Effort was made to adjust for fatness in the autopsy sample using triceps and subscapular skinfold measurement to estimate lean body weight. The correlation coefficient (Pearson's r) was calculated for each measurement and body weight.

The results of this study did not resemble those from Aiello and Wood or Gauld. Whether considered as separate samples (autopsy or skeletal) or one combined sample, none of the cranial measurements produced correlation coefficients higher than .6. The results did not improve when individuals below 100 pounds were removed from the Terry sample. The cranial thickness measurements were particularly poorly correlated to body weight, such that only one of the seven measurements (at lambda)

produced a significant correlation. These contrasting results are likely the product of 1) having a strictly human reference sample, 2) incomplete replication of the cranial measurements between this and the previous studies, and/or 3) using only measured not predicted body weights. This current study indicates that while resources are available for estimating body weight from postcranial material, more research is needed into the feasibility of using cranial measurements.

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Body Weight, Biological Profile, Craniometrics

H44 Radiographic Human Identification Using Bones of the Hand: A Validation Study

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Attendees will discover how to utilize posterior-anterior radiographs of the hand to make a positive identification of unknown human remains and learn the results of a validation study testing this method.

This paper has 3 objectives: (1) to demonstrate how forensic scientists can utilize posterior-anterior hand radiographs for positive human identification, (2) to disseminate the results of a validation study testing this method, and (3) to explain which anatomical criteria proved to be the most useful and least beneficial to the examiners in the identification process.

Positive identification of unknown human remains is a critical part of the medic-legal investigation. Common methods of obtaining a positive identification include DNA, fingerprints, dental radiographs, and other radiographic comparisons such as frontal sinus pattern. A recent Supreme Court ruling from 1993, Daubert v. Merrell Dow Pharmaceuticals, Inc., requires that the standard for scientific evidence in a federal court is the reasoning or methodology underlying the expert's testimony must be scientifically valid. The Daubert test of scientific evidence relies on a preliminary ruling by the judge on whether the scientific theory or technique is scientifically valid based on "widespread acceptance", peer review, publication, testing, rates of error, and the existence of standards. Validation studies, as noted by previous publications and papers at American Academy of Forensic Sciences meetings, therefore, are important for each discipline in the American Academy of Forensic Sciences because scientists need to be able to prove that their scientific testimony is supported by the Daubert test. It should be noted that Daubert is a federal court requirement for evidence, but many states have accepted it for their evidence standards.

In order to investigate the validity of posterior-anterior radiographs of the hand for human identification purposes, a series of radiographs was taken on human cadavers that are part of the Willed Body Program directed by Michigan State University, Department of Radiology, Division of Anatomy. In an effort to approximate antemortem x-rays, radiographs of 50 left hands were taken in the Michigan State University Gross Anatomy Lab using a General Electric Amx2 portable x-ray unit. The radiographs were taken in a manner to replicate the standards employed by radiographic technicians for posterior-anterior hand radiographs of living patients in clinical situations. The distance between the x-ray source and the film cassette was maintained at 40 inches, while the central ray was directed perpendicular to the film at the third metacarpophalangeal joint. The settings on the x-ray machine were set at 50 kVp, while mAs varied from 8-10 mAs for the antemortem radiographs, and 50 kVp and 3 mAs for the skeletal postmortem radiographs. A large, square piece of plexiglass was used to force the hands of the cadavers to remain flat on the radiographic film.

Taking radiographs of 10 of the hands from 40 of the above individuals generated the "postmortem" sample. These hands were removed from the body and processed at the Michigan State University Forensic Anthropology Lab into bony specimens by removing all the soft tissue. The specimens were then re-articulated using a low temperature hot glue gun. Care was taken to orient the bones in an orientation that was similar to the antemortem radiograph. A radiograph was then taken of these reconstructed hands, in essence mimicking a skeletal postmortem radiograph.

The validation component of this study examined the accuracy of making positive identifications between antemortem and postmortem radiographs of the hand. Participant examiners, one forensic anthropologist, four forensic anthropology graduate students, and two forensic pathologists received 50 radiographs from 40 different individuals. They compared 40 antemortem radiographs of fleshed hands from known individuals to 10 postmortem radiographs of bony hands from unknown individuals. No more than one individual represented each one of these 10 postmortem radiographs from the group of the original 40. The participants worked independently, without assistance from others, to match the correct postmortem radiograph to its appropriate antemortem match. The participants were also asked to note on a data sheet which specific anatomical and morphological features were used for identification purposes.

Nine participant examiners were involved in the validation study, with eight completing the study. One individual did not complete the study due to a lack of radiological identification training, thus the individual was not comfortable assigning any positive identifications. Of those who completed the study, results varied. In general, profession, experience level and specific training in radiological identification had a drastic effect on not only the ability to complete, but also perform well in the study. Three forensic anthropologists and three experienced forensic anthropology graduate students had a perfect score in positively identifying the 10 postmortem hand radiographs, which included one radiograph that did not have a corresponding antemortem match. The participants with the most experience and training in radiological identifications had higher accuracies when compared to those with less experience and specific training. Participant examiners noted trabecular patterns of the proximal and middle phalanges, distinguishing radiopaque and radiolucent features, and degenerative changes as the anatomical features that aided their identification. Distal phalanges and carpals were most frequently noted as the skeletal features that were least helpful in the identification process.

This study demonstrates that the comparative analysis of hand radiographs is an appropriate method for positive identification. When experienced forensic anthropologists completed the exercise, their accuracy was 100%. The study also illustrates that examiners with less experience and training may not be qualified to perform comparative radiographic analyses. Further research is intended to expand the pool of expert examiners in order to provide a sufficient sample for statistical validation.

Human Identification, Hand Radiographs, Validation Study

H45 Using Amplification of Bacteriophage Lambda DNA to Detect PCR Inhibitors in Skeletal DNA

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The goals of this presentation are to present to the forensic anthropological community a technique to detect the presence of PCR inhibitors in skeletal DNA. Using a mixture of a small amount of concentrated skeletal DNA and dilution of bacteriophage lambda DNA, the analyst can successfully detect PCR inhibitors early in the process and add additional purification steps to remove them from the skeletal DNA.

The analysis of DNA from skeletal remains is becoming a useful tool for forensic anthropologists. Genetic analysis complements the osteological examination and aids in the identification process. However, analysis of DNA samples obtained from bone may be challenging due to the presence of contaminating molecules that can later interfere with the process of DNA fingerprinting. These inhibitory substances may not be removed with conventional methods used to extract purified skeletal DNA. The cause of PCR inhibition may vary among samples because the different taphonomic forces that effect bone degradation also have an affect on skeletal DNA. Soil components, such as iron or tannins, may leach into the bone tissue during diagenesis and co-purify with the DNA contained within the skeletal remains. PCR inhibitors may also be the maillard products of sugar reduction or humic acids, which are a mixture of substances produced by the decay process. In the case of PCR analysis, the presence of these inhibitory molecules may result in a failure to amplify a decedent's DNA sequence needed for identification. Genetic analysis is expensive, time consuming, and destructive to the skeletal remains. If PCR inhibitors can be detected early in the process of genetic analysis, it can reduce the amount of skeletal remains lost to unsuccessful amplification. This paper will present a simple technique that can be used to detect PCR inhibitors in skeletal DNA.

A series of dilutions were performed using lambda DNA in order to find a concentration that would be both sensitive and not saturating to the inhibitors. A preliminary amplification of lambda DNA was then used as a quality control indicator for the skeletal DNA. The lambda DNA was mixed with a small amount of concentrated bone DNA and lambda specific primers. The mixture was then subject to 35 rounds of PCR at 95°C for one minute, 62°C for one minute, and 72°C for one minute. Inhibitors carried through the DNA purification process may block the amplification of the lambda DNA, and a failure to amplify the lambda DNA from the mixture indicates the presence of inhibitors in the skeletal DNA samples. Bacteriophage lambda DNA was chosen for this study because it is inexpensive and abundant in molecular laboratory facilities. The DNA tested for the inhibitors was extracted from the femora of 6 different historic human skeletal specimens. These DNA samples previously failed as templates for PCR using human specific primers. As a control, DNA from a human skeletal specimen that previously was successfully subjected to PCR analysis for human specific DNA fragments was also analyzed.

Sampling of bone tissue for genetic analysis is becoming an important aspect of the identification process in forensic anthropology. The skeletal material is valuable to the anthropologist and a minimal amount should be destroyed in the DNA extraction process. Contaminating molecules introduced into the skeletal remains during decomposition may complicate genetic analysis. With the early detection of inhibitors, additional purification steps may be added to remove them from the sample and save valuable amounts of skeletal DNA from loss due to fruitless PCR amplification. The results of this experiment show a concentration that is effective in detecting the PCR inhibitors found in some skeletal DNA samples.

Skeletal DNA, PCR Inhibitors, Lambda DNA

H46 Nuclear DNA Preservation in Soft and Osseous Tissues

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The goals of this presentation are to further elucidate the relationship between gross tissue condition and nuclear DNA preservation. Participants will learn about the utility of organic vs. inorganic DNA extraction techniques as well as troubleshooting failed PCR amplification attempts when dealing with degraded DNA. Furthermore, environmental and laboratory contamination prevention and detection will be addressed.

During the previous decade, forensic investigators have witnessed a paradigm shift to an increased reliance on DNA based decedent identification techniques. The benefits of DNA evidence include relatively high discriminatory powers as well as the capability of providing a match probability and likelihood estimate for each comparison. However, DNA identification has several limitations. Of primary concern is the ability to obtain authentic DNA from the decedent remains. This limitation has prompted research on biotic and abiotic variables affecting postmortem DNA degradation. In the laboratory, investigators have subjected isolated teeth, ribs, and bloodstains to a range of temperatures, pH, UV irradiation, soil types, and humidity levels for varying amounts of time [1,2,3,4]. Relatively few investigators have explored the possible correlation between tissue preservation and DNA survival under actual rather than laboratory conditions [5,6,7]. This study will refine the current understanding of postmortem nuclear DNA degradation by sampling a range of tissues under natural conditions from individuals with documented taphonornic histories. The following questions will be addressed: (a) Which DNA extraction method (phenol chloroform vs. silica) appears to be most effective for each tissue and postmortem sampling interval? (b) Is there a positive correlation between locus size and postmortem interval as measured by total body score and accumulated degree-days? (c) Are there variations in DNA quantity and quality when comparing a range of soft and osseous tissues? What are some potential reasons for these variations in DNA preservation? (d) Can DNA degradation and PCR inhibition be distinguished when presented with a failed amplification? Which PCR inhibitor prevention strategies work best given the taphonornic history of the samples?

Weighing between 45 and 60 pounds, 28 pigs (Sus scrofa) were stunned using a captive-bolt gun and exsanguinated on June 8, 2001. The pigs were then deposited, 14 in each of two environments: tree cover surface and pond shore. These environments were located adjacent to each other within the Cornell University Experimental Ponds facility in Ithaca, New York. Tissues were collected on a scheduled basis beginning several hours postmortem, continuing on a biweekly, monthly, and bimonthly basis for 20 months. During this time, tissues were harvested from each pig twice, once in the first 10 months and once in the second half of the experiment. This schedule minimized anomalous tissue exposure in the early postmortem period, which would compromise the "natural" degradation process. When present, lung, liver, spleen, psoas muscle, adipocere, skin, and hair samples were collected. Additionally, ribs, lumbar vertebrae, femoral shafts, and parietal bones were collected at each sampling period. All samples were placed in a -20°C freezer upon procurement to minimize further DNA degradation. At each sampling event, gross decomposition was quantified and accumulated degree days were calculated as described by Megyesi [8]. This method results in a representation of decomposition state that will potentially reduce the subjective nature of qualitative descriptions, allowing a proper assessment of the relationship between gross preservation of sampled tissues and DNA preservation.

For comparative purposes, each tissue sample was extracted using an organic (phenol-chloroform) and inorganic (silica) protocol. Following extraction, the DNA was quantified using slot-blot hybridization with a porcine specific radioactive probe. PCR amplification of four short

tandem repeat (STR) loci varying in size was then utilized to assess DNA degradation by measuring allele dropout. Five percent of the samples were then sequenced to assure amplification of the target loci. In situations where repeated amplification attempts failed, several methods were employed to overcome PCR inhibition. These include the addition of more DNA polymerase to the amplification reaction, which might overcome a potential inhibitor, the addition of bovine serum albumin (BSA), and the addition of sodium hydroxide. Each of these methods is compared for their effectiveness in resolving PCR inhibition. Contamination issues, which are of primary concern when dealing with degraded samples, are also addressed through the use of positive and negative controls throughout the study.

The ability to use a rapid, non-invasive screening process to assess potential DNA yield from various tissues allows for the optimization of sampling protocols in cases where limited sample is available. Optimizing tissue sampling for DNA analysis is also of keen interest to the mass fatality incident investigator who is charged with the identification of numerous decedents whose remains are often highly fragmented and degraded due to thermal and/or decomposition processes.

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Nuclear DNA Preservation, Taphonomy, Decomposition

H47 The University of Tennessee/ FBI Human Remains Recovery School

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The goals of this presentation are to inform the audience of class objectives and what agents learn about recovery of human remains.

Since 2000, the Federal Bureau of Investigation has sponsored the Human Remains Recovery School designed by the Forensic Anthropology Center at the University of Tennessee. During a week each spring, 40 Evidence Response Team agents attend this course to gain training in clandestine-grave discovery and excavation. The Forensic Anthropology Research Facility provides the unique opportunity for this training with decomposing/skeletal remains in a variety of mortuary settings. This is a modified sister version of a course long offered by W.C. Rodriguez and W.D. Lord at the FBI Training Facility at Quantico, VA.

The course involves lecture for 2.5 days on introductory anthropology (including bone trauma), pathology, odontology, entomology, and botany with detailed presentations on clandestine grave discovery, mapping, excavation, and recovery. This is followed by 2.5 days in the field recognizing surface anomalies and excavating decomposing/skeletal remains.

Annually, the Bureau performs recovery operations without the services of a board-certified forensic anthropologist experienced in forensic mortuary site archaeology. The purpose of the class is not to transform Bureau agents into anthropologists, pathologists, or dentists, but to make them cognizant of clandestine grave evidence. In the class, agents become familiar with the complexities of discovery and recovery. The training makes them aware that the quality of their field abilities affects the quality of the remains and the information that can be discerned from the remains.

Forensic Anthropology, Forensic Mortuary Site Archaeology, Continuing Education

H48 Presenting Forensic Anthropology Training Seminars and Workshops to Forensic Science, Medico-Legal, and Law Enforcement Professionals: Consequences for Death Investigations Involving Decomposed, Skeletal, and Burned Human Remains

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The goals of this presentation are to encourage and engage those attending to consider and discuss the benefits and consequences of providing training seminars and workshops in Forensic Anthropology to medico-legal, forensic science, law enforcement, and legal professionals.

This presentation will discuss the content and target participants of Forensic Anthropology workshops presented to various medico-legal, forensic science, and law-enforcement agencies. These lectures and training workshops have had both positive and negative effects on the investigation and litigation of cases involving skeletal, burned, and decomposed human remains.

Training seminars and workshops in Forensic Anthropology are a relatively recent occurrence in Minnesota. This is largely due to the infrequent and informal nature of local forensic anthropological consultation on cases involving skeletal, burned, and decomposed remains before 1991, as well as a lack of awareness by local medico-legal, law enforcement, and legal professionals of exactly what a forensic anthropologist could contribute to a death investigation. Prior to 1991, the few cases that were perceived to warrant the expertise of a forensic anthropologist were sent to the Smithsonian Institution or to other anthropologists outside of the state. Since 1991, the author has been invited to participate in an ever-increasing number of seminars centering on death investigation and the different areas of expertise relevant to such investigations. These presentations have resulted in an increased and more widespread awareness by state, city, and county law enforcement, forensic science, and medico-legal agencies of the significant contributions by anthropologists to death investigations. Since 2000, the author has been providing one- to three-day workshops to a small number of city and county agencies, as well as opening up a limited number of spaces in a semester-long, undergraduate course in forensic anthropology. The focus of each workshop varies according to the agency requesting the training. The workshop presented

to the Hennepin County Medical Examiner's Office, for example, emphasized the information possible to determine from the analysis of skeletal remains and another, presented to the Hennepin County Sheriff's Office, on the location, documentation, and collection of surface-deposited remains. Each workshop provides the participants with hands-on opportunities to apply the methods/protocols they are introduced to. Additionally, a two-day workshop on the investigation of clandestine graves, jointly organized by the author and the Minnesota Bureau of Criminal Apprehension, the state crime laboratory, is scheduled for the summer of 2003.

It is the opinion of the author that the presentation of the lectures and training workshops on various aspects of Forensic Anthropology has had, overall, a positive effect on death investigation in Minnesota. It is apparent that the cornerstones of the U.S. criminal justice system are law enforcement, the legal system, and forensic science. Each of these is inextricably linked to the other two and justice requires communication and interaction between them. The workshops and presentations have worked to establish such communication and interaction and have resulted in an increased understanding by the law enforcement, legal, and larger forensic science communities of the contribution of forensic anthropologists to death investigation. A greater understanding and appreciation by the anthropologist of the roles, responsibilities, and procedures employed by different agencies in these situations has also occurred. Specific benefits from these training opportunities include establishing a relationship for future cooperation in relevant cases, clarifying the role of the forensic anthropologist in such cases, and informing crime scene personnel of established protocol for location, documentation, collection, and packaging of human remains resulting in more thorough scene processing. However, there are opportunities for the information and experiences presented in training workshops to be misused. A little knowledge can be dangerous and there have been instances where, after a short workshop or semester-course, a participant decides they are qualified to analyze human skeletal remains. This is, of course, potentially harmful for the case, as well as for the reputation of Forensic Anthropology as a legitimate and respected forensic science. Such misuse of the information presented in a training workshop may be avoided by clearly stating the objectives of the workshop, defining the educational and experiential qualifications necessary to be a practicing forensic anthropologist, and discussing the consequences of going beyond one's area of expertise.

It is likely that the short seminars and training workshops in Forensic Anthropology will continue and, in fact, occur more regularly in Minnesota. The effect of such educational opportunities on death investigation is still being assessed; however, it is the author's opinion that the effect has been primarily positive, resulting in a better understanding by the legal, law enforcement, medico-legal and forensic science communities of what forensic anthropology is, when the involvement of a forensic anthropologist is warranted, and what the contributions of forensic anthropology are in investigations involving skeletal, decomposed, or burned human remains.

Forensic Anthropology, Education, Short-Courses

H49 Fifteen Years of Forensic Anthropology Short Courses at the National Museum of Health and Medicine/AFIP

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The goal of this presentation is to describe the development of the curriculum of a forensic anthropology course and present a demographic profile of the course participants.

The National Museum of Health and Medicine, Armed Forces Institute of Pathology (NMHM/AFIP) has offered a short course in forensic anthropology for the past 15 years. As the only forensic anthropology course offered in the U.S. to carry CME credit hours, it must meet the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME). From the beginning, the course was designed to present the basic tenets of forensic anthropology to military and civilian medical examiners, coroners, law enforcement personnel, forensic odontologists and other medico-legal investigators.

In February 1988, the first annual forensic anthropology course was offered by the NMHM/AFIP. Since then, nineteen courses have been successfully conducted including courses held in Albuquerque, New Mexico; Mexico City, Mexico; and Bradford, England. Currently, the annual course is held each spring in Bethesda, Maryland at the Uniformed Services University of the Health Sciences (USUHS) and is accredited for a maximum of 30 hours in Category 1 credit towards the AMA Physician's Recognition Award.

The format of the course has essentially remained the same over the years with morning lectures by the faculty and afternoon hands-on lab stations. The lectures provide the methological basis of the osteological techniques that will be covered in the afternoon lab session. Lectures also introduce additional applications of the field that vary each year dependent upon the expertise of the visiting faculty. Core topics covered include age, sex, stature, and ancestry assessment of skeletal remains; distinguishing forensic from non-forensic remains; body search and recovery techniques; forensic taphonomy; forensic odontology; and trauma analysis. From the beginning, the course has covered the special application of forensic anthropology in mass disasters. This continues today with the inclusion of topics such as media relations during mass fatality incidents, deployments of the Disaster Mortuary Operational Response Teams, and the role of the National Transportation Safety Board.

The afternoon lab sessions are a hallmark of the course and provide an opportunity for the participants to interact one-on-one with the faculty. The lab session give the participants an opportunity to practice the osteological techniques discussed in the lectures and to view actual examples of skeletal pathology and trauma. Over 100 museum skeletal specimens are used in the lab stations, and often faculty will bring examples from actual forensic cases. The USUHS Anatomy Teaching Lab provides additional support by allowing access to their articulated and disarticulated study skeletons and anatomical models. In recent years, the final lab session has consisted of six simulated forensic cases that the course participants must analyze and identify from a list of missing persons.

The course has been marketed through a variety of avenues including the AFIP newsletter, a course brochure, and advertising in medical journals. Since the late 1990s, the AFIP has maintained a web site through which potential participants can not only access the course syllabus but also register directly on line. The web site has become an increasingly important marketing venue, accounting for over 20% of the registered participants in the most recent course. The board based marketing approach has resulted in a diverse participant profile. Civilian, military, and other federal employees attend the course. Scientific disciplines are well represented with pathologists, dentists, archaeologists, and physical anthropologists representing the bulk of the participants over the years. Other, less traditional, professions have also been served by course including writers and high school science teachers.

From the beginning, the NMHM/AFIP forensic anthropology course has been well received. Course evaluations indicate high level of satisfaction with the course content and the quality and professionalism of the faculty. The evaluations have played an important role in the development of the course curriculum. Comments from the course participants have directly impacted the structure and content of the course. The 1993 course held in Albuquerque, New Mexico included in a mock field recovery exercise as a result of comments from the 1991 and 1992 students. Similarly, lectures on DNA forensic identification have become a core topic since 1992. Student evaluation has also influenced the inclusion of occasional lectures in radiographic identification, forensic anthropology in

the courtroom, and human rights cases, among other topics. In addition, the organization of the course manual has been modified and improved due to the input of the participants.

Education, Participant Demographics, Forensic Anthropology

H50 Forensic Anthropology for Sale: A Perspective From Law Enforcement

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The goal of this presentation is to present the forensic anthropological community with issues concerning specialized training in forensic anthropology for law enforcement personnel and forensic anthropological consultants.

With the introduction short courses, forensic anthropology has entered into the training arsenal of law enforcement. This paper outlines the role of short courses in law enforcement, the types of personnel trained, and current issues in forensic training. In addition, this paper will specifically address what short courses in forensic anthropology should cover.

Civilian or sworn personnel with specialized crime scene training typically process major crime scenes, including homicides. Depending on the department size, resources, and frequency of major crimes, crime scene personnel may be available in-house or through an agreement with another agency or state crime laboratory. Less frequently, crime scene assistance will be requested of experts outside the criminal justice system, in areas such as forensic anthropology, odontology, and entomology. Law enforcement personnel with crime scene training largely originate from two pools: 1) individuals hired and trained as sworn peace officers that rotate into a crime scene investigation unit and 2) individuals hired as civilian support personnel who have education in the sciences, forensic sciences, or evidence technology. In many police departments and crime laboratories, forensic training is provided solely through on-the-job training and specialized training available through short courses.

For law enforcement personnel, short courses provide a valuable educational resource. These courses prepare employees for specific situations, court presentation, and expert testimony. In addition, specific training is often mentioned during qualification as an expert witness in court to establish expertise. Short courses may also help fulfill certification requirements in a specific area, such as the certification tracks provided through the International Association for Identification. There is a legitimate expectation on behalf of the funding agency that the information provided in short courses will be relevant to an individual's daily work assignment and in specific crisis situations. In most law enforcement departments, money is tight and training expenses are considered carefully with regard to cost versus benefit.

Short courses in forensic science are often geared towards different tracks. For example, classes may be geared towards the recognition, documentation and collection of particular types of evidence (for crime scene technicians) and / or positive identification, analysis and interpretation (for specialized experts).

For non-anthropologists, including crime scene technicians and criminalists, forensic anthropological training should be geared towards how to document a crime scene for future analysis by a trained forensic anthropologist. Training for non-anthropologists could include recognition of bone (not the distinction of human versus animal but rather bone from non-bone), photography, videography, exhumation and surface recovery strategies, sketching, evidence collection, storage and preservation of anthropological evidence, court presentation of crime scene recovery, ethics, and how and when you need to find an expert in forensic anthropology.

For graduate level anthropologists with advanced training in osteology and human variation, forensic anthropology short courses potentially offer an excellent opportunity to supplement academic education and could provide training on how to successfully interface with the criminal justice system. Short courses for physical anthropologists should include training on recovery of human remains from a forensic context combined with general techniques of crime scene investigation, forensic photography, videography, trauma analysis, positive identification, determination of interval since death, recognition of non-biological evidence, collection and preservation of evidence, report preparation, and chain-of-custody. Training for consultants should also include discussion on ethics, professional conduct, and court testimony / presentation.

In addition to concerns over appropriate training topics in forensic anthropology, the lack of standards in the field is highly problematic, especially as training becomes more accessible. In many specialized areas of forensic science, scientific working groups have been formed and these groups are producing documents that specifically address definitions, standards, proficiency testing and guidelines for training and practice. These documents are largely in response to growing court challenges that have attacked the validity of forensic science and it's practitioners.

The current position of forensic anthropology contrasts with trends in the forensic community. In forensic anthropology, there is no scientific working group or document, no certification program or proficiency testing for crime scene investigation at any level, and no certification program for graduate level trained forensic anthropologists under the PhD level. Of special concern is that many forensic anthropology short course instructors and practicing forensic anthropologists are not eligible for certification or any other type of periodic proficiency testing. In addition, there are no guidelines in forensic anthropology for validation of results while in other forensic sciences; peer review and independent verification are an integral part of a final report. As forensic anthropology expands out of academia, stringent and concise guidelines for the practice and training of forensic anthropology must be established to place it in line with other forensic sciences.

Forensic Anthropology, Law Enforcement Training, Certification

H51 Supply and Demand: Trends and Training in Forensic Anthropology

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This presentation will address patterns in forensic anthropology casework over the last decade and reflect on training programs.

The year 2001 marked the thirtieth anniversary of the Physical Anthropology section of the American Academy of Forensic Sciences, and the twenty-fifth anniversary of the founding of the American Board of Forensic Anthropology. A review of the past three decades since Forensic Anthropology was accepted within the Academy shows the evolution of the discipline, with key advancements in analytical techniques, and a new and increasing popularity of the field in both academic and popular arenas.

The 1970s were characterized by the development and refinement of approaches to determine the age, sex and ancestry of decedents. The following decade saw an increase in the application of these techniques, as forensic anthropologists became integral players in the medico-legal field. During this time several universities created and supported centers that specialized in the training of future section members. The 1990's reflected an ever-increasing commercial popularity of the field, coupled with a reduction in the influence of major research universities.

A presentation in 1994 at the Academy meetings in San Antonio recorded the patterns in casework during the 1980s at The University of Tennessee Knoxville. During that decade, the number of cases steadily increased with a large percentage involving field recovery by forensic anthropologists. A review of cases in the 1990s demonstrates a reversal in this trend, with fewer requests for field assistance in the latter half of the

1990s. The majority of cases during that period were conducted at the request of the medical examiner within the morgue setting, reflecting a change in the focus of cases from field recovery to morgue-based analyses.

To investigate whether this trend is a Knoxville phenomenon or a pattern noted by other anthropologists as well, a questionnaire was distributed to members and diplomates. The focus of the questionnaire was twofold: to ascertain patterns in casework and to address the issue of training. Specifically, respondents were asked about the nature of their casework, including whether the majority of cases were field recoveries by anthropologists, cases transported to the anthropologist by law enforcement personnel, or medical examiner requests. An additional line of inquiry addressed what training these members and diplomates provide to students, law enforcement agents, and the general public in the form of classes, short courses, seminars, or field schools.

This presentation will discuss the results of these questionnaires, and trends and patterns in case work during the three decades of the Physical Anthropology section will be reviewed. The information provided will illuminate the new and changing role of the forensic anthropologist in the medico-legal setting, and may help to better train members of the agencies forensic anthropologists interact with.

Forensic Anthropology, Case Reviews, Training Programs

H52 Teaching Forensic Archaeology to the Masses: The Death Scene Course at Mercyhurst College After a Decade

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Attendees can expect to learn more about courses offered in the field of forensic archaeology. Curricula offered, justification and objectives of these courses, faculty, and primary audiences will be detailed.

For the past 11 years, on an annual basis, the Mercyhurst Archaeological Institute (MAI), Mercyhurst College, Erie, PA, has presented an annual 6 day short course in forensic archaeology entitled "*Death Scene Archaeology: Field Methods in the Location, Recovery and Interpretation of Human Remains from Outdoor Contexts*." As currently configured, the short course represents the only international multi-day seminar devoted exclusively to the presentation of current methods in the field of forensic archaeology. In this presentation, an overview of the short course will be given along with a discussion of original goals and objectives, prospective audience, faculty, curriculum, and offspring courses.

Goals and Objectives of the Course: The primary objective of this introductory course is to expose participants to the field of forensic archaeology by describing the range of activities typically involved in the discipline, explain the basic principles and methods of the field, and present—through case studies—the benefits derived from employing these techniques in terms of maximizing physical evidence location, documentation and collection. This is accomplished through lecture-based presentations that are strongly supplemented with hands-on opportunities to experience some of the techniques discussed. It should be noted that a small percentage of the participants, especially active law enforcement investigators, can immediately incorporate some of these methods into their everyday work (or at least know where to find expertise); however, most participants require much more education and training in archaeology, forensic anthropology, and forensic science and/or law enforcement. At the beginning of each short course it is strongly emphasized that these and other short courses and seminars provide one of a multitude of contributions to the entire educational package of the forensic anthropologist.

Audience: The participants typically include advanced undergraduate and graduate students in anthropology departments throughout North America and Canada, law enforcement officials at the local, state, and federal agencies, coroners, medical examiners and their deputies, forensic pathologists, and administrators from public and non-profit research foundations. To date individuals from 39 states, Puerto Rico, Spain, the Netherlands, South Africa, and Columbia, have participated. There are currently only a very limited number of forensic anthropology courses available to undergraduates beyond an introductory course, and even fewer, programs of study in the field. For the advanced undergraduate student, this course offers a rare opportunity to gain insight into an area of anthropology that has recently generated much interest. At the graduate student level, few graduate programs provide courses or a portion of the curriculum to forensic archaeology. Individuals in law enforcement are particularly interested in courses that will improve their data collection methods at outdoor scenes, areas of investigation that are typically not addressed adequately during basic training regimes.

Curriculum and Faculty: The curriculum focuses on the location and processing of a variety of outdoor scenes including surface scatters of human remains, buried body features, fatal fire scenes and mass fatality localities. The faculty includes board-certified forensic anthropologists, an FBI agent who also heads an evidence response team, professional archaeologists, a board-certified forensic entomologist, and crime scene specialists. Following an introduction to the subject of forensic anthropology, more detailed lectures regarding archaeological principles as they apply to the crime scene are presented. This is followed by lectures and demonstrations relevant to the search for unlocated crime scenes, addressing topics such as the role of the cadaver dog, probing techniques, and pedestrian searches. Next, techniques used to create precise topographic, plan-view and profile maps are discussed followed by practical exercises that require the mapping of the surface distribution of physical evidence. Forensic entomological lectures and demonstrations of proper insect collection methods using white-tailed deer carcasses are also emphasized at this time.

The remaining three days of the course are devoted to the proper excavation of the buried body feature, which in this case, involves mock burials containing plastic human skeletal elements and other physical evidence arranged in a particular burial context scenario. More sophisticated methods of burial location involving geophysical instrumentation such as the EM-31 and ground-penetrating radar have recently been added to the curriculum. Following brief experimentation a few years ago with human cadavers and animal carcasses, it was determined that attention had shifted to the repulsive factor of the physical evidence, and away from the intended primary focus; the employment of exacting excavation methods that maximize evidence documentation and collection procedures. The use of decomposing biological specimens in the grave feature was abandoned.

Offspring Courses: Recently, two programs were added to the Mercyhurst training repertoire that represent direct descendants of the Death Scene course; a week-long short course in Death Scene Investigation presented in the town of Taramundi, Asturias, northern Spain, covering the basics of forensic anthropology, and a two-week intensive field school in forensic archaeology which expands the complexity of recovery scenarios as compared to the week-long course and also requires a written report of activities.

In 1998, the Federal Bureau of Investigation's St. Louis Division Evidence Response Team first sponsored a five-day short course modeled after that developed by MAI. "*Crime Scene Archaeology: A Field Training Program in Forensic Archaeology and the Recovery of Human Remains*," was offered exclusively to medico-legal death investigators as advanced training. Recently, the course was accredited by the Missouri Police Officers Standards and Training (POST) board and the American Board of Medicolegal Death Investigators for continuing education certification. Attendees for the tuition-free course are selected, in part, on the basis of years experience in crime scene investigation.

Like the Mercyhurst course, the St. Louis seminar serves to introduce investigators to the wide array of disciplines required for a thorough examination and reconstruction of outdoor crime scenes. Divided into two days of lectures, one day of round-robin format mapping

exercises, and two days of recovery practicals, the course was designed to mimic as closely as possible true crime scene investigations. Federal, state, and local public safety and private resources such as helicopters, fire department aerial platforms, cadaver dog teams, total station mapping teams, and geophysical engineers were incorporated into a multiple homicide/buried body scenario addressed by half the class and a small airplane crash scenario addressed by the other half. The course intentionally includes long hours, night sessions, and mandatory team assignments which mixed investigators from different departments, in order to create an atmosphere much like that encountered during a true major case-task force type investigation. One noted benefit of the course has been the tendency for attending departments to call on outside expert assistance in real cases while conducting appropriate site preparations prior to the arrival of that assistance.

Another offspring course closely modeled after the Mercyhurst Death Scene course is presented by the York Regional Police Department in York, Ontario. Like the FBI course described above, the primary intended audience is local and regional law enforcement investigators and serves to introduce the discipline and raise the level of expertise brought to bear on outdoor crime scenes in the region.

All of these courses have had a significant impact relative to exposing this under appreciated discipline to a wide audience both within anthropology/forensic anthropology and within the law enforcement community at the local, state and federal levels.

Forensic Archaeology, Training Opportunities, Teaching

H53 The National Forensic Academy

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The goal of this presentation is to educate the general public of the courses available in the forensic arena.

The National Forensic Academy is an intensive 10-week training program designed to meet the needs of law enforcement agencies in the areas of evidence identification, collection, and preservation. The goal of the academy is to prepare the forensic practitioner to recognize key elements at a crime scene and to improve the process of evidence recovery. Participants are challenged in over 25 disciplines through classroom instruction, lab activities, and field practicums. Investigative scenarios include, but are not limited to, burned houses and buildings, exploded vehicles, and an in-depth study of forensic anthropological techniques in conjunction with the University of Tennessee's Forensic Anthropological Research Facility. Access to this unique facility allows students to study human decomposition, utilize anthropological and archaeological skills to excavate clandestine graves, recover surface scattered human remains, and perform TSD techniques used at crime scenes. Classroom activities in this discipline will instruct students in basic skills necessary to identify skeletal elements and evaluate bone trauma. The entire academy consists of over 400 hours of training, 170 hours of in-class work, and over 220 hours of field practicum.

National Forensic Academy, Forensic Courses, Training Programs

H54 Advances in Surveying and Presenting Evidence From Mass Graves, Clandestine Graves, and Surface Scatters

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This presentation will describe methods of surveying complex graves and associated environments and demonstrate advances in the visual display of this surveyed data developed during field operations for UN ICTY 1997-2000.

Mass graves, clandestine graves, and surface scatters consist of numerous, complex, and layered pieces of evidence which are often distributed in their environment in a way that limits conventional photography and planning of all associated relationships. Use of electronic surveying equipment and computer software allows a variety of explanatory images to be produced from one data set for report, courtroom, and non-expert use showing evidence association in two and three dimensions.

Use of electronic surveying equipment, such as EDM's (electronic distance meters) for surveying and mapping archaeological excavations has increased greatly in the last ten years. Their application to police work developed in many agencies worldwide through automobile accident survey. Their use in war crimes and human rights work developed in Rwanda and the Former Yugoslavia with PHR. The use of EDM's and computer software to map graves and crime scenes for ICTY field investigations continued from 1997. Accuracy, speed, large area coverage, non-interference with other site activity, and flexibility of data use are main factors that make such survey suitable for these types of excavations.

Excavation of mass graves in Bosnia revealed the need to plan evidence and map locations from several different perspectives:

1. Two-dimensional area plans to allow site location of a grave or crime scene on published maps, aerial photographs, and within a given physical locality.
2. Two-dimensional contour plans to show the topographical features of a site area and topographical properties of graves.
3. Two-dimensional plans to show distribution of different evidence types across a grave/crime scene.
4. Three-dimensional contour plans showing the topographical properties of graves and crime scenes.

Images showing the distribution and association of evidence in three dimensions.

A single set of survey points taken on topographical features such as houses and roads, on ground surfaces, and on evidence locations can be used to produce different plans which can be viewed from any direction.

Many gravesites in Bosnia were also execution sites. Hundreds of pieces of surface evidence such as fragmentary bone and tissue can rapidly be mapped using an EDM in a single day. This is particularly useful when the evidence may be layered or cannot be located and collected at one time such as densely distributed shell casings in grass and topsoil.

Excavation of complex mass graves has often necessitated the removal of grave walls to allow access to bodies. Survey of visible grave dimensions before destruction allows plan reconstruction of the grave topography in three dimensions including areas 'lost' to removal.

Mass graves excavated in Bosnia and elsewhere often contain multiple intertwined bodies. Photography cannot show the relationship and position of these bodies because complete exposure of all remains at one time is usually impossible. Conventional planning from a base line or fixed grid is slow and interferes with other site operations such as movement of heavy machinery. Use of EDM survey allows recording of a body position even when all of a body is not visibly exposed at one time. The surveyed points of a single body taken at different times can be reunited on computer.

For ICTY exhumations bodies were mapped by recording points on the head and joint locations to produce a simple 'stick man' image. The data collected was processed through a series of software programs called Bodrot developed by Professor Richard Wright. This allowed the position of all bodies in a grave to be displayed as a rotatable three-dimensional image in a software program called Rotate developed by Marijke van Gans. Viewing grave contents in this simple form helps to understand its complexity in a variety of ways:

1. Revealing the method of disposal of bodies.
2. Demonstrating separate episodic disposal events, resulting in spatial separation between layers of bodies.
3. Revealing the pattern of arrangement of bodies that may indicate disposal methods such as bulldozing a mass of bodies to the end of a trench or dumping batches of bodies from trucks.

4. Demonstrating that shell cases, and other objects, are uniformly or non-uniformly distributed among the bodies in a grave or on sur faces.
5. Supporting evidence that there has been tampering with a grave, with partial removal of bodies, demonstrating the association of incomplete bodies and body parts with disturbed areas that intrude into the original grave.

Rotate images are small, computer files that are simple to operate and can be attached to documents on floppy disks or CDs for distribution. The various types of plans and images described have been used in reports and as courtroom evidence of exhumations and surface scenes in successful prosecution cases for ICTY. The use of EDM survey and three-dimensional images may have wider applications for evidential viewing in police work, mass disaster or terrorist events such as air crashes and explosions.

Survey, Mass Graves, Visual Imagery

H55 Cervical Smears as an Alternate Source of DNA in the Identification of Human Skeletal Remains

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The goal of this presentation is to increase the forensic community's awareness of alternate sources of DNA in the process of identifying human skeletal remains.

In May 1978 a 35-year-old female and her male companion went missing while boating on Lake Winnipeg in Manitoba, Canada. Although the man's body was recovered during the ensuing search, the woman's body was never found. In April 1999 a property owner, who was clearing a swampy area of land that bordered Lake Winnipeg, recovered a skull. Anthropological examination established that the skull belonged to a Caucasian female between the age of 34 and 50 years. When a check of police Missing Persons files revealed similarities in criteria (age, sex, locale, etc.) between the skull and the woman who had disappeared 21 years earlier, attempts to confirm the skull's identity continued. Dental analysis failed to positively include or exclude the skull as belonging to the missing woman. However the medical examiner's office was able to locate and review her old hospital records. The medical chart, which contained results of both cervical smears and biopsies, revealed she had dysplasia. As the hospital's policy was to retain slides of cervical smears and paraffin blocks for at least 25 years in all patients with dysplasia and cancer, slides from her cervical smears, including one taken in March 1978, were obtained. In September 2000 the medical examiner's office submitted these slides, together with teeth and a temporal bone cross-section from the skull, for DNA testing to the Armed Forces Institute of Pathology (AFIP) in Rockville, MD. Following comparison of the DNA material, the AFIP confirmed the skull belonged to the 35-year-old woman in question. The probability of observing another individual in the general population with an identical profile was estimated at 1 in 12.4 trillion. This case is unique, as the DNA from the 22-year-old cervical smear slide was the oldest DNA sample successfully retrieved and used from slides of this type by the AFIP.

Cervical Smear, Human Skeletal Remains, DNA

H56 Unusual Sharp Force/Penetrating Trauma Pattern on a Cranium; Cooperative Examination and Evaluation by the Forensic Pathologist and Forensic Anthropologist

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After attending this presentation, the participant will become familiar with a case with unusual sharp force/penetrating trauma patterns seen on a cranium and should have renewed respect for the value of combined pathology and anthropology examination of decomposed remains.

Background: The assessment of sharp force and penetrating trauma can at times be quite difficult. Yet, through the combined efforts of the forensic pathologist and anthropologist, sharp force and penetrating traumas can be located and correctly identified, and in many cases the type of weapon or tool utilized to inflict the trauma can be ascertained.

Case History: The severely decomposed partially clad body of a young adult female was discovered in a desert area of New Mexico approx. 2 ½ months after having disappeared. The cause of death was determined to be multiple stab/cutting wounds of the head, neck, chest and back. There were cutting injuries of the neck with probable transection of a carotid and other vessels, perforating stab wounds of the chest, abdomen, and back, some of which left clear impressions of a knife in cartilage, and cutting/stabbing wounds of the cranium some of which were sharp and others of which had characteristics of more blunt impacts.

Pathological/Anthropological Assessment: A total of 14 defects were present and noted on the cranium, located on the left temporal and left greater wing of the sphenoid. Combined evaluation of the skin and soft tissue defects along with the bone impacts and penetrations revealed at least two different instruments. Three of the defects were complete perforations of the cranium: measuring - 10mm x 5mm, 7mm x 3mm, and 6mm x 4mm. Radiating fractures connected two of the perforation defects. Ten defects had the appearance of "divots," running from posterior to anterior, indicating that the tip of the weapon was held at an angle or the trajectory of the blow was tangential to the surface the cranium. Of those "divots," four were partial penetrations of the crania with resultant displacement and hinged fracturing of the inner table. All of the "divots" had a characteristic width of 1.5mm. Several of the defects appeared to be perpendicular blows to the cranium, producing patterned marks reflecting the physical appearance of the tip of the weapon or tool. These defects had an oval outline, measuring 1.5mm x. 3mm. One small projection was observed on each side of the oval, but on opposite ends, projecting laterally, producing a pattern similar to a "hurricane" symbol. Though the exact type of weapon or tool utilized to make these defects is not known, it is hypothesized that these defects were produced with the tip of a pair of very small needle-nose pliers.

A more traditional sharp force trauma defect was observed with a 5mm cut of the superior margin of the left zygomatic arch, through the root of the zygomatic arch into the squamous of the temporal. A 3mm x 2mm triangular piece of metal was found lodged in the temporal squamous, possibly a knife tip. The cut sliver of zygomatic arch was still attached posteriorly to the arch at the time of examination. A smooth, single edged knife was the most likely weapon utilized to produce this defect.

Conclusions: Photographs of the wounds and suggested tool(s) were presented in court by both the pathologist and anthropologist and were instrumental in the jury's understanding of the wounds and how they were inflicted. Although the defendants who were convicted at trial did not confirm the specific instruments, circumstantial and associated evidence suggested that the interpretations of the wounding instruments were substantially correct.

Sharp Force Trauma, Penetrating Trauma, Unusual Patterned Trauma

H57 Gunshot Wounds and Other Perimortem Trauma to the Sub-Adult Skeleton

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The goal of this presentation is to expose the forensic community to several specific examples of gunshot and blunt force trauma to sub-adult skeletons recovered from mass burials.

The information in this poster has been collected from investigations of killings from Guatemala, Central America, dating to the early 1980s. The seven case studies provide examples of the effects of gunshot wounds and blunt force trauma to the skeletal remains of individuals aged between two months and 16 years. One case in particular shows the erosion damage resulting from over 20 years of burial and the difficulty in determining the cause and manner of the trauma. In other cases preservation is much more complete and erosion plays a less drastic role in the analysis process.

All seven of the following cases provide the age and sex (if known) and details of the perimortem trauma observed. The samples were taken from skeletonised remains exhumed by the Foundacion de Antropologia Forense de Guatemala (FAFG) from 20 year old mass graves during 2001 and 2002. The individuals were all buried a short time after a violent death resulting from the conflicts in Guatemala between 1981-1982. In several cases relatives have identified the remains based on clothing and grave goods, these identifications are often confirmed with results of laboratory analysis where biological sex and age are determined through osteological analysis.

Case 1: a gunshot wound was identified in the cranium of a probable female aged 2-6 months. The entry appears as a circular orifice 6mm in diameter with internal beveling located in the left parietal. Radiating fractures affect the frontal, parietals, right temporal and sphenoid. The exit hole is not observable due to loss of bone tissue. Radiographs show no evidence of radiopaques, no ballistics were recovered either in the field or in the laboratory.

Case 2: the vertebrae and ribs of a probable female aged 7-9 years display trauma compatible with a gunshot wound to the abdominal region. Two right ribs (#9 and #11) exhibit complete fractures and plastic deformation; and six vertebrae (D11-L4) have comminute fractures, plastic deformation and loss of bone tissue. The left ulna has multiple fractures. The radiographs of vertebrae show evidence of radiopaques and fragments of projectile were recovered during excavation associated with lumbar vertebrae. A projectile was recovered in the laboratory from the clothing and a metal fragment with green oxidation was recovered in the area of the right scapula.

Case 3: the mandible of this probable male aged 8-12 years has undergone blunt force trauma (probably secondary to a gunshot wound to the cranium). The cranium (not displayed) also had multiple fracturing; however, erosion and loss of bone tissue prevents identification of the cause of trauma. The radiographs of thorax *en bloque* shows evidence of radiopaques. Metal fragments and a projectile were recovered from the thorax region during excavation. A projectile was recovered from the thorax in the laboratory.

Case 4: the cranium of this female aged 14-16 years, shows trauma to the cranium affecting the parietals and occipital. It is probable that blunt force trauma caused these fractures. Radiographs show no evidence of radiopaques, no ballistics were recovered either in the field or in the laboratory.

Case 5: the cause of the trauma as well as the sex of this individual aged 5-7 years is not determined. The cranium has simple fractures in the right parietal and occipital. Plastic deformation and loss of bone tissue as well as erosion prevents more accurate descriptions. Radiographs show no evidence of radiopaques, no ballistics were recovered either in the field or in the laboratory.

Case 6: this male aged 12-13 years suffered three gunshot wounds. The first in the proximal third of the right femur has an entrance wound 6x7.3mm on the anterior-lateral surface, and an exit hole measuring 6x8mm with beveling 34x17mm on the posterior and medial surface. The left femur has two gunshot wounds in the distal third of the diaphysis. The entrance, on the posterior and medial surface, measures 12x12mm, five fractures radiate from this, there is no evident exit hole. The second entrance hole is on the anterior and medial surface, below the first, and measures 9x9mm, two fractures radiate from this and are interrupted by fractures radiating from the first entrance hole, the is no evident exit hole. The radiographs of the femurs show evidence of radiopaques, ballistics were recovered during excavation from the femora, and in the laboratory ballistics were recovered from the trousers.

Case 7: the cranium and thorax of this probable female aged between 13-16 years suffered gunshot wounds and fractures secondary to these. In the skull there is extensive loss of bone tissue in the right frontal, parietal, and sphenoid, and polifragmentation of the left temporal and parietal featuring multiple radiating and concentric fractures as well as several diastastic fractures (parieto-frontal, parieto-termporal, tempero-occipital, and tempero-zygomatic). Thoracic vertebrae #3, 4 and 7 have complete and infraccion fractures in the arc and body compatible with firearm damage which also caused the damage to the right 4th rib and the left 6th and 7th ribs. Lumbar vertebrae #2-3 suffered blunt force trauma. The radiographs show evidence of radiopaques and ballistics were recovered during the excavation phase.

These seven cases are a preliminary demonstration of the damage caused by firearms and other weapons to the sub-adult skeleton. This sample is by no means representative of all the cases seen by anthropologists at the FAFG, instead, these cases were chosen to provide a variety examples with differing variables such as trauma location, trauma type, taphonomic effects and age that effect the analysis of trauma to the skeleton.

Gunshot And Blunt Force Trauma, Sub-Adult Skeletons, Burials

H58 The "Next Utility" in Field Recovery of Scattered Human Remains

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The goals of this presentation are to discuss and illustrate the technology and applicability of GPS and GIS in forensic anthropology for research and field recovery of scattered human remains.

Field recovery of human remains is an essential role of the anthropologist in forensic investigation. Sites are often mapped and photographed to create a scaled depiction of the remains for study or medico-legal purposes. In situations where remains are widely scattered through animal activity or other processes, or where the landscape is topographically varied, hand drawn maps, even with the help of total stations, can be difficult to complete. In such instances, the Global Positioning System (GPS) can be a useful tool.

In the U.S., the GPS was first developed by the Department of Defense (DoD) to enable accurate navigation and positioning across the globe. Though available to the general public in 1983, GPS was declared fully operational by the DoD in 1995. Since then, its applications have proven useful in a wide variety of professions, including anthropology, for locating and mapping archaeological sites. Recently, anthropologists at the Louisiana State University Forensic Anthropology and Computer Enhancement Services (FACES) Laboratory have begun to use GPS and Geographic Information Systems (GIS) for research and to assist with mapping forensic cases recovered in the field.

As a powerful data collection tool, GPS in combination with GIS, offers benefits to field recovery, such as creating accurate site maps, particularly in cases where remains are widely distributed. Also, each site can be provided with a unique global address, enabling law enforcement

to navigate back to the scene should further search be necessary. Additionally, GPS data collected in the field can be used for research purposes. Using GIS techniques and software, analyses of data may elucidate patterns of distribution when variables such as time since death, topography, environment, and seasonality are considered.

Despite the benefits of GPS for data collection, inherent within the system are certain limitations to its practicality for field recovery that should be considered. Such drawbacks include the inability to receive data from the satellites in certain environments (*e.g.*, inside structures/buildings or beneath heavy tree cover), and the "peak time" to use the system (*i.e.,* when satellite positioning is ideal) may not coincide with the time of retrieval.

Advances in GPS technology allow the collection of both code- and carrier-phase data with relatively inexpensive hand-held units. Such data can further be differentially corrected either in real-time (using a beacon) and/or through post-processing in order to increase the positional accuracy of the data. The most accurate positions can be recorded, if carrier-phase data are corrected in both real-time and through post-processing. But, such accuracy may not be sufficiently high for cases where remains do not move far from the site of original deposition. In such circumstances, the exact position of some individual skeletal elements may not be distinguishable.

A clear trade off exists between accuracy and the price of GPS receivers. Because law enforcement agencies and anthropologists involved in the field recovery of human remains have limited financial resources, they cannot purchase and use highly accurate, surveying-grade GPS receivers with a price tag of tens of thousands of dollars. For this reason, the discussion presented in this poster focuses on GPS technology that is reasonably priced and can be acquired and used by any law enforcement agency or anthropologist involved in the field recovery of human remains.

In conclusion, the use of GPS does not preclude the necessity for hand drawn site maps, especially in cases where remains have not been widely scattered. However, GPS is a valuable tool in providing a fast and effective means of pinpointing site locations, and in combination with GIS, creating accurate and reliable maps where remains are widely distributed.

Field Recovery, GPS, Anthropology

H59 Age Progression: How Accurate Is It?

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This presentation will examine the accuracy of age progressed photographs.

The creation of the National Center for Missing and Exploited Children (NCMEC) in 1984, coupled with the National Child Search Assistance Act of 1990, greatly improved the recovery rate of abducted children throughout the last decade. In the U.S., approximately 725,000 missing children reports were filed with the National Crime Information Center (NCIC) during 2001, averaging more than two thousand reports per day. The great majority of these cases were resolved with the child returned unharmed. The NCMEC reports that currently over 90% of missing and endangered children are recovered, an increase of nearly 30% over the last decade. One in six of these successful recoveries is credited to the practice of immediately distributing photographs of the missing child to law enforcement officials, the media, and the public; demonstrating the importance of visual photographic images in the discovery of missing children.

As a recovery tool the use of photographs is undeniably successful. In situations where the child has been missing for at least two years, NCMEC oversees computer manipulation of a photograph as a means to demonstrate the present age-progressed appearance of the missing child. The standard technique of age progression/enhancement involves computer-graphically stretching a photograph to reflect the increase in overall size of the face. This image is then enhanced with facial features drawn from siblings and parents at the corresponding age. Although the NCMEC reports that such computer images have resolved approximately 275 abduction cases, this approach and specific techniques remain untested with reference to actual craniofacial growth patterns in children.

The purpose of this presentation is to assess the accuracy of standard age progression techniques, and to identify new methods that may further improve this approach and aid in the resolution of more cases. To test the accuracy of age progression images, three adult females were assessed, using a chronological series of school photographs (kindergarten through twelfth grade). For each subject, the school photographs were standardized for size, and measurements incorporating standard anthropometric landmarks were taken on each photo. These were then analyzed to assess the craniofacial development of each subject with respect to age. Additionally, for each participant a photograph was randomly selected and subjected to an age progression. The age enhanced images were then compared to the photograph of the subject at that age. Without a doubt, the practice of age progressing photographs of missing children has proven successful. However, this present examination indicates that this technique can be enhanced, potentially serving to further improve the recognition and recovery rate of missing children.

Age Progression, Craniofacial Growth, Computer Imaging

H60 Three-Dimensional Digital Data Acquisition: A Test of Measurement Error

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The goal of this research project is to present to the forensic community the results of a study that compared linear measurements taken with 3D digital techniques with those taken on dry bone by hand.

The use of 3-dimensional (3D) digital technology is a growing method for acquiring and processing scientific data among the many subfields of forensics, including physical anthropology. This poster presents the results of a study that questioned the comparability of measurements taken of skeletal material through the traditional method of inspecting bones by hand with calipers with a new method of analyzing bones virtually on a computer. Three-dimensional digital data acquisition of human skeletal material, captured either by computed tomography, magnetic resonance imaging, ultrasound, or laser assisted stereo modeling creates a quasi-permanent virtual record of the bone for which many types of analyses can be performed. This includes measurements of simple variables such as length, width, and circumference, but also permits researchers to study those that have been nearly impossible to obtain in the past (or at least not without great difficulty), such as surface area, volume, degree of angle, and curvature. One question that arose with the increased practice of taking digital measurements was whether those taken through the digital medium were comparable to those taken manually on dry bone. The null hypothesis that there is no significant difference in measurement is a crucial assumption for many 3D data research designs.

Twenty femora were used from Arizona State University's (ASU) archaeological collection of Nubian skeletons. Each skeleton was selected randomly (though bones with poor preservation were omitted). For each femur, three linear measurements were taken macroscopically by the author with digital calipers and an osteometric board. They were the maximum head diameter (mhd), the maximum mid-shaft circumference (msc), and the maximum length (ml). After macroscopic evaluation, each femur was then digitally analyzed at ASU's Partnership for Research in Stereo Modeling (PRISM) laboratory. This was done by first scanning the bone with a Cyberware Model 15 high-resolution laser scanner that

captured cortex data with a high-density "wire" mesh of triangles. Each triangle was generated at 300 microns enabling extreme detail of the bone surface to be digitally rendered. The wire mesh is then modeled by adding topography to create a 3D virtual replica. This digital model was saved in an *.xml* format, creating a permanent duplicate of the bone (barring loss of the digital file). Using research software developed at the PRISM laboratory, the same three measurements were once again taken on each bone by selecting beginning and end points on its virtual replica. To further test error, both measurement trials were repeated one month later by author, making a total of four trials. This study was conducted "blind" with each femur labeled with different catalogue numbers so no bias of memory could influence measurement.

All measurements were entered and statistically processed with the *Statistica* software program. Each femur had three independent observations taken during four separate trials. If the 3D imaging created an exact virtual replica, then the specific observation for each measurement should be identical for all four trials. To test the null hypothesis that there is no statistical difference in both measurement techniques (H_0: $\mu_1 = \mu_2$), the mean score of the manual trials was compared with the mean score of the computed trials using a paired *t*-test (at an alpha level of 0.05). Separate tests were conducted for each of the three measurements. In addition to the *t*-test, a one – way ANOVA was conducted using the scores of all four trials, with a subsequent Scheffe's test to identify the significantly different trial. Again, separate tests were conducted for each of the three measurements.

The results of this study are important, as 3D knowledge becomes more valuable and accessible to researchers. A similar focus was generated decades ago with the increasing use of radiographic technology. In physical anthropology, studies of skeletal maturation, morphological change, and sex determination have been conducted using measurements of bones from radiographs with the goal of creating aging and sexing standards to be used with dry bones. With the knowledge that radiographs increase the magnitude of a subject by approximately 5%, studies employing radiographs allowed researchers access to a revolutionary way to study human biology. Three-dimensional knowledge may follow radiographic technology in a similar manner, and perhaps with even greater applications. While this study focused only on quantitative data from skeletal material, researchers at PRISM are currently using 3D stereo modeling of quantitative and qualitative data on a wide array of materials such as archaeological artifacts, intra-cellular organisms, diatoms, and fossils. In forensics, 3D knowledge may have many applications not just in physical anthropology, but also in criminalistics, engineering science, and pathology / biology. Testing the comparability of measurements taken through the computer with those taken the old fashion way is crucial in fostering a new generation of research.

3-Dimensional Digital Data Analysis, PRISM, Physical Anthropology

H61 In Search of Floyd Britton: Investigations of Human Rights Issues on the Island of Coiba, Republic of Panama

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The purpose of this paper is to discuss how physical anthropologists apply their skills in working with Truth Commissions and taphonomic variables affecting recovery of skeletal remains in a tropical environment.

The task of investigating human rights issues is sometimes complicated by ill perceived and misguided "territorial" claims by some colleagues. Unfortunately, this is not an atypical phenomenon in the forensic realm, in particular among forensic anthropologists working in human rights (e.g., Bosnia, Kosovo, Panama, etc.). The role of forensic practitioners is to investigate, provide the most accurate and parsimonious interpretation of the evidence, provide unbiased testimony, and ultimately closure to the victims families.

The island of Coiba (positioned between 7° 10'N and 81°32' - 81° 56' W) is Panama's largest island in the Pacific, which is administered by the Veraguas province. Coiba is located 24 km offshore and is separated from the mainland on the east by the Gulf of Montijo and on the northwest by the Gulf of Chiriquí. It has an area of 494 sq km and a maximum elevation of 425 m. The island has served as a penitentiary since 1919 and was declared a national park on 17 December 1991.

Floyd Britton was a leftist university student leader who was arrested on October 12, 1968 and sentenced by the military government of Omar Torrijos (1968-1981) to the Penal colony on the island of Coiba on November 3 of the same year. He died in November of 1969, allegedly beaten to death by prison guards under direct orders of General Omar Torrijos. His body was flown to Panama City for an autopsy and his death was determined to be of natural causes. Purportedly, his body was then sent back to Coiba and interred at the "Marañon" Cemetery. Was the autopsy report legitimate? Why return the body of Floyd Britton to Coiba and not release it to family members or bury him in Panama City?

Previous attempts to locate Floyd Britton occurred in May of 1991 and then again in 2001. The first excavation was concentrated in the northeast sector of the cemetery. New eyewitness testimonies led to another exhumation on August 2 and 3, 2001, by the Comisión de la Verdad de Panamá (Panamaian Truth Commission) and another team of U.S. forensic anthropologists. Skeletal remains were recovered from four burials on the northwest sector of the cemetery. During this phase, two of the burials were only partially excavated.

Continued efforts to locate Floyd Britton during a third excavation and exhumation phase took place between February 26 and March 6, 2002, by field crew members from both the University of Florida and Panamanian Truth Commission. Three burials were identified for excavation from information derived by la Comisión de la Verdad de Panamá from several eyewitness accounts and the remains of the three burials were transported to the C.A. Pound Human Identification Laboratory for analysis. Because of various taphonomic processes, for example, soil acidity, insect activity, and bacterial activity, roots, humidity, etc., the conditions are not conducive to good skeletal preservation and therefore the remains sustained considerable postmortem damage. However, the biological profile determined from the remains of burial 3 were consistent with biological information made available for Floyd Britton, two molars were sent out for mtDNA testing. The mtDNA results will be presented to confirm identity. In addition, excavation protocols and taphonomic processes in a tropical environment are discussed.

Physical Anthropology, Taphonomy, Central America

H62 Reconstructing Facial Freeform Images Using FREEFORM Software

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This presentation introduces the participant to a software package that has applications to facial imaging, useful to law enforcement or medical examiner personnel.

Reconstruction of facial images can be facilitated through a number of different techniques. This poster will present the adaptation of a sculpting software program entitled FREEFORM, to the task of facial reconstruction, superimposition and image progression. Designed for the character animation industry, this package offers technology that allows the "reconstructionist" to fully interact with the image via the sense of touch through a stylus.

In a cooperative research venture between SensAble Technologies, the Office of the Chief Medical Examiner, Boston Crime Lab, and the Louisiana State University FACES Laboratory, this product has be applied to the task of facial imaging and reconstruction. Libraries of population-specific average tissue depths and anatomical facial features and landmarks, have been developed to provide the artist with a series of options to select from in the reconstruction process.

Skeletal and live facial images were captured utilizing a Polhemus, Fastscan 3-D imaging wand. These images were downloaded directly as 3-D "clay" images, fully interactive in a digital format. Through the use of a stylus, the artist can manipulate the raw image manually or refer to libraries of marker templates that can be applied directly to the skull image. Again through manual manipulation, the artist can add tissue depth, dimension and form to the image, thus modeling a facial likeness. Through the use of the libraries, the artist may select several different eye shapes for instance, to render multiple likenesses from the same skull template.

The application of sculpting software to the techniques of facial reconstruction can expedite the accuracy, variety, and distribution of facial images for both law enforcement and medical examiner systems. Having these types of technologies available can facilitate the identification process and be applied to other forensic tasks.

Facial Reconstruction, Digital Modeling, Virtual Clay

H63 Operacion Eagle: Clandestine Graves and a Taphonomy of Tyrants — Part 1: The Truth Commission of Panama, Witness Testimony, and Searches in Western Panama

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After attending this presentation, participants should be better able to use death investigation dogs and forensic anthropologists to search for clandestine graves.

While passing through the Miami airport, a U.S. lawyer working in Panama purchased the September/October 1999 issue of Archaeology Magazine featuring a story on the role of a dog named Eagle in locating a "lost" historic cemetery in Monroe, MI. Eagle is a Doberman Pinscher/German Shorthair Pointer mix that was trained by Sandra Anderson to find only human remains ranging from intact bodies on through skeletal fragments and human trace evidence (blood, etc). This includes fresh, decomposed, burned, as well as recent and ancient remains (Saul, JM, Anderson, S, and Saul, FP, Proceedings of the AAFS 2001:247)

Brought to the attention of the Panamanian Truth Commission, members quickly recognized the potential value of such an "investigator" in their search for the remains of political opponents and others who were secretly "disappeared' during the military regimes of Generals Torrijos and Noriega (1968-1989). The Commission had accumulated a great quantity of witness and other testimony concerning potential gravesites that needed to be explored quickly, as the Commission's mandate was scheduled to expire soon.

The Commission's invitation was accepted on a volunteer basis by Anderson and her anthropologist associates, Julie and Frank Saul, who formed the U.S. nucleus of a joint Panamanian-U.S. team that was coordinated and overseen by Bruce Broce, an anthropologist who holds both Panamanian and U.S. citizenship. They were accompanied in the field by additional personnel from the U.S. and Panama. These included anthropologists and archaeologists, lawyers, law enforcement/crime scene specialists (Policía Tecnica Judicial de Panama, or PTJ) and members of the Panamanian Presidential Guard. The latter provided security with the help of the PTJ. The PTJ and lawyers witnessed and maintained the chain of evidence for each find. The President of the Truth Commission, Licenciado Alberto S. Almanza, constantly supported efforts by his presence and actions while also maintaining continuity with both the President of the Republic of Panama, Mireya Moscoso, and the families of the "Disappeared Ones."

In preparation for work in this new environment, Eagle was introduced to non-human primate remains and trained to ignore them. The Sauls' years of experience living and working in Central American jungles excavating ancient Maya remains also proved to be helpful - sometimes in unexpected ways, such as understanding the root and vine systems of tropical vegetation and their potential role in transporting the scent of human remains.

Due to time constraints, the Truth Commission charged the team to quickly check as many potential disposal sites as possible (as indicated by witness testimony), and where indications by Eagle were positive for human remains, to attempt to recover at least one portion of human remains as proof and for future DNA analysis. Complete recovery was not possible nor was it desired at this time. Others carried out subsequent excavations in several locations after Eagle and preliminary recovery of remains confirmed the presence and location of human remains.

Eagle's special abilities, and the results achieved as a consequence, proved to be an inspiration to the people of Panama. For reasons of security the authors had hoped to come and go quietly in Panama, but the President of Panama decided to surround the team with media as a means of protecting them (in addition to providing them with members of the Presidential Guard and the PTJ). This seems to have worked well and as a byproduct of this constant media attention, new witnesses, who had previously considered the situation hopeless, were encouraged to come forward. Eagle became a national hero with full-page photographs as well as editorial cartoons in the newspapers. The extent of this public approval is suggested by an incident while searching for remains on the grounds of a maximum-security prison. As the heavily guarded group (including three women) passed a few hundred feet from a razor wire fence surrounding a prison yard filled with male prisoners, shouting was heard that was at first assumed to be obscenities but turned out to be cries of "Eagle! Find our dead!"

The Province of Chiriqui and city of David, Noriega's home province and initial power base, provided the team with a number of very different settings for disposal of single and multiple victims. In addition, as in other areas, witness testimony needed to be related to changes to the crime scene brought about by human and/or natural agencies over time. For instance, stories of "animal" remains encountered during relocation of a rural road brought the team to a hillside near the road that produced human remains from both the steep cliff over which the "animal remains" had been tossed and the bottom of the rapidly flowing river below. This difficult recovery took place during a cold rain, making the cliff face treacherous and causing the water to rise during the search. Nevertheless, several bones and bone fragments were recovered, with an MNI of two individuals indicated by the recovery of duplicating portions of two right tibiae. One of these individuals would probably have walked with a limp, as the right patella recovered bore signs of severe osteoarthritis.

Eagle investigated another cliff below a mountain roadside winery after witnesses told the team that bodies were disposed of by throwing them over the cliff. Eagle indicated that human remains were indeed present in several locations on the cliff face and its drainages, and the team was able to recover the distal half of a human tibia showing signs of burning. This again was a fairly difficult recovery - the drainage was steep and full of slippery rocks, vegetation and trash. There was insufficient time to recover more.

Rumors of an individual tortured and buried to his waist, presumably while still alive, produced one metacarpal buried in the rumored gravesite with a sacrum and several rib fragments found scattered in the dense vegetation of surrounding jungle. Subject to confirmation by DNA these finds are consistent with partial burial followed by scavenger scattering (surface bones show evidence of animal activity). Or, in this case as in many

others, possibly some remains such as the skull and the perpetrators surreptitiously removed recognizable long bones in order to prevent recovery and identification. Although the sacrum and rib fragments appear to be consistent with being from one individual, the metacarpal may be from a different individual.

A search of an isolated area indicated by witnesses failed to yield anticipated burials. However, Eagle was attracted to a large tree with embedded barbed wire that was located some distance away, at the edge of the forest. His indications on the trunk of this tree produced several small bone fragments imbedded in the bark at about 34 inches above ground level, including a circular 9 mm diameter human bone fragment. This is consistent with the possibility that this may have been a "killing tree" to which victims were bound and then executed.

Several other potential sites within this province were investigated with both negative and positive results. These included the Cuartel, the regional police station/jail where a witness said that he had dug (with a bulldozer) a large excavation for a "swimming pool" into which many bodies were later thrown. Eagle's indication began inside one end of the current office building and lead the team through the building to the floor at the other end, resulting in an excavation under that floor that produced a mix of human and animal bone fragments but no mass burial as yet (excavations are continuing). Eagle confirmed a now unused well in the town of Volcan, rumored to be a body disposal site. Excavations by Panamanian archaeologists and local firemen yielded large quantities of non-human bone plus small fragments of probable human bone, but were halted due to concerns for the health of excavators, who were working deep in the well with hazardous breathing conditions.

As the authors continue to review some of the findings from the three search missions of Operación Eagle to date (August 2001, October-November 2001 and January-February 2002) it must be emphasized that the search and recovery procedures utilized and the resultant finds were directly related to Eagle's abilities as he enabled the team to rapidly check witness testimony in a large number of unusual and frequently difficult settings. It must also be noted that the starting points for Eagle's investigations were based on the witness testimony gathered with great skill and effort by the various investigators employed by the Truth Commission of Panama.

Skeletal Identification, Death Investigation Dogs, Taphonomy of Clandestine Graves

H64 Operacion Eagle: Clandestine Graves and a Taphonomy of Tyrants — Part 2: Searches on Coiba Island, Panama City, and Vicinity

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After attending this presentation participants should be better able to use death investigation dogs and forensic anthropologists to search for clandestine graves.

The cemetery of the penal colony located on the island of Coiba presented an unusual problem. Witness testimony indicated that selected political prisoners were brought to the island for "special treatment" followed by burial in unmarked graves within or near the prison cemetery that had been in use since the 1920s. One individual in particular was said to have been tortured, killed, and disposed of at this site, and his brother, also an activist, accompanied the authors to Coiba. Witnesses provided possible locations within the cemetery and Eagle indicated that human remains were present in several unmarked places within those general locations. As time allocated by the Truth Commission for this site was short (one day only) a small group of prisoners were paid to assist by removing earth until the level approaching remains or coffins was reached. Dr Murray Marks excavated and recovered two sets of well-preserved remains found in coffins (one without a lid), while the Sauls concentrated on fragmentary remains in two other graves. One of these yielded badly deteriorated cranial and upper body remains. The remainder of that burial had to be left in situ for future excavation, as were the poorly preserved and even more fragmentary remains found in an adjacent grave, due to the Truth Commission's desire for the team to explore several other sites before the scheduled time in Panama ran out.

The two individuals in the coffins were later determined to be victims of blunt force trauma. Remarkably, a cut posterior arch of the first cervical vertebra was found associated with the fragmentary cranial remains recovered from one of the other two graves. This grave also contained an apparently clandestine marker consisting of two large nails fused in the form of a cross and placed upright beside the head. These nails may have been originally tied together but were now held together by rust. Rotted, blackened wood fragments were located under the cranial fragments and later excavation by Dr Ann Ross found that, based on the presence and arrangement of other nails, a coffin (or partial coffin) had once been there.

While the above excavations were underway, Anderson used Eagle to check on the possibility of additional unmarked graves. Eagle methodically indicated in less than an hour that although there were 29 crosses present he believed that there were actually 129 graves within the cemetery confines.

A series of possible gravesites located in or around Panama City, including Tocumen SAN, the major airport for Panama City, and Panama Viejo were investigated following witness information. Tocumen SAN includes a large (football field size) pit created by extensive searches with bulldozers after four fairly intact sets of remains were found in 1999 and 2000, a runway, a firing range and the former "House of Pilots." Each locale presented its own challenges, but the Tocumen pit is perhaps the most disconcerting inasmuch as it is suspected that the buried isolated bones and fragments found by Eagle might have originally been part of intact burials that were scattered by the intensive bulldozing that took place during earlier excavations. Recovery efforts were complicated by the adherent nature of the red clay itself, heavy rains and the huge area involved. Nevertheless the numerous scattered and fragmented bones and teeth recovered yielded an MNI of two individuals represented by bone and an MNI of three individuals represented by dentition.

Other witness testimony suggested that remains were located under a peripheral runway area. Small holes were drilled to provide olfactory access. When Eagle returned the next day he indicated between two of the holes that had been drilled. Water was used in the process of drilling a new hole, and the team soon realized that Eagle was indicating on small bone fragments brought to the surface by the water. An excavation unit in this location yielded several burned bone and tooth fragments from the gravel just beneath the pavement. Burning may have been due to the heat of the macadam during construction.

Checks of witness testimony regarding the area in front of the "House of Pilots" yielded surface finds of three tooth fragments plus a portion of fibula that appeared to have had its distal portion severed perimortem (the cut was old with possible blood staining and no signs of healing) through a collar of reactive bone that might have been the result of trauma produced by shackles (there are reports of people tortured by being suspended by bound wrists or ankles for long periods of time). The other end of this fragment had been recently broken. Two tibia fragments were found at an animal burrow entrance behind the firing range targets.

Reports that skeletal remains were encountered during construction of a building at historic Old Panama and then "put into the wall" brought the authors to a one-story office building. Holes were drilled in the sidewalk and juncture of sidewalk and wall to facilitate scent access. Eagle indicated scent at the bottom of the wall and then stood up to tap on the outer wall surface. When allowed to enter the building he led the team

immediately to the other side of the wall, again standing up to touch the wall. Excavations by Panamanian archaeologists resulted in the finding of human teeth, small bones and bone fragments both within the wall and under the sidewalk at the wall's base.

Altos de Miraflores sits on the highest hill in Panama City. The split-level house there had become known as the "House of Torture." During the time when it was leased to the military, it was rumored that political prisoners were brought to the house, tortured, and then "disposed of." The house has since been unoccupied, except for a caretaker in the lower level. During his first visit Eagle indicated the presence of blood spatter in the house (later confirmed by the Technical Police [PTJ]) and the presence of surface remains in the adjacent yard. A cranial fragment was recovered just beneath the soil surface beside the house. Metatarsals and phalanges were found scattered in the grass a short distance away. During subsequent visits, Eagle indicated the presence of additional human remains in several locations on the hillside below the house as well as more buried remains near the house. These locations were scheduled for future attention. Upon return, the team discovered that some of these "positive" locations were now "negative" locations and new areas were "positive." Bones seemed to be moving around. It became apparent that the team's recoveries were followed by clandestine attempts to move and destroy remaining skeletal evidence. A field that was scheduled to be examined was burned and traces of accelerant were found after the local fire department hosed it down. Fortunately, Eagle finds burned human bone, especially when wet, and Eagle located several bone fragments, some of which had been cut or fractured both in the past and recently. The property owner initially gave permission for searches but became increasingly hostile as human bone was found. However, these finds provided the PTJ with a basis for continued access to the property.

Perhaps the most meaningful information comes from a foul smelling culvert down the hill that became known to the team as "Lower Purgatory" in relation to the house at the top of the hill ("Upper Purgatory"). Indications by Eagle and subsequent excavations in the culvert yielded two separated but articulating maxillary fragments with teeth and an unusual dental restoration. Also recovered in this evil smelling place were two projectiles and rotting fabric with remnants of elastic similar to that of men's under shorts. In addition, a portion of femur shaft found lying within the drainage pipe was later joined to a smaller fragment that was excavated from the yard adjacent to the house at the top of the hill, thus physically linking "Upper" and "Lower Purgatory."

Adding to the taphonomy of the "migrating" remains is a virtually intact and unburned fibula that Eagle found standing on end in the tall grass above and adjacent to the culvert as if it had been tossed there from the culvert below, perhaps during a hasty attempt to remove remains. This location had been searched a few days before.

In conclusion, Eagle's ability to find very small units of remains (surface, buried and under water) both complicated and enhanced the investigation. Shallow burials or surface deposition allow access for carnivores and other scavengers, and the tropical climate not only quickly reduces the human body to skeletal remains but torrential tropical rains and rapidly growing vegetation combine to scatter remains. The initially disturbing fact that mainly bone fragments, teeth and small bones were being found, with few larger bones, skulls or mandibles, also suggests that remains may have been systematically removed to new and possibly multiple locations after skeletonization in order to "disappear" the victims. During such a procedure, more easily located and recognized bones are collected, while less easily located and recognized small bones, fragments and individual teeth are left behind. In some cases, this may be followed by dispersal of the collected remains in several different (and possibly widely separated) locations.

Eagle's special talents have provided insights into an unfortunate taphonomy of clandestine body disposal patterns – a "taphonomy of tyrants."

Skeletal Identification, Death Investigation Dogs, Taphonomy of Clandestine Graves

H65 Utilizing Ground Penetrating Radar and Three-Dimensional Imagery to Enhance Search Strategies of Buried Human Remains

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The purpose of this paper is to present to the forensic community the advantages of a collaborative approach when searching for buried human remains.

Locating the clandestine burial of human remains has long perplexed law enforcement officials involved in crime scene investigations, and continues to bewilder all the scientific disciplines that have been incorporated into their search and recovery. Many notable forensic specialists and law enforcement agencies, in an effort to alleviate some of the bewilderment that commonly accompanies the search for a buried body, suggest that multidisciplinary search efforts are becoming more of a necessity, and less of an option.

Research at the University of Tennessee's Anthropological Research Facility (ARF) in Knoxville supports this theory through a collaborative research effort directed toward the development of more efficient and effective methods in the search for, and detection of, buried human remains. The Department of Anthropology, in conjunction with the University's Department of Biosystems Engineering and Environmental Science, has coupled the use of ground penetrating radar (GPR) with 3-dimensional imagery programs to better detect buried human targets.

Two different ground penetrating radar systems, the SIR-20 and the GPR-X, were employed to obtain 27 designated scans over six constructed grave plots. This procedure was replicated every 4-6 weeks, over an eight-month period. Two and three dimensional imagery programs were then applied to the acquired images, which in turn were compared by GPR system used, and overall changes that occurred within the graves over time.

The results of this research support and acknowledge that GPR is capable of enhancing field methods in the search for clandestine burials, and when coupled with target-specific geophysical imagery software, contributes valuable working knowledge in regards to the contents of the burial itself. Hence, such resources can only be seen as beneficial to a search team's endeavors.

Buried Human Remains, Ground Penetrating Radar, 3-Dimensional Imagery

H66 Location, Identification, and Repatriation of Remains of Victims of Conflict: Implications for Forensic Anthropology

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The objective of this presentation is to inform the forensic community of the current standing of positive identification of victims of conflict and the role of forensic anthropology in humanitarian efforts of victim identification.

The Declaration on the Protection of all Persons from Enforced Disappearances calls for protection from acts committed by, or with the acquiescence of, national governments depriving individuals of the basic human rights of life, liberty, and security of person. The Working Group on Enforced or Involuntary Disappearances, established in 1980 by the Commission on Human Rights, provides assistance to family members seeking information on the fate and whereabouts of missing relatives when disappearances are the result of domestic affairs. In international armed conflict, the International Committee of the Red Cross (ICRC)

serves to aid in the location of missing family members. The work of the two preceding groups ends when living relatives are located or the missing family member is presumed dead. The International Criminal Tribunals for the Former Yugoslavia (ICTY) and Rwanda (ICTR) provide for judicial action against those guilty of international crimes such as disappearances and extra-judicial executions in an effort to promote the restoration of peace and security. The International Criminal Court (ICC) will serve similar purposes in years to come, both for international and internal armed conflicts. Therefore, it is clear that persons are protected from disappearances by international law, and guilty parties are not free from prosecution. However, positive identification of victims of conflict remains a secondary emphasis.

This paper explores the current lack of emphasis on positive identification of victims of conflict. Recognized international human rights such as the right to family, the right to information and the right to be free from torture, as established by the Universal Declaration of Human Rights and the international covenants (ICCPR and ICESCR), are reviewed as bases for the establishment of stricter mandates securing rights and privileges for surviving relatives in the positive identification of family members. The disparity in emphasis and allocation of funding between missions aimed at the prosecution of perpetrators of extra-judicial executions and those established for the identification of victims is highlighted, as well as the role of forensic science in the exhumation and analysis of remains. Current efforts towards identification of missing persons in Kosovo are discussed as mandated by the FRY Agreement and administrated by the Office of Missing Persons, established by the United Nations Mission in Kosovo (UNMIK). Finally, current difficulties in establishing anthropological standards and identifying individuals from non-Western populations are addressed, as well as the future role of forensic anthropology in humanitarian efforts of positive identification.

Forensic Anthropology, Human Rights, International Law

H67 This Grave Speaks: Forensic Anthropology in Guatemala

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The goal of this presentation is to present the forensic community the results of the work done by forensic teams for a decade in the fields in Guatemala. These results seen in photographs and in several graphics show and demonstrate individual and mass graves with different patterns of inhumations. Inhumations performed by relatives, soldiers and paramilitaries in the decade of the 80s.

Forensic investigations provide key points of substantiation of physical and testimonial evidence in the reconstruction of the scene, it is a job for the multidisciplinary team who focuses in the exhumations in Guatemala.

Exhumations performed due the violent acts occurred in the 80s, during a period of several military governments; in which more of the civil population was affected. Over 80% of the victims were Maya indigenous people.

Some of these cases are now following a national and international legal process. These processes came about as a desire to denounce these acts for human rights violations by the families of these victims; who want to know where relatives are.

This investigation compiles the mechanisms of inhumation from clandestine graves. Individual and mass graves were found in which from one to twenty, thirty, sixty, or more skeletonized individuals could be seen.

The way to order the bodies, the different positions in which they are found, one behind the other, one thrown above others, gives clues to find which group performed the inhumation process.

In these regions (different counties, mountainous areas) the skeletons of individuals from different ages, sexes and conditions, articulated and disarticulated bodies, have been found.

In fact, because of the acts that occurred, relatives bury these dead persons and several bodies where also buried by military and paramilitary elements. In the first case it becomes easy to find these places because the relatives are witnesses. In some occasions a wood box was improvised and introduce personal things in a way as to offer them the other life; the things the people most commonly used daily.

In the cases where the army forces buried them, bodies can be found disposed in dramatic patterns, showing some ways of torture and the strategies of murder.

These places show diversity in the execution strategies: to behead, decapitate, hang, patterns of gunshot. In some places there are houses that have been burned with children and women inside; caves where the men were first stabbed and then throw.

In other cases like the ones where military detachments operated near the communities during these violent years, it has been necessary to use geophysical methods in the search for graves. The recovered evidence shows lassos round the neck, hands, and the faces covered.

In other cases bones, rope, and lassos are still found on the surface, near the roads, after 20 years these items stand as silent witnesses.

Graves, Patterns of Inhumation, Strategies of Murder

H68 The Role of Anthropology During the Identification of Victims From the World Trade Center Disaster

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After attending this presentation, the participant will become familiar with all of the different roles and contributions made by forensic anthropologists during the recovery and identification process of the World Trade Center Disaster.

This presentation has three objectives: (1) to illustrate where anthropological assistance was called upon and why, including how many anthropologists participated in NYC, their roles at Ground Zero, The Staten Island Landfill and at the Medical Examiner's Office, (2) a general overview of how the remains were processed from recovery to identification, including which traditional anthropological techniques were employed and which ones were obsolete due to the population size and the physical characteristics of the specimen received, and (3) to highlight some lessons learned during such an evolving and fluid situation. Protocols were modified and changed based on 10 months of feedback and simultaneous processing.

On the morning of September 11th, two fully fueled airliners were flown into the World Trade Center buildings in downtown Manhattan. Hundreds were killed instantly upon impact and thousands more perished when the two towers and five other commercial buildings collapsed. Subsequent to the collapses, fires continued to burn at over 1500 degrees for more than twelve weeks within the destruction site. The area of destruction covered over 16 acres and was piled over 70 feet tall, later to be excavated over 70 feet deep. The uncertainty in the initial number of reported missing and presumed dead prompted the Office of Chief Medical Examiner, New York City, to call upon the assistance of DMORT, the National Disaster Mortuary Operation Response Team, to provide ancillary staff of all types to assist with the disaster. In addition, assistance in the identification process was also provided by the New York City Police Department, the New York Port Authority, the New York Fire Department, the Department of Corrections, and the FBI. Specific to this presentation will be the role of the 30+ forensic anthropologists that came to assist in the recovery and identification process.

The recovery operation was very slow and difficult, and often very

dangerous. Along with the danger of the fires and the constant watering, there were large pockets and void areas always threatening to collapse. The searches and excavations were done by hand and bucket brigades, as well as by huge grapplers, cranes, and other types of heavy machinery. Steel beams weighing many tons criss-crossed the entire site. The amount of destruction and pulverization was so extensive, that no piece of recognizable office furniture was found.

Anthropologists were assigned to work at the temporary morgue set up next to the recovery operation, the medical examiners office where all of the identifications were done, and at the Staten Island landfill where over 1.6 million of tons of debris from Ground Zero were transported and sifted manually and mechanically for human remains. The actual role of the anthropologists varied greatly from site to site. At the temporary morgue, the anthropologist helped sort out civilian and Member of Service remains, and later were called upon to assist in difficult recoveries of burned and commingled remains. At the landfill, the primary role of the anthropologist was to sort out human from non-human remains. The role of the anthropologist at the medical examiners office ranged from triage to bone identification. The anthropologist was the beginning of the assembly line, processing each case, sorting out commingled remains, labeling bone identifications and adding anthropological analysis when pertinent. In addition, anthropologists were later added at the end of the assembly line, rechecking links made by DNA to verify that the pieces can and did belong together. These roles also evolved over time as the operation changed.

After recovery at Ground Zero was complete, the role of the forensic anthropologist changed yet again, due to retrospective evaluations and the fact that the unidentified and unclaimed remains were to be dried and sealed in bags that were non-transparent. An anthropological verification protocol was established to recheck and provide more detail of the cases, once the sense of urgency settled. In addition, this verification program allowed reevaluation of cases that might have been commingled, needed resampling or where details were overlooked during the initial processing. The lessons which initiated the verification protocol are most valuable for the documentation and instructions needed in the future should another disaster of this magnitude or larger occur.

Mass Fatality, Forensic Anthropology, Identification

H69 Anthropology at Fresh Kills: Recovery and Identification of the World Trade Center Victims

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The purpose of this paper is to review the role that anthropologists played in the recovery and identification of the victims of the September 11th attack and discuss flexibility in the application of methodologies in dynamic field conditions.

The terrorist attacks of September 11, 2001, initiated an unprecedented challenge for forensic scientists. The massive scale and scope of the recovery and identification effort, the force and uniqueness of both the traumatic and taphonomic mechanisms, and the psychological stress of working in such an emotional environment, combined to make the events of September 11th a powerful and lasting experience for all involved. Forensic anthropologists deployed to New York's World Trade Center by the U.S. Public Health Services' Disaster Mortuary Operational Response Team (DMORT), working at the behest of the Office of Chief Medical Examiner, were integrated into the operation at three primary arenas of action: the New York City Medical Examiner's Office, the on-site staging areas on Trinity and Vesey Streets, and the Fresh Kills landfill on Staten Island. This paper will discuss the anthropologist's role at the Fresh Kills site and describe the conditions and challenges that confronted the team.

The Fresh Kills (*Fresh stream*; Dutch) landfill on Staten Island opened in 1948 and was, at one time, the largest human-made object on earth. Fresh Kills received its last barge of New York City garbage in March of 2001, after which the mountain of refuse was capped. Immediately after the events of September 11th, the landfill was re-opened to serve as a repository for the massive amounts of debris transported from the World Trade Center complex. Additionally, the Fresh Kills site was the final stage of recovery for the World Trade Center victims. After the initial on-site search and recovery failed to discover human remains, the structural debris was removed by heavy equipment to barges and ferried across the bay to Staten Island. During the early weeks of the operation the debris was sifted, sorted and recovered by law enforcement officers and additional personnel. Material suspected to represent human remains, as well as additional material thought to have evidentiary value, was brought to on-site staging areas operated by the New York Police Department (NYPD) Crime Scene Unit and the Federal Bureau of Investigation. The anthropologists were stationed with the NYPD crime scene unit, where possible human remains were examined and, if found to be human, were given identification numbers, photographed, and stored for transport to the Office of Chief Medical Examiner in Manhattan. As time passed, the operation became more mechanized, with the use of large sifters and conveyor belts that provided searchers examining passing material some protection from the inclement winter weather.

The decision by the Medical Examiner's Office to depend heavily on genetic testing of specimens to establish positive identification meant that many of the usual techniques employed by DMORT anthropologists, such as determining group and individual skeletal characteristics, would not be utilized. As a consequence, the primary role of the anthropologists stationed at the Fresh Kills site was to differentiate organic material from various types of debris, and then identify human from non-human remains. The contribution of the Fresh Kills teams was ultimately to increase the efficiency, and decrease the expense, of genetic testing by excluding non-human specimens from entering into the chain of evidence. On a more immediate basis, the examination and triage of potential human remains by the Fresh Kills teams greatly reduced the numbers of items requiring photographic and written documentation by overworked NYPD crime scene personnel.

The anthropologists encountered a singular taphonomic phenomenon in terms of the magnitude of forces resulting from the aircraft impact, burning, and collapse of the World Trade Center's twin towers. These same taphonomic forces (extreme heat, compression, torsion, commingling, etc.) created unique "pseudo human remains" from construction and other material that often confounded the law enforcement personnel collecting the evidence – almost all of whom were untrained in the recognition of fragmented human remains. Additional circumstances that complicated the recovery process were the incredible amount of organic material already within the landfill, including an unexpected amount of non-human organic material from the large number of restaurants in the World Trade Center complex and surrounding streets. The debris, massive amounts of organic material and associated methane gas produced a hazardous and confusing condition for the cadaver dogs, many of whom had not been trained to avoid indicating (or alerting) on food or dead animal remains.

The identification effort at the Fresh Kills site can be considered a model that demonstrates the essence of the DMORT mission statement. Each deployment is unique in that each scenario may require that the DMORT experts demonstrate flexibility in the application of their methodologies contingent upon the needs and desires of the requesting Medical Examiner's Office or other agencies.

Forensic Anthropology, Human Identification, Terrorism

H70 Scene Recovery Efforts in Shanksville, Pennsylvania: The Role of the Coroner's Office in the Processing of the Crash Site of United Airlines Flight 93

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Attendees can expect to learn about new techniques, based upon contemporary archaeological methods, employed during the recovery of large aircraft mass fatality sites in general, and specifically, with regards to the recovery of the United Flight 93 crash. The role played by the coroner of a rural county is also explored at length.

On September 11, 2001, at 10:10 AM, a Boeing 757 (United Airlines Flight 93) crashed in an open field near the small town of Shanksville in Somerset County, PA. All 44 individuals aboard were killed. It was clear from the start that terrorists who intended to use the plane as an instrument of suicide and mass homicide had hijacked the plane. In this presentation, issues related to the role of the coroner's office during the forensic processing and subsequent mitigation of the scene will be discussed.

Following the initial response by local fire and law enforcement agencies to put out the fires and search for survivors, the Somerset County Coroner (WM) was summoned to assess the crash scene and determine how best to recover and identify the human remains. Part of the coroner's response was to assemble a team of advisors (including other coroners, funeral directors, and forensic anthropologists) and support personnel. The crash site included two forensic features: a vehicle impact crater and a large fan-shaped debris-splash area emanating from the crater. The plane impacted the ground at a steep angle near the edge of a reclaimed strip mine. Since the ground was rather soft, much of the plane imbedded into the ground, creating a pit about 10 feet deep and 15-20 feet wide with an associated mounded pile of dirt opposite the initial impact point. A portion of the plane sheared off upon impact and fell into the adjacent forested area, scattering in an approximately 70-acre fan-shaped debris field. A concentration of debris and jet fuel landed in the forest near the crater and significantly charred the trees in this area.

Phase 1 Recovery. The first step in the recovery process required the formulation of a successful strategy for locating, documenting, and removing the associated physical evidence. This process involved consideration of jurisdictional matters, personnel, equipment, and a myriad of other issues. It was decided at the outset that the recovery strategy should provide a balance between the rapid recovery and documentation of potentially forensically significant physical evidence (e.g., voice and flight data recorders, important mechanical parts of the vehicle, items related to the cause of the crash such as explosive devices and residue, weapons, and personal effects of terrorists) with maximal recovery of the biological and personal effects of the victims. The coroner suggested using a new search, documentation, and recovery protocol, recently developed by the first author, which included sequential and concurrent stages involving thorough and meticulous searches, sectioning of the scene into manageable grid sections, and the use of an electronic total station to precisely document significant physical evidence location. The protocol had been tested at a mock crash scene during an FBI training short course in St. Louis and successfully implemented during the recovery efforts of the plane crash involving Melvin Carnahan, Governor of Missouri.

Given the context of the crash relative to other national events of September 11, and since it was immediately clear that the crash involved criminal activity, the FBI assumed responsibility for recovery of the forensically significant physical evidence (and larger fragments of human remains) from both the impact crater and the forested area impacted by the crash debris. FBI and Pennsylvania State Police personnel completed these efforts. Approximately 500 pounds of human tissue was recovered. During this time, civilian efforts were focused on the documentation and identification of the human remains at the temporary morgue as part of the DMORT operation.

Phase 2 Recovery Efforts. Federal authorities released the scene two weeks later. Due to the tremendous forces imparted upon the aircraft and associated materials during a crash of this nature, a nearly overwhelming volume of debris was created and deposited on the scene. Much of this material—deemed non-forensically significant and including, primarily, plane debris and small fragments of human remains—remained on the scene. The decision was made by the coroner to comprehensively (i.e., as close to 100 percent as possible) recover and remove this material from the scene prior to the final release of the scene to the public. The coroner's office, Mercyhurst Archaeological Institute personnel, and Pennsylvania Emergency Management Agency officials organized recovery efforts utilizing forensic archaeological methods during two subsequent weekends involving approximately 200 volunteers (firemen, funeral directors). The entire 70 acres of crash debris field was searched using pedestrian in-line shoulder-to-shoulder visual scanning methods. Teams of 10-12 individuals were assembled and coordinated by a team leader who set the direction and pace of the search. In the areas most distant from the impact crater, pedestrian search sufficed because debris was widely scattered and not abundant. In areas closer to the impact crater, the searchers performed the recovery efforts on hands and knees since much of the remaining debris was hidden under leaf litter and natural forest debris. Approximately 100 pounds of highly fragmented human tissue was recovered.

In the following three months, additional site mitigation efforts by an independent company hired by the airline resulted in the location of additional human remains, personal effects, and plane debris, especially during removal of charred trees in the burn zone. In May of 2002, another 100 volunteers resulting in nearly complete recovery of site crash debris conducted a final search of the crash site.

Mass Fatality Recovery, Forensic Archaeology, United Flight 93

H71 Roles of the Biological Anthropologist in the Response to the Crash of United Airlines Flight 93

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The goal of this presentation is to examine the multiple roles filled by anthropologists during the recovery and identification of the victims following the crash of United Airlines Flight 93 and to explore the training and skills that allowed the anthropologists to play such diverse roles.

Traditionally, medical examiners and law enforcement agencies have consulted biological anthropologists in the investigation of crimes, accidents, and mass disasters. Conventional training in biological anthropology provides the professional with a background in human anatomy and physiology, growth and development, epidemiology, genetics, and the scientific method. Biological anthropologists who specialize in skeletal biology have a unique suite of skills that is applicable to certain types of forensic investigations. An extensive knowledge of human and nonhuman bones is utilized to recognize and identify skeletal fragments and human remains and to collect biological information from those remains and fragments. In addition, anthropologists have the skills to collect biological and other evidence at scenes, using field and

archaeological methods. On September 11, 2001, terrorists took control of United Airlines Flight 93, a Boeing 757 flying from Newark to San Francisco. Passengers and crew on the flight learned through telephone calls that other flights had been used to attack the World Trade Center and the Pentagon earlier that morning, and were able to thwart the terrorists' plans. However, the plane crashed into an open field in Somerset County, PA, and all those aboard (40 passengers and crew and 4 terrorists) were killed.

On September 13, the U.S. Department of Health and Human Services DMORT Region III team was activated to respond to the crash site. This team deployed six anthropologists, including the team commander, and other Regions loaned two additional anthropologists. Several of the team's anthropologists had responded to other air crashes and terrorist attacks (e.g., EgyptAir Flight 990, Executive Air, Korean Air Flight 801, Oklahoma City Murrah Building) and were thus experienced in working on mass fatality incidents with the National Transportation Safety Board and other disaster response agencies. However, due to several unusual circumstances, the anthropologists found themselves filling new roles in this response.

First, the Flight 93 crash site was considered to be a crime scene and was under the control of the Federal Bureau of Investigation; a situation the team had not dealt with previously. Prior to deployment, several of the team's anthropologists were involved in the initial recovery at the crash site. This cooperation facilitated later morgue operations by providing information about recovery strategies and the organization of remains. Collaboration between FBI and DMORT personnel in the morgue was necessary to maintain continuity throughout the processing of remains and evidence. An anthropologist assumed the role of morgue manager to assure smooth operation in the facility and to supervise protocol development for each area of activity within the morgue. These activities included triage, admitting, radiography, photography, anthropology, pathology, odontology, and DNA sampling. Protocols were written based on previous experiences and modified during the September 11 incident to reflect the medico-legal aspects of the situation. With written instructions, team members were able to work confidently in their areas, and turnovers in staffing were smooth. These standardized protocols will be made available to other disaster response teams through the DMORT website. They can be modified to reflect the circumstances of future responses.

Second, anthropologists were involved in aspects of the recovery operation and were fully integrated into the morgue operation. In addition to the initial recovery at the crash site, anthropologists visited the site to monitor the recovery of human remains. In the months following the crash, anthropologists volunteered to return to Pennsylvania several times to help recover more remains and clear the site. Anthropologists analyzed these newly recovered remains and assured that the analysis of these remains proceeded according to the protocols developed during the DMORT deployment, including triage of the remains and DNA sampling. Anthropologists further assisted the local coroner in the final reassociation of the positively identified remains. The anthropologists were able to combine electronic data from several different data sources, manipulate the data to a consistent format, and generate a final data table to facilitate the reassociations.

Third, anthropologists were assigned to staff the triage station and played a key role in the triage selection strategy. The training of the physical anthropologists in both skeletal biology and human anatomy enabled them to readily identify the fragmentary remains and make appropriate decisions regarding the processing of remains through the morgue stations. Given the high fragmentation level associated with the UA 93 crash, the majority of remains processed through the triage station were composed of fragmentary bone with some associated soft and connective tissue. The ability of the anthropologists to correctly identify these remains and assess their identification potential helped ensure that the morgue processed the human remains in a timely and efficient manner.

The positions and responsibilities of DMORT anthropologists for the Flight 93 response included team commander, morgue management, triage, anthropological analysis, DNA sampling, protocol development, site recovery, database management, and data verification. In addition, the anthropologists were able to communicate effectively with pathologists, dentists, radiological technicians, coroner's staff, law enforcement agents, DNA specialists, and other team members. The anthropologists' training and experience made them valuable and flexible members of the disaster response team.

United Airlines Flight 93, Forensic Anthropology, Victim Identification

H72 Attack on the Pentagon: The Role of Forensic Anthropology in the Examination and Identification of Victims and Remains of the '9/11' Terrorist Attack

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The learning objective of this presentation is to present the forensic science community with an overview of the role of the crucial role forensic anthropology played in the processing of remains recovered form the 9-11 terrorist attack on the Pentagon.

On September 11, 2001, at approximately 9:43 am, just 26 minutes after a second hijacked plane struck the South Tower of the World Trade Center in New York, American Flight 77 out of Washington – Dulles crashed into the Pentagon. American Fight 77, whose destination was Los Angles, was hijacked by five Islamic terrorists who took control of the cockpit and crashed the airliner into the Pentagon. The crash resulted in the death of 189 people, which included all 64 individuals on Flight 77 and 125 individuals on the ground in the Pentagon. A second terrorist attack on Washington, DC, was thwarted by passengers aboard United Flight 93, resulting in the airliner crashing just 125 miles outside Washington, in Somerset County, PA. Shortly after the Pentagon attack all federal buildings in the capitol were evacuated, and the various local state and federal entities went into action.

Being that the jurisdiction for the Pentagon is federal, the FBI and military were tasked with the lead role investigation and recovery efforts. A temporary morgue was established on the Pentagon grounds which served as an initial collection and processing site for the bodies and remains of the victims. Each body or portion of human remains recovered at the crash site was assigned an evidence number that correlated to their respective recoveries. The bodies and remains were then photographed at the temporary morgue and then transported directly by helicopter to the Dover Air Force Base Port Mortuary in Dover, Delaware. Processing of the bodies and remains was conducted by the Office of the Armed Forces Medical Examiner. The Dover port mortuary was staffed around the clock by multiple military and federal personnel. Personnel assisting in the processing of victims included the forensic pathologists, anthropologists, odontologists, radiologists, federal and military investigators, and an enormous staff of medical support personnel.

Processing the bodies and remains involved passing them through a complete network of stations in were they were radiographically screened for evidence and hazardous materials, photographed, entered into a computer data base, fitted with a secure numerical and bar-coded identification tag, fingerprinted, received full body x-rays, postmortem odontological exam, postmortem autopsy and anthropological exam, DNA collection, then embalmed and casketed awaiting confirmation of positive identification. The explosive forces of the crash and ensuing fire resulted in the burning, fragmentation and commingling of a number of the victims. Forensic anthropological examination was utilized extensively to deal with the burnt and fragmented remains as well as intact remains in which there was a question of approximate age, skeletal injury or re-association.

In order to deal with anthropological requirements the assistance of eight forensic anthropologists were employed. The forensic anthropologists who volunteered to assist included those from the Armed Forces Institute of Pathology, the U.S. Army Central Identification Lab in Hawaii, and the Department of Anthropology - Smithsonian Institution, Washington, DC. Forensic anthropological examination of the remains were divided into two areas, one being examination at the initial triage of remains as they arrived and at autopsy in conjunction with the forensic pathologists examinations. During triage the incoming specimen was examined to determine if the remains were human, non-human, or crash debris. Those specimens determined to be human tissue were examined to ascertain their anatomical origin, then were re-packaged with a specimen tag and brief description of the specimen. During triage specimens were also evaluated as to suitable for identification by DNA analysis. In the autopsy area forensic anthropologists provided assistance to the forensic pathologists by identifying skeletal elements, providing biological profiles based on skeletal morphology, reconstructing skeletal anatomy, conducting radiographic comparisons in reference to positive identification, conduct separation and re-association of commingled remains, and provide consultation on skeletal injuries.

The role of forensic anthropologists in the Pentagon mass disaster was extremely important, as were the roles of the other forensic scientist and investigators who were involved. The teamwork of the forensic anthropologists and their scientific colleges lead to an extremely high level of identification of the victims and remains recovered from the Pentagon. The tremendous loss of lives will not be forgotten, but through the dedication of the forensic sciences families of the victims can find comfort and closure to the families of the victims.

Forensic Anthropology, Identification, Mass Disasters

I1 An Empirical Test of a Bias Crime Offender Typology

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The learning objective of this presentation is to introduce the ideas of offender motivation and level on capability in the instance of bias motivated crimes.

Proposition: That a more refined analysis of offender motivation and level of culpability will result in improved decision-making by members of the criminal justice system.

This paper will present the results of an empirical test of a suggested typology of hate crime offenders. Previous research has suggested that there are three major motivations for hate crime offenders and that these motivations could be associated with different offender typologies. This research suggested that bias crime offenders could be seen as individuals who commit their crimes for the "thrill" or excitement involved, others who see the crime as "defending" their turf from outsiders, and a very small number are associated with organized hate groups and have made their life's "mission" to change the world. This typology has been widely used by law enforcement, including the FBI, and is part of the national hate crime training curriculum. However, to date this typology has never been empirically tested. This paper presents a test of this hypothesis using data from the Boston Police Department's bias crime investigation unit. Researchers from Northeastern University reviewed the case files from 169 investigations conducted between 1991-1992, where bias crime offenders were known. Research assistants classified each case by the motivation of the offender; this classification was subject to inter-rater reliability and was found robust. Each case was classified according to the original typology and to see how each case might be classified and how many cases did not fit with the original typology. The research supports the original typology but does suggest some subcategories that may have been overlooked in the original. The research also suggests that certain characteristics of the crime can help local law enforcement officials make a designation as to which category of the typology the incident is likely to fall. The research also investigates the role of offender in the incident. Many local decision makers (e.g., judges, prosecutors and police) have a difficulty in attribution of culpability for bias crimes. Since many bias crimes are group events where more than one offender is involved, the level of culpability of each offender may and often does vary. Many local criminal justice decision makers find themselves in a difficult position of needing to send a strong public message that bias crimes will not be tolerated while believing that some of those involved in the incident had less culpability than others. This paper presents a scale of culpability where each offender can be located and punishment can be affixed in accordance with the level of culpability. The paper suggests a four level model including those who would be consider "leaders," those who go along but would most likely not be involved if someone else did not assume a leadership role, "Fellow Travelers," those who disagree with the actions of the group but for a variety of reasons can't disassociate themselves from the group, Unwilling Participants, and finally those who at significant personal risk attempt to intervene and stop the incident "Heros." These categories can be used to differentiate among the various participants in most bias crimes and to then assist the determination of the level of punishment that should be allocated. This framework can be used outside he criminal justice system and is being utilized in other settings such as schools and universities. Finally, the paper attempts to combine the offender typology with the culpability model to suggest how groups of offenders from each typology area might vary in terms of culpability and the implications of these differences for public policy. This paper suggests that the way bias crimes are being investigated and prosecuted at present is rather limited. By considering the motivation of offenders and the culpability of those involved, the major decision maker in the criminal justice system would be able to employ a more equitable and effective decision making process.

Bias Crime, Hate Crimes, Offender Motivation

I2 Offender Typology in Action: Case Studies of Hate Offenders and the Impact on Law Enforcement Training

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The goals of this presentation are to present to the forensic community case studies of mission and thrill-seeking hate offenders, as defined by the research of McDevitt and Levin, that assist in understanding the implications of alternative sentencing guidelines, as well as evaluating existing screening mechanisms as useful in predicting hate-related violence. In addition, the paper will explore the means of educating law enforcement on this topic as it relates to criminal investigation skills and practices.

Proposition: That a greater understanding of how McDevitt and Levin's theory as practically applied to real world examples of offender behavior will result in better decision-making by members of the criminal justice system.

This paper focuses on the experiences of Anti-Defamation League staff, who, through the implementation of a "Juvenile Diversion Program," as well as law enforcement training and community response, came in contact with both members of extremist groups as well as those connected to them. In addition, the paper highlights effective training techniques utilized by the presenter in educating law enforcement as to the need to understand Offender Typology, as not only a predictor of violence, but as a means of enhancing follow-up investigations.

In July of 1999, Benjamin Smith, a member of the white supremacist group, World Church of the Creator, went on a multi-state killing spree, murdering two and injuring several others in his racially motivated attacks prior to taking his own life in a police standoff. Smith had been a student at the University of Illinois at Urbana-Champaign (UIUC), and had several run-ins with both the University police as well as the Student Judicial system for crimes unrelated to bias; he had been picked up for exposing his genitals at a girls dormitory and had been repeatedly cited for physically battering his girlfriend. Extensive conversations with his girlfriend, as well as Student Judicial staff paint a vivid portrait of a young man who was not only seduced by the mission of a particular hate group, but of an individual who actively sought out the "right" group to seduce him.

In the spring of 2000, ADL reached out to UIUC, participating in anti-bias programming and leading educational programs on offender typology. In preparing for this effort, staff researched possible screening mechanisms for violent or suicidal behavior in youth, and presented it to UIUC judicial staff. The screening mechanisms were found at the web site *www.OregonCounseling.org*, operated by Mentor Research Institute (MRI), a non-profit 501(c)3. MRI is affiliated with the American Mental Health Alliance-Oregon (AMHA-OR), a non-profit mutual benefit professional corporation. According to the Student Judicial Staff who had met repeatedly with Smith, not only did he fit the "mission offender"

typology; he also met nearly all of the criteria of the violent or suicidal behavior in youth screening mechanisms.

ADL staff has also worked with the criminal justice system to devise juvenile diversion programs as part of court-ordered sentencing on hate crime cases. Part of that training requires that all prospective offenders be screened by ADL staff to determine if their level of commitment to their particular extremist group is so severe as to prohibit them from growing beyond their violent, racist tendencies. Upon acceptance to the program, the offender meets with a broad range of ADL staff, where issues including racism, anti-Semitism, and extremist group ideology are explored. Through these conversations, staff was given a window into the world of the "thrill seeking offender," where part of the thrill comes from dabbling in extremist group ideology, enhancing the youth's sense of self and connectedness, buoying him into criminal action. In fact, the similarities between the needs of youth whom join extremist groups were, minus the element of financial gain, identical to youth who joined traditional street gangs.

ADL plays a large role in educating law enforcement nationally on issues of hate crime and extremist group activity. The presenter has ten years of experience in law enforcement training, and has found empirically that this audience responds most effectively when new theories are related to practices already implemented on some level. For example, connecting "Offender Typology" to what the criminal justice community currently knows about the profiling of stalkers and the varying levels of risk posed by them has been very successful, as has the aforementioned gang reference. Key to effective training is the level of practicality provided by the presenter, as well as the relationship of new material to older, accepted material.

In conclusion, it is critical that the forensic and greater criminal justice community recognizes the utility of both the research that supports McDevitt and Levin's work on offender typology, as well as its practical applications. In addition, by utilizing other screening mechanisms to augment it, the theory may be applied in a manner that supports better understanding of offenders so that they may be sentenced justly, treat them appropriately, and protect communities with a higher degree of thoughtfulness and care.

Hate Crimes, Offender Motivation, Bias Crime

I3 Police-Induced False Confessions in the Post-DNA Age

Steven A. Drizin, JD, Associate Clinical Professor of Law, Northwestern University School of Law, 357 East Chicago Avenue, Chicago, IL*

The goals of this presentation are to present to the forensic community an overview of the problem of false confessions and the police interrogation tactics that often produce them.

In recent years, numerous individuals who confessed to and were later convicted of serious felonies have been exonerated of these crimes when other evidence has surfaced, proving conclusively that the individuals were factually innocent of the crimes to which they confessed. DNA testing, often unavailable at the time of prosecution or a conviction, has played a key role in many of these exonerations. For example, according to figures compiled by the Innocence Project at Cardozo Law School, false confessions played a role in 22% of the first 74 (out of 110 total) DNA exonerations.

The Innocence Project's database of DNA exonerations, which are limited to wrongful convictions, greatly underestimate the true scope of the false confession problem. DNA has also exonerated dozens of men, women, and children who confessed to and were charged with serious crimes before their cases went to trial. Moreover, many other defendants who confessed were later exonerated in cases in which DNA evidence was unavailable, typically because the real perpetrator was apprehended and confessed to the crime. Finally, it is fair to presume that there are unknown numbers of other innocent defendants who have confessed to crimes they did not commit who do not have access to DNA testing or whose cases involve biological evidence recovered from the crime scenes that has been lost or destroyed.

While the true extent of the problem is unknown, widespread false confession scandals have been documented in the *Washington Post* (involving Prince Georges County) and the south Florida newspapers (Broward and Miami-Dade Counties) to go along with numerous sporadic cases of false confessions which have been uncovered around the country. However, perhaps no jurisdiction has been more tainted by false confessions than Illinois, and in particular, Cook County, IL. In Illinois, the convictions of seven of the 13 innocent men condemned to death were tainted by false confession evidence. A December 2001 series in the Chicago Tribune, *Cops and Confessions,* documented over 247 Cook County cases over the past ten years, a 10-year period beginning in 1991 compromised by police officers who illegally obtained incriminating statements that were later found inadmissible in court. Perhaps the most chilling finding of the series was that police obtained scores of confessions, many of them proven false, from the most vulnerable suspects - the mentally retarded, the mentally ill, teenagers, and children as young as 8 years old.

Using a tape of an actual police interrogation in a probable false confession case, Professor Drizin will illustrate standard police interrogation tactics which produce both true and false confessions, raise some concerns about the risks of some of these tactics in producing false confessions, and argue that it is absolutely essential to require that law enforcement video or audiotape police interrogations, in order to minimize the risk of false confessions and wrongful convictions.

False Confession, Police Interrogation, DNA Exoneration

I4 The Many Roads to False Confession

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The goal of this presentation is to demonstrate with specific cases examples that false confessions occur even in the absence of coercive interrogation techniques as a result of various factors including the psychological state of the suspect, the assumptions of the interrogators, and the circumstances of the case.

This presentation will consist of a discussion of several cases from the Chicago area where subjects gave confessions to murders, which subsequently obtained evidence showed that, in fact, these defendants did not commit. These cases suggest that many factors may lead a suspect to falsely confess even to such a serious charge as murder. Examples will include cases in which characteristics of the suspect appear to have been a cause of the false confession. This includes the infamous case of two young boys who confessed to the rape and murder of a little girl, but were later released when DNA evidence implicated another man. Other cases will show how mental deficiencies and personality defects of defendants may have led to their demonstrably false confessions.

Examples will also include a case where the assumptions of the interrogators and their single-minded pursuit of a particular theory led to a false confession. Because the suspect was the victim's boyfriend and the victim and the suspect had a history of fighting with each other, police assumed that he was guilty and repeatedly accused him. In doing so, they ignored other important evidence pointing in other directions. Their persistence ultimately led to a written confession, but that confession would later prove to be false when DNA testing showed the semen in the victim's anus and vagina matched the profile of a man who was awaiting trial on similar charges.

The circumstances in which the suspect finds himself may also lead to a false confession. This will be illustrated by a case in which a man

called the police to get himself arrested because he was convinced someone was trying to kill him. He would later confess to murder in order to ensure he would be kept in police custody and not released to the streets where he was convinced he would be targeted for murder.

Finally, the presentation will examine the possibility that there may be a profile "serial confessor." That is, a person who, for their own psychological reasons, and with the encouragement of interrogators may confess to one or more crimes they in fact committed, but then continuing to confess to multiple crimes they did not commit. Illustrative cases will include a man who confessed to seven murders for which he was convicted and sentenced to death. His death sentence was later vacated when another man confessed to committing one of the murders (which was supported by evidence). Another man confessed to committing fourteen murders, but would later plead guilty to just one murder after prosecutors closely investigated the cases and found that the evidence to did not strongly support many of his confessions.

False Confession, Police Interrogation, DNA Exoneration

I5 The Study of Sociological and Demographical Variables of Unnatural Deaths Among Young Women in South Delhi Within Seven Years of Marriage

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The present study has tried to find various sociological and demographical factors in unnatural death in young married girls in Delhi.

This study was carried out between July 1998 and November 2000 to study the dynamics of dowry deaths in South Delhi. A total of 117 cases were studied. Illiterate, issueless Hindu housewives of lower socioeconomic class were the worst affected. The most vulnerable age group was 21-25 years. The most common cause of death was burns followed by poisoning. Of the total deaths, 59% were accidental in nature followed by 30% suicidal deaths. About 23% cases had alleged history of dowry demands, harassment, torture, and subsequent death. In the initial three years of marriage, 57% of the victims died indicating possible maladjustment and strenuous relationship between husband and wife or that with in-laws. The associations between various social and economic forces have given shape to the phenomenon of dowry demands in India leading to dowry deaths of young girls. In this paper all such variables are discussed.

Dowry Death, Bride Burning, Unnatural Death

I6 The Rate of Morbidity and Suicide Among Police Officers and Military in Lithuania

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There are a lot of problems concerning psychic and somatic health both among police officers and military. The situation concerning suicides among the population is very complicated. In Lithuania last year the number of suicides reached 45/100,000 inhabitants. Suicides among nearly 20,000 of police officers included 12/year, i.e., more than 60/100,000.

Every year there are 2-3 suicides among soldiers (the total number of soldiers in the Lithuanian army is about 6,000 persons). Such high rates of suicides among the Lithuanian police officers and soldiers prompted a check of the medical work as new policemen and soldiers entered this new work. The focus was on the following: how many police officers and new soldiers were not fit for their job. The investigated persons were divided into four groups: soldiers entering the War Academy, young persons intending to study at the Police Academy or Police faculty at the University of Law, new persons beginning work as police officers, and police officers annually undergoing medical testing. From 1989-2000 there were 63,583 police officers, recruits, and/or students examined. From 1995-2000, 2,726 recruits were studied.

The main focus was on somatic and psychiatric situations and other issues, such as: how many persons were dismissed from the police and/or what were the reasons applicants for positions in the police or army were denied. Somatic reasons were investigated: muscle-bone system, gastrointestinal tract, cardio-vascular (c-v) system, central nervous system (CNS) and analysators, infectious diseases, poisoning, and traumatisms.

About 80% of those who applying to the War Academy were denied for medical reasons while approximately 50% were denied due to psychiatric health. About 50% under investigation could not enter the Police Academy because of CNS and analysators problems, but in almost all cases no problems were found with the c-v system. However, every year about 12-13% are dismissed from police work and more than 50% of demonstrate problems in the c-v system

The study enables the authors to make the following conclusions: there are a lot of problems concerning psychiatric and somatic health among policemen, soldiers, and the population and only a complex solution of these problems can reduce the suicide rate among Lithuanian people, as well as among policemen and the military.

Suicide, Police, Military

I7 Search for Association Between Suicide and Dopamine D2 Receptor Polymorphism

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The goals of this presentation are to search for the relationship of dopamine D2 polymorphism and suicidal behavior on DNA samples of completed suicides, in order to lead to insight into the mechanisms involved in suicidal behavior and eventually suicide prevention.

Suicide is an important public health problem. Despite the serious efforts to develop prevention programs little exists that can be offered in order to avoid this tragic outcome because the specific mechanisms that lead to suicide are ignored. Various genetic-epidemiologic studies have been consistently suggesting that genetic factors play an important role in the predisposition to suicide; however, the precise genetic mechanisms involved are not yet known.

Several lines of evidence indicate that dopaminergic neurotransmission is involved in the pathogenesis of suicidal behavior. Studies have shown that the density of dopamine receptors is varied in brain regions of depressed subjects. Genes that code for proteins, involved in regulating dopaminergic neurotransmission, have thus been major candidate genes for association studies of suicide and suicidal behavior.

The authors' hypothesis is that genetic factors that code for components of the dopaminergic system may account for an important part of

the total genetic variability involved in suicide. Thus, the authors' goal is to identify the polymorphism of these genes. To do so, a study was conducted where completed suicide cases in Crete were studied and genetic variations in these subjects were compared to a control group.

Blood samples from 30 unrelated suicides of Cretan origin have been collected. DNA obtained from these cases as well as from 30 controls were genotyped dopamine D2 receptor polymorphism.

DNA was extracted from blood using Chellex extraction method and quantified. DNA amplification was carried out in 20 ?L reactions using approximately 100 ng of genomic DNA 50 ng of each primer and 0.5 U *Taq* DNA polymerase (5 units/µL) 250 mM of each of the four dNTPs, 2.1-2.75 mM MgCl2, and 2 mL of buffer. Thermocycling was carried out on a Perkin Elmer 490 Thermal Sequencer. Samples that had a good yield of PCR product as determined by electrophoresis, were digested with the restriction enzyme *Taq* I. Digested DNA electrophoresed in a polyacrylamide medium and visualized by silver staining. Individuals were genotyped as A1A1, A1A2 or A2A2 based on the pattern of banding. Following the direct counting of genes for the observed values the expected ones were calculated and Hardy-Weinberg equilibrium was estimated. Contingency tables and chi 2 test was carried out for the statistical interpretation.

Although slightly elevated the A1 gene frequency in the samples of suicide completers (A1=0.18) compared to the control (A1=0.11), the statistical interpretation did not show any association. These results suggest that the dopamine D2 polymorphism is unlikely to play a major role in the genetic susceptibility to suicide.

Conflicting results among the present and previous studies regarding an association between the polymorphism and suicidal behavior, suggest the possibility that there may be unidentified specific subtypes of suicidal behavior that are significantly associated with the polymorphism. Possible reasons for this may be the relatively small number of subjects studied which might not be adequate for a satisfactory statistical evaluation.

Finding genes that are involved in the predisposition to suicide will represent an important step in the genetic study of behavioral and psychiatric disorders that may lead to insight into the mechanisms involved in suicidal behavior, impulsivity and aggression. In addition, the identification of genes implicated in suicide may be useful to elucidate targets for intervention and eventually suicide prevention.

Suicide, Dopamine D2 Receptor, Polymorphism

I8 Stalking as a Risk Factor in Domestic Violence Revisited

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After attending this presentation, the audience should understand the use of stalking as a violence risk factor in domestic violence cases, the types of stalking behaviors conducted, and the relationship between stalking behaviors, domestic violence behaviors, and suspect's demographics and violence, mental health, and criminal history.

This paper is an update to the AAFS 2001 presentation, "*Stalking as a Risk Factor in Domestic Violence.*" This study analyzed the use of stalking behaviors by individuals who were court referred for domestic violence treatment. The relationships between stalking behaviors and the domestic violence perpetrator's demographic, mental health history, criminal history, general violence history, and domestic violence history variables were analyzed. Results indicate that a broad spectrum of stalking behaviors and levels of violence are perpetrated in domestically violent relationships. Implications for assessing violence risk in stalking cases are discussed.

Stalking, Domestic Violence, Risk Assessment

I9 Behavioral Analysis vs. Profiling: Assessing 9/11 and Preventing Future Attacks

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The attendee should understand the techniques of behavioral analysis and profiling, and their applications to counter-terrorism investigations upon completion of this presentation.

Following 9/11, law enforcement and behavioral science experts proposed several methods of analyzing the World Trade Center/Pentagon attacks. Their goal was to understand how this attack was planned and carried out in order to prevent future attacks. Two methodologies previously used in the violent crime and threat assessment fields were applied terrorist attacks: profiling and behavioral analysis. Profiling has traditionally been used in violent crimes in which the subject's identity is unknown. Its purpose has been to assist investigators with narrowing down a pool of suspects in order to identify who is most likely the perpetrator. Behavioral analysis has been used in cases of targeted violence as a method for assessing the subject's patterns of behavior prior to carrying out the attack. By analyzing the subject's behavioral patterns, one can assess where the subject is on an "idea to action" continuum, and thus assess how close he/she is to carrying out the attack. This paper will discuss the applications of profiling and behavioral analysis in assessing terrorist attacks. The presenters will discuss their analysis of Al-Qaeda's methodology and the utility of using behavioral analysis rather than profiling in counter-terrorism investigations. A behavioral analysis of the 9/11 attack will be presented, with specific regard to the attackers' acquisition of skills, collection of materials, travel history, target identification, surveillance, weapons acquisition, and final attack preparations.

Behavioral Analysis, Profiling, Counter-Terrorism Investigations

I10 The Genesis of Serial Killing Behavior in the Case of Joel Rifkin Using the Combined BRACE/NDM Approach

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The goals of this presentation are to acquaint the forensic community with the use of the BRACE and NDM models as a potential pathway to further understanding serial killing behavior.

The study of serial killing behavior continues to be the subject of considerable discussion and intense study. However, serial killing behavior has traditionally been studied from psychiatric and criminological perspectives and rarely from neuroscientific perspectives. More specifically, impressive progress has been witnessed in the study of serial killing behavior by means of behavioral classification and profiling. In this presentation, the authors make use of two paradigms that are seldom integrated in the study of serial killing behavior, namely behavioral profiling and neuropsychiatric characterization. The first approach makes use of a highly sophisticated model of behavioral analysis known as Behavioral Relativity And Cognitive Economics (BRACE). BRACE is a comprehensive cognitive-behavioral-existential model of human nature developed in 1984 by Russell L. Smith, MS. The BRACE model extends the functional analysis of behavior, including the domain of cognitive psychological constructs involving the imagination. A basic premise of the

BRACE model is that humans strive to diminish uncertainty and to seek control. BRACE contends that this "drive" is directed and expressed through the equally powerful, complementary, mutually exclusive cognitive forces of generalization (similarities) and discrimination (differences) the "I am ... not" of human experience. Fundamentally, the BRACE paradigm, aims to understand human nature by combining the drive or need to diminish uncertainty and to seek control with the natural desire to increase pleasure/comfort and decrease pain. The BRACE Character Profile applies the BRACE model to core aspects of human nature to reveal an individual's cognitive-behavioral-existential character. The character profile in the BRACE model consists of 75 randomly ordered maladaptive characteristics, which are rated on a 5-point scale (0 to 4). The scoring key orders the 75 items into three character types (Type A, Type B, and Type Q). These constructs are based on 8 cognitive variables, 8 behavior variables, and 8 motivational or existential variables. The resulting profile reflects the degree to which an individual's thoughts, behavior, and desires are consistent with the three character types. The character profile in the BRACE model has the potential for wide application in the study of many categories of individuals such as serial killers, serial rapists, terrorists and many other categories of individuals who may be associated in different types of criminal behaviors.

The second paradigm is known as the Neuropsychiatric Developmental Model (NDM), and focuses of the characterization of serial killing behavior as a function of neurodevelopmental parameters, aggression, personality psychopathology variables and sexual factors. The model also takes into account ecological factors that interact with the above named components. The NDM has been applied to both cases of sexual serial killers such as Jeffrey Dahmer and to serial killers who do not present with a prominent sexual component to their homicides.

In this presentation, the case of convicted serial killer Joel Rifkin is used to highlight the potential utility of the **combined BRACE/NDM paradigms** in the characterization of sexual serial killing behavior. Although convicted of killing 9 females, mostly prostitutes, he has been thought to have killed at least 17 people. He was an adopted child who was raised in an intact family in New York State, Rifkin was known during childhood and adolescence to have displayed longstanding difficulties with social peer interactions. He has been described as having fundamental difficulties appreciating and understanding other human beings. Although his capacity for empathy was severely compromised, it is improbable that such deficit can be simply explained via his level of psychopathy. Psychosexually, he failed to develop healthy intimate sexual relationships with females, and eventually gravitated to satisfying his sexual desires with prostitutes. Although his case received considerable media attention (from daily periodicals to books), many fundamental questions remain unanswered, including potential interactions between behavioral variables and any atypical neurobiological substrates. In this presentation, besides describing the BRACE and NDM models, potential future uses of the BRACE model in regard to forensic psychiatric questions are explored.

Forensic Psychiatry, Violence, Serial Killers

I11 A Biopsychosocial Analysis of the Serial Sexual Crimes of Serial Killer Richard Ramirez

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The goal of this presentation is to acquaint the forensic community with a biopsychosocial model for the study of serial killers, which includes a neurodevelopmental component.

From 1984 to 1986 serial killer Richard Ramirez terrorized the citizens in the southern California counties of the Los Angeles and Orange. Ramirez was eventually convicted of 19 murders and many other sex crimes. Several accounts of Richard Ramirez have been published. However, his case has received relatively little attention by forensic mental health professionals and criminologists. This may be in part due to the lack of any in-depth mental health evaluation. However, there is a wealth of information that is centrally relevant to the psychiatric nature of Richard Ramirez crimes. In this presentation, the defendant was studied from a neuropsychiatric developmental perspective. The authors have focused on the defendant's character structure by using criteria from the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR). Also used was DSM-IV-TR in an effort to clarify Ramirez's paraphilic psychopathology. The possibility that neuropsychiatric and neurodevelopmental disorders may be associated with his serial killing behavior was also explored. In addition, because serial killing behavior may be associated with behavioral factors that do not always fit well with psychiatric categories, other methods of behavioral categorization were used that may shed some light on his crimes.

Richard Ramirez was the fifth and youngest child born February 29, 1960, to Julian and Mercedes Ramirez. During his mother's pregnancy she worked in a factory in which there was putative exposure to hazardous materials. However, Richard Ramirez was born without birth defects unlike his brother Joseph who was born with a degenerative bone disease. Ramirez was raised in a two-parent family with his mother assuming most of the child rearing tasks. Of his four siblings, Richard was most attached to his only sister who was a couple of years his senior. At age two years Ramirez sustained a head injury with resulting loss of consciousness that lead to a medical evaluation. Subsequent to this injury, he began experiencing seizures and long staring spells. He was eventually diagnosed with temporal lobe epilepsy but apparently never received treatment for this condition. The seizures apparently stopped all together during early adolescence.

During his early adolescence Ramirez became more isolative from his family and other acquaintances. He had three older brothers who also became involved in drug abuse. However, none of them had any influence on him. A notable exception to Ramirez's social isolation was his relationship with a cousin who had recently returned from military duty in Vietnam. His cousin who introduced him to recreational drugs, sex, guns, and a violent lifestyle profoundly influenced Ramirez. At age 12, Richard witnessed his cousin kill his wife. Although Richard did not report having been the witness of a serious crime, his cousin was eventually convicted for the murder of his wife. Thereafter Ramirez became increasingly involved in burglaries and related drug seeking activities as well as refining his interest in paraphilic ideas. At age 15 he attempted to rape a woman. Fortunately for her, the woman's husband intervened. However, the victim refused to return to El Paso to testify against him. The charges against him were then dropped. At about age 17, he made his way to Los Angeles, CA, to visit a brother residing there. This visit convinced Ramirez that Los Angeles would be an ideal place to pursue his drug habit, his stealing, and his paraphilic sexuality. Ramirez settled in Los Angeles at age 18 where for approximately the next decade he developed an idiosyncratic version of Satanism in association with serial rape and sexual homicide.

In this presentation the authors propose that sexual serial killing behavior such as that exhibited by Richard Ramirez may be optimally explained by a four component system that includes 1) sex drive, 2) aggression, 3) psychopathy, and 4) a neuropsychiatric developmental component. Each of these components in turn interacts with the environment of the serial killer to make his predisposition to sexual serial homicidal behaviors possible.

Serial Killers, Serial Crime, Sexual Homicide

I12 A Transcultural-Forensic Psychiatric Analysis of a Filicidal Hispanic Man

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After attending this presentation, the participant will understand the value and utility of a biopsychsociocultutal approach in forensic psychiatric evaluations.

Filicide is the homicide of a child by his or her parent. Homicides of children committed by parental figures, such as non-biological stepparents or other equivalent parental figures, are often similar to those committed by the biological parent, so that a class of filicidal-type homicide is defined. There is a considerable amount of literature on filicidal or filicidal-type killing, which is first surveyed. Several investigators have attempted to provide a classification system for filicidal or filicidal-type behavior. Of particular note has been the evolution of a multisystemic approach. A little over two decades ago, the biopsychosocial model was proposed. This model has since enjoyed widespread endorsement. Although cultural factors can arguably be subsumed under the social component, cultural factors in many cases exert the greatest degree of influence upon the thinking and behavior of an individual or social unit (e.g., family). The latest diagnostic nosology as promulgated by the Diagnostic and Statistical Manual of Mental Disorder, Fourth Edition (DSM-IV) has underscored the potential relevance of cultural factors and has introduced to American psychiatry a tool called the cultural formulation. Previously utilized was a biopsychosociocultural approach based in part on the cultural formulation tool to explore another case of filicial-type behavior. This approach increases the likelihood of a sytematic and comphrehensive assessment of cases, i.e., there is a clear advantage of a biopsychosociocultural approach over schemes searching for classification by motives only. In particular, the richness of the biopsychosociocultural approach increases the likelihood that all relevant factors receive consideration.

To illustrate the biopsychosociocultural approach, the authors describe the case of Mr. B. Mr. B had who killed his stepchild. Mr. B is a 27-year-old male from El Salvador who became unemployed three months prior to the death of the child victim. Several weeks after losing his job, he had become increasingly irritable, hostile, and depressed. As a Latino male, Mr. B experienced a significant loss of face and self-esteem when he found himself in the reversed social role where he was forced to take care of the children while his wife worked full-time outside of their home to financially support the family unit. It was in this situation in which Mr. B acted aggressively with culmination in the homicide of his stepdaughter. Mr. B also experienced longstanding symptoms of depression and anxiety originating in psychological and physical abuse that he experienced as a child when he lived with his parents, as well as by army superiors after he was inducted in the Salvadoran Army.

Given that female parents more frequently kill their children, the index case provides a look at the less often encountered filicidal parental male. The case of Mr. B is classified in accordance with motivational factors potentially relevant to filicidal or filicidal-type behavior. From a biological viewpoint, neurobiological factors may specifically affect a given organism to engage in this type of homicidal behavior. In addition, evolutionary considerations have also been raised as potential influences. Socioecological factors, independent of psychosociocultual issues can also play a pivotal role. However, an in-depth exploration of psychosociocultural issues is utilized to arrive at a more comprehensive explanation of the causes of filicidal activity. The cultural formulation of DSM-IV is used to evaluate relevant psychosocial factors and it is composed of five sections. These sections are: 1) The cultural identity of the individual where the person's cultural and ethnic reference groups are explored; 2) The cultural explanations of the individual illness; 3) The cultural factors associated with the psychosocial environment and levels of functioning; 4) The relationship between the (treating) clinician and the patient; and 5) The development of the cultural assessment with its diagnostic, therapeutic, and social objectives. Each of these sections receives exploration. In the case of Mr. B, the social component also encompasses legal considerations.

In the final part of the presentation, current needs for improved methods aimed at assessing and classifying parental child killing behaviors from an integrated, comprehensive perspective are discussed.

Homicide, Filicide, Forensic Psychiatry

I13 Deconstructing Sexual Offender Civil Commitment Laws: Appearance, Reality, and Psycholegal Implications

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The goals of this presentation are to compare and contrast a sample of existing state sex offender civil commitment statutes and to discuss their legal, forensic assessment, and research implications.

This research project initially deconstructed and compared the legal standards and language contained within various sexual offender civil commitment statutes. It was found that although these statutes appeared superficially similar, they differed markedly in their language, legal standards, and procedures. It was concluded that these differences have significant legal implications while also impacting forensic clinical practice and research.

Currently, 17 states, including Arizona, Illinois, and Massachusetts, have enacted so-called "sexual predator" laws. These statutes provide for the civil commitment of sexual offenders, lasting from a day to natural life, although the initial petition for commitment is based upon a criminal offense. The general framework of these laws includes the following provisions. First, the individual must have committed a violent sexual offense, such as rape, an offense involving a child, or a "sexually motivated" act, although some states have also incorporated other crimes, such as attempted offenses and conspiracies. Further, there must be proof of a mental condition, defined as a "mental abnormality," "mental disorder," or "personality disorder," for instance. Lastly, as a result of this mental condition, it must be demonstrated that the person is "likely to engage" in future sexual criminal acts (i.e., be dangerous). The U.S. Supreme Court opinion in *Kansas v. Hendricks* (1997) upheld the constitutionality of the sexual predator laws.

Initially, copies of the existing sex offender civil commitment statutes were acquired and then deconstructed in a spreadsheet according to legal standards and language (e.g., definitions of the "sexual predator" and "mental disorder" constructs), special provisions (e.g., procedures pertaining to the handling of persons found incompetent to stand trial or not guilty by reason of insanity), and standards of proof, to facilitate their comparison. Upon cursory examination, the statutes appeared similar, each containing a description of a "sexual predator," a definition of mental illness or mental disorder, and stringent legal standards of proof, for instance. The statutes of Arizona, Illinois, and Massachusetts were selected for particular examination. Specifically, their legal standards, language, special provisions, procedures, and standards of proof were represented graphically in a flow chart format, attempting to illustrate the various "pathways" to being designated or not designated a so-called "sexual predator." Similar legal standards and language were uniformly color-coded.

An inspection of the graphics revealed a number of major differences among the legal standards, language, and procedures of the Arizona, Illinois, and Massachusetts sex offender civil commitment

laws. For instance, the Massachusetts statute, unlike the others, contains a specific procedure for cases where an individual has been previously adjudicated as a "sexually dangerous person." Although the Massachusetts and Arizona statutes similarly ask whether or not the person will be "likely to engage" in sexual offenses, the Massachusetts law adds the proviso "if not confined to a secure facility." Alternatively, the Illinois statute asks whether it is "substantially probable that the person will engage in acts of sexual violence." The Illinois and Massachusetts statutes contain standards asking whether or not the person has a "congenital or acquired condition" affecting "emotional or volitional capacity," encompassing a "mental disorder" and "mental abnormality," respectively. However, in Massachusetts, if the person is found not to have this "mental abnormality," there is a subsequent test to ascertain whether or not the person has a "personality disorder," defined as a "a congenital or acquired physical or mental condition," resulting in "a general lack of power to control sexual impulses." Uniquely, the Arizona statute asks whether the person has a "paraphilia, personality disorder or conduct disorder or any combination of paraphilia, personality disorder or conduct disorder," representing a "mental disorder." Both the Massachusetts and Arizona laws contain similar legal procedures for addressing persons who have been charged with a sexual offense and found incompetent to stand trial, unlike the Illinois law. The Illinois and Arizona statutes contain provisions, addressing whether or not the person has been found "not guilty or not responsible" for a sexual offense "by reason of insanity, mental disease, or mental defect" or "guilty but insane" of such a crime, respectively. The Massachusetts sexual offender civil commitment law does not address this issue of criminal responsibility.

There are a number of significant implications of the diversity (i.e., the lack of uniform sexual predator and mental illness definitions, differences in statutory language, and varying legal procedures) of the state sexual offender civil commitment statutes. First, this diversity makes the generalization of Federal court decisions across jurisdictions difficult, and it appears highly likely that these opinions will impact the various states differently. In addition, the varying legal standards among the sexual predator laws will markedly influence the structure of forensic assessments. Lastly, because of the variation among the sexual predator constructs (e.g., what comprises a "sexually violent person" versus a "sexually dangerous person"), individuals conducting research in this area should be aware of the resulting comparative challenges presented by these statutes.

Sexual Offender, Sexual Predator, Civil Commitment

I14 Closing the Gap Between Statute and Practice: An Analysis of Two Clinical Cases and Their Sexual Dangerousness

Michael H. Fogel, PsyD, 500 North Michigan Avenue, Suite 300, Chicago, IL*

The goals of this presentation are to illustrate how to operationalize the statutory language of the Massachusetts Sexually Dangerous Person Act and the Illinois Sexually Violent Persons Commitment Act through the presentation of two clinical case examples.

The first case to be discussed involves a 45-year-old, single, white male who was convicted of possessing Child Pornography. He was sentenced to a 2½-year split sentence with 6 months to serve and the balance suspended with probation; he was to be on probation for approximately 5 years following his release from custody. Due to the instant offense and previous sexually related offenses (e.g., Sodomy, Indecent Assault and Battery, Rape of a Child), he was referred for an evaluation to determine whether he met the Massachusetts statutory criteria of a Sexually Dangerous Person prior to his release from custody. Specifically, Massachusetts General Laws defines a Sexually Dangerous Person, in part, as someone who "suffers from a mental abnormality or personality disorder which makes the person likely to engage in sexual offenses if not confined to a secure facility." The Law defines the term "mental abnormality" as a "congenital or acquired condition of a person that affects the emotional or volitional capacity of the person in a manner that predisposes that person to the commission of criminal sexual acts to a degree that makes the person a menace to the health and safety of other persons." A "personality disorder" is defined by Law as a "congenital or acquired physical or mental condition that results in a general lack of power to control sexual impulses." Aspects of this individual's index offense will be addressed, as well as his history of sexual behavior and sexual offending. In addition, static and dynamic risk factors will be reviewed to explain this individual's sexual dangerousness.

The second case to be discussed involves a 41-year-old, single, white male who was convicted of Aggravated Rape and three counts of Rape. He received a 10 to 20 year sentence for each charge, to be served concurrently. In addition, pursuant to previous statutory language, at the time of conviction he was adjudged a Sexually Dangerous Person and committed for a day-to-life to a Massachusetts facility for the treatment of Sexually Dangerous Persons. Per statute, if the committed person believes that he is no longer a Sexually Dangerous Person, he may petition the court for examination and discharge once every twelve months. Consequently, after approximately 13 years in confinement, this individual submitted said petition and was referred for an evaluation to determine whether he continued to meet the statutory criteria to be deemed a Sexually Dangerous Person. In contrast to the aforementioned statutory definition that was enacted in 1999, this individual was adjudicated under prior statutory language; therefore, Massachusetts General Laws provides alternative parameters under which to evaluate these persons. For the purposes of these individuals, a Sexually Dangerous Person is defined as "any person who has been previously adjudicated as such by a court of the commonwealth and whose misconduct in sexual matters indicates a general lack of power to control his sexual impulses, as evidenced by repetitive or compulsive sexual misconduct by either violence against any victim, or aggression against any victim under the age of 16 years, and who, as a result, is likely to attack or otherwise inflict injury on such victims because of his uncontrolled or uncontrollable desires." This individual's index offense, history of sexual offending, and course of sex offender specific treatment will be reviewed. In addition, as above, static and dynamic risk factors will be addressed to explain this individual's sexual dangerousness. Lastly, this case will be analyzed using the statutory language of the Illinois Sexually Violent Persons Commitment Act.

Sexual Offender, Sexually Dangerous Person, Sexual Dangerousness

I15 Determining Clinical Criteria for Use in Evaluations of Sexually Violent Offenders: Exploration of Case Examples

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The goals of this presentation are to present to the forensic community assessment strategies to assist the courts in determining which defendants meet criteria for being "sexually violent offenders."

This oral presentation will discuss assessment strategies used by the author when performing court ordered evaluations of defendants in Nebraska who were convicted of specific violations deemed to be sex offenses. Courts often ordered such defendants to be committed to the state inpatient forensic mental health facility for the purposes of determining a defendant's diagnosis, treatment needs, and prognosis for treatment. In addition, the courts specifically requested these evaluations to determine if a defendant met statutory criteria for being a

"sexually violent offender." In the Nebraska Revised Statutes (section 29-4005), a "sexually violent offender" is defined as follows: "a person who has been convicted of one or more offenses listed in subdivision (1)(a) of section 29-4003 (e.g., 1st degree sexual assault on a child), and who suffers from a mental abnormality or personality disorder that makes the person likely to engage in sexually violent offenses directed at a stranger, or at a person with whom a relationship has been established or promoted, for the primary purpose of victimization." "Mental abnormality" is specifically defined as a "congenital or acquired condition of a person that affects the emotional or volitional capacity of the person in a manner that predisposes that person to the commission of a criminal sexual act to a degree that makes the person a menace to the health and safety of other persons."

A specific example will be presented that seems to fit the sexually violent offender criteria well. This middle-aged offender had a history of victimizing young female girls. He would minimize the impact of his behavior on his victims and would often blame the victims for "coming on" to him. He appeared to establish relationships with mothers of young girls so that he would have easy access to young girls for sexual exploitation. On tests specifically designed to measure deviant sexual interests and behaviors, he evidenced a very "defensive" profile. Despite this, his performance on these tests was similar to persons known to be repeat offenders with histories of child molestation and rape. On measures of psychopathy designed to gauge personality characteristics shown to predispose persons to criminality, violence, and impulsive acting out, he scored high on the trait representing a general lack of empathy, remorse and guilt. His penile plethysmograph results showed a significant heightened sexual arousal to scenarios involving both persuasive and coercive scenarios with female preschool and grammar school girls. His history of abusing alcohol and street drugs further predisposed him to the perpetration of sex crimes. This case example can be easily seen to fit the statutory definition of a sexually violent offender.

Another example will be given in which it will be much more difficult to show a connection between the unlawful behavior constituting the sex crime and criteria for being a sexually violent offender. In this case, the offender is a family member who had a long-term relationship with the victim. The relationship did not appear to be specifically "established or promoted for the primary purpose of victimization." In fact, both the victim (a granddaughter) and the defendant appeared to have a good friendship and caring relationship that had lasted over many years. Family members substantiated this as well. The defendant appeared very remorseful for his actions. He did not score high on measures of psychopathy and showed no significant physiological arousal to deviant (pedophiliac) stimuli on the penile plethysmograph. It did not appear to this evaluator that he met criteria for being labeled a violent sexual offender.

These and other examples will be presented shedding light on the difficulties entailed in this kind of evaluation. The Nebraska statute seems to put great emphasis on the relationship with the victim. In this sense, perpetrators of incest do not appear to easily qualify for the sexually violent offender definition. Also, the use of the word "violent" places the evaluator in a difficult position at times. For example, what happens when the offense(s) that the perpetrator is convicted of meets the legal criteria for assessment of sexually violent offender status, but the actual nature of the offense is not violent per se (e.g., child pornography, or groping). These issues will be discussed and the ethical obligations of the examiner (e.g., whether or not to answer the ultimate issue) will be explored. A determination that one is a sexually violent offender can have a significant impact on the ultimate legal disposition of a case and have long-term consequences as well. Sexually violent offenders are often required to register with the State Patrol who may give formal notification to the community depending on how the offender is classified.

Sexually Violent Offenders, Sex Offender Registration, Forensic Mental Health Assessment

I16 Preliminary Analyses of Nonparental Child Abductors Who Murdered Their Victims: Victimology and Offense Characteristics

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The goals of this presentation are to provide the forensic science community insight into the modus operandi, victim selection, and background history of child abductors who murder their victims. Analyses may also help to enhance investigative strategies for child abduction cases.

The presentation will focus on findings from the child abduction/homicide: interviews with incarcerated offenders and child abduction/homicide archival research studies currently being conducted by the FBI. These studies have been underway since April 2000. However, there have been significant delays in the progress of the research due to the 9/11 terrorist attacks.

To date, 25 interviews with child abductors who murdered their victims have been conducted within various prison facilities throughout the United States. Inclusion criteria for the studies include 1) victim was less than 18 years of age, 2) offender was convicted of the murder or linked by police investigation and evidence accumulated, and 3) victim was "abducted" by offender. Abduction was operationally defined as "the coerced, unauthorized, or otherwise illegal movement of a child for the purpose of a criminal act." Exclusion criteria included parental abductions and cases wherein the offenders were processed through the juvenile system. The face-to-face interviews, conducted by Supervisory Special Agents and professional support from the FBI's National Center for the Analysis of Violent Crime (NCAVC) staff, utilize a protocol developed by members of the NCAVC. The protocol covers numerous content areas including offender socio-demographic information (e.g., marital/dating history, IQ level, education, employment, military experience, family structure and environment, and religion), offender psychiatric history, offender criminal history, victimology, and offense information (e.g., distances, media involvement, arrest information, and sentencing). The data obtained has been supplemented by review of related and available case documents from various federal, state, and local agencies. In addition, approximately 55 archival cases have been thoroughly reviewed and subsequently analyzed. The archival research utilizes a modified protocol in which interview only questions have been eliminated.

Nonparental child abduction/homicides have a low base rate of occurrence despite the significant media attention these types of cases often attract. Recent cases such as Danielle Van Dam (San Diego, CA), Samantha Runnion (Anaheim, CA), Cassandra Williamson (St. Louis, MO), and Elizabeth Smart (Salt Lake City, UT) are emotionally charged cases that quickly overwhelm and exhaust law enforcement resources and traumatize the general public. The purpose of the present research is to glean data on offender background, victim-offender relationships, offender approach to victim, victimology, and detailed offense characteristics including factors such as location of abduction, means of transportation, type of weapon, and distances between various locations. Data for the study were obtained through both face-to-face interviews and archival review of case records.

Some of the preliminary analyses of the archival research indicate that the victims had a mean age of 10.8 years, ranging from 4-17 years. Approximately 78% of the victims were Caucasian, 15% Hispanic, and 5% African American (2% unknown). The majority of the victims were female (87%). The nature of the relationship between the victim and offender indicated that 41% of the offenders were considered strangers to the victim while 24% were considered acquaintances, 20% were neighbors, 9% friends, 2% relative (non-parent), and 2% client/customer. Therefore, over half of the offenders had some degree of familiarity with the victim.

The location of the abduction site was somewhat varied. In highlighting only the higher percentages, 26% of victims were abducted from a street/highway, 20% abducted from their residence, and 13% abducted from the offender's residence. Approximately 53% of the offenders were driving as a means of transportation to the abduction scene while 22% of offenders reported walking. The offenders' initial approach to the victim was again somewhat varied such as 28% of offenders exploited a position of friendship or authority with the victim, 28% capitalized on a normal situation or interaction, 15% physically attacked the victim, 7% used a ploy of providing service or assistance to the victim, 7% used a pretext of seeking help or assistance from the victim, and 7% bribed the victim or offered reward, money, toys, or candy. Approximately 30% of the abductors brought a weapon (e.g., firearm, knife, ligature, bludgeon/club) to the abduction site while 11% reported obtaining a weapon at the abduction site. Approximately 18% of the offenders used a knife as a primary murder weapon while 15% used a ligature, 13% multiple weapons, 9% firearm, 9% bludgeon/club, and 3% asphyxiant. Approximately 65% of the cases reviewed indicated the abduction scene and the murder scene were no more than ten miles apart: 20% occurred at same location, 15% less than ½ mile, and 28% over 1 to 10 miles. Approximately 67% of the cases indicated the abduction scene and the body disposal scene were within ten miles: 11% occurred at same location, 22% less than ½ mile and 32% over 1 to 10 miles. Approximately 67% of the cases indicated that the abduction scene was within a mile of the victim's residence. In addition, 68% of the records indicated the offender's residence was within 10 miles of the victim's residence.

The goal of the present research is to provide insight into offender background history, victim selection, and the modus operandi of child abductors who murder their victims. Analyses of these results may help to enhance the investigative strategies of law enforcement agencies. Limitations of the study will also be discussed including offender self-report issues, analyzing available data, small sample size, and lack of gender representativeness.

Child Abduction, Homicide, Child Homicide

I17 The Psychiatric Evaluation of the Perpetrators in Cases of Filicide With Respect to the State Institute of Forensic Medicine of Istanbul Between 1992-2001: A Retrospective Analysis

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The audience will learn how the forensic experts in Turkey profile filicide cases and special criminal arrangements related to filicide in Turkey. Intrafamilial child homicides will also be discussed.

Filicide is the killing of a child by his or her parent. Since this act has approached differently among homicide cases, it has special penalty arrangements in Turkey just like all over the world. There are various factors that lead the parents to kill their children in filicide cases. The leading cause is mental disorders followed by economic conditions, incompatibility among family members, and uncontrolled child punishments.

In this study, the reports of psychiatric examinations of the perpetrators in filicide cases at The State Institute of Forensic Medicine of Istanbul, Fourth Specialization Board between 1992-2001 were evaluated. The Institute is the only state organization belonging to the Ministry of Justice composed of Forensic Sciences Committees assigned by experts in different fields of this scientific area. Fourth Specialization Board (The Board of Forensic Psychiatry) is the department assigned to psychiatric examinations where psychiatrists, forensic medicine specialists, neurologists, and psychologists work together.

During the study, a total of 115 filicide cases were evaluated. Of these 59 were mothers (51.3%) and 56 were fathers (48.7%). The average age of the first group of both parents was 25-29 years of age with mothers averaging 22 yeas or 37.2% and fathers averaging 19 years or 33.9%. Of the perpetrators 103 or 89.5% were biological parents. The cases were evaluated with respect to education level, occupation, the place of residence (village, town, city), the method used for filicide, reason for filicide, existence of mental disorder and its type, if the act had been committed previously, if perpetrator had ever committed any crime before. The findings of this study and the literature will be discussed.

Filicide, Forensic Psychiatry, Turkey

I18 Paedophile Homosexual Sadistic Serial Killers Juergen Bartsch and Luis Alfredo Garavito

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This presentation will compare two killers whose crimes have not been reported in scientific literature in English text by use of material that was never presented before (first hand accounts). Insight into similarities of modus operandi, and behavior of highly intelligent, pedophile sadistic homosexual serial killers of different age in two different cultures, and two different times (1960s vs. 1990s).

Report on two sadistic homosexual pedophile serial killers, based on (a) a meeting with Luis Alfredo Garavito Cubillos in Columbia (July 2002), and (b) on the original files of the trials against Juergen Bartsch, and letters written by him. The resources have never been used in scientific investigation until now, and in contrast to the well-known case of Jeffrey Dahmer, the cases of Bartsch and Garavito have not been reported in scientific literature as yet.

Bartsch: In 1966, then 19-year old homosexual serial killer Juergen Bartsch (1946-1976) was arrested after an unsuccessful attempt to torture, kill, and dismember a young boy. The victim, left in an unused air raid shelter, had been able to free himself by burning his ties with a candle flame while the offender had gone home to eat and watch TV with his parents as he did every evening. Between 1962 and 1966, Bartsch had killed four young boys. He estimated to have undertaken more than one hundred further homicidal attempts. The method of actual murder was beating and strangulation. He dismembered most of the bodies, pricked out the eyes, decapitated the bodies, and removed the genitals. He also tried but failed to perform anal intercourse with the victims. His actual goal was to slowly torture the final victim to death. His wish for dominance, control, and sexual gratification as well as his strategies of avoiding prosecution were topics that were openly discussed with Bartsch from the start of the investigation.

The role of the (loving) parents who owned a butcher shop, and who had adopted Bartsch as a baby, is discussed. Under the influence of psychiatric consultations, Bartsch's views on his parents, as much as memories of sexual abuse performed by a teacher, seemed to change. It is not clear if these were true memories, or fabrications of a very intelligent, juvenile who received nearly unlimited attention after his confessions.

After two trials, Bartsch was moved to a psychiatric hospital where he could not receive psychological assistance due to a lack of personnel. He nevertheless managed to marry a woman who had written letters to him. During a voluntary castration operation, Bartsch died due to an error in the anesthetic procedure (the medical doctor was sentenced to nine months on probation). A month before the operation, Bartsch fought

vigorously against castration. Later, he believed that this might be the only way towards a possible healing, and fought as vigorously for it.

Garavito: Between 1992 and 1999, Garavito killed more than 200 children at core ages between 8 and 13 years. His modus operandi remained stable. During the day, he lured children of a lower social status out of crowded parts of the city into hidden areas that were overgrown with large plants. Garavito promised either payment for easy work, drugs, or made other socially believable offers. The children were tied up, tortured, raped, and killed by at the least a cut in the lateral part of the neck, or by decapitation. During the killings, Garavito was drunk.

Even after his arrest (for attempted rape) under a false identity it was not immediately possible to track his crimes since Garavito had frequently changed residences and jobs. He also changed his appearance with different hairstyles and used false identification. During his ongoing confessions, he directed the investigators correctly to the scenes of crime all over Columbia. The violent environment and juridical peculiarities in Columbia are discussed.

In spite of an initial sentence of 2,600 years, it is formally possible that Garavito will be released from prison within the next 10 to 20 years, after serving his maximum sentence in jail.

Similarities: Both killers were highly organized, very intelligent, and both believe(d) in, and work(ed) on their release from prison. In prison, they easily managed to manipulate their environment and were/are treated extremely well. Both claim(ed) that they had a right to a second chance.

The modus operandi of both offenders remained stable over the course of their crimes, irrespective of the different number of victims (Bartsch: 4, Garavito: more than 200 confirmed), the offender's age (Bartsch: ~19, Garavito: ~30), and the different cultures they lived in (Europe vs. South America). Both were drinkers. Also, the promises made by Bartsch and Garavito to the children were quite similar.

Finally, the choice of killing locations, the course of investigations, and severe juridical problems involved in both cases are discussed.

Serial Killings, Sadism, Pedophile Killers

I19 Neuroimaging Characteristics of the Brain, Scull, and Cranio-Vertebral Area of Violent Serial Sexual Offenders

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The goal of this presentation is to present findings of the neuroimaging study of serial sexual offenders.

MRI examination was conducted on 24 young male patients with a history of violent serial sexual offences (mean age: 22.4 ± 2.4 years). Pathological MRI findings have been detected in 100% of cases. Large hemisphere pathology (dilated subarachnoidal spaces and fissures, narrow and straightened subarachnoidal fissures, loss of gyral contour, abnormal gray-white matter differentiation, dilated CSF cisterns, focal pathology in a form of post-traumatic changes and cysts) was discovered in 22 (91.66%) patients. In the majority of cases (16, or 66.66%) this pathological findings were located in prefrontal areas of the brain. In 14 cases findings described above were combined with pathology of temporal lobes. Pathological findings of the ventricular system included widening, narrowing and/or pronounced asymmetry of lateral ventricles in: 17 cases and widening or prominent narrowing of the third ventricle in 17 cases. Pathology of deep brain structures included abnormalities of septum pellucidum (displacement up to 9 mm, cysts) in 15 cases, and of corpus collosum (hypoplasia) in 10 cases. Anatomic anomalies and pathological findings in cranio-vertebral bony structures were found in 20 patients (83.3%) in a form of enlargement of sphenoidal and maxillary bones, dilation of ethmoidal and frontal sinuses, small cranial fossae, hypoplasia and increased pneumatization of basic bone and reduced clivo-axial angle. Majority of the pathological findings were inborn and related to dysraphia indicating abnormal ontogenesis. Presentation will review linear measurements of outlined above pathological findings. Despite the variety of anomalous structural brain lesions, they can be organized into two groups: 1. Lesions of cortical and subcortical areas with predominant localisation in the frontal and frontal-temporal areas. Most of these lesions are localized to the right hemisphere. 2. Pathology of the limbic area of the brain, predominantly of the septal area. The nature of the majority of the described lesions is most likely dysontogenetic. They can be regarded as neuropsychiatric predisposing factors for the pathological drive to repeatedly commit brutal sexual offences.

Neuroimaging, Sexual Offenders, Violence

I20 Animal Cruelty: A Prodrome of Antisocial and Aggressive Behavior or Not?

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The goal of this presentation is to provide an updated literature review on the relationship between a pattern of serious, recurrent animal cruelty in childhood and other aggressive and antisocial behaviors.

Cruelty to animals during childhood is a behavior that is included in checklists for conduct disorder in childhood and psychopathy in adulthood; it is a diagnostic criterion for conduct disorder and antisocial personality disorder; and it is often viewed as a manifestation of abnormal aggression that may be associated with increasingly serious physical aggression against people at a later age. Yet prospective studies examining the diagnostic and prognostic significance of childhood animal cruelty are essentially nonexistent, and the scientific literature appears to present contradictory results. Here scientific literature pertaining to this behavior is discussed with the goal of understanding discrepant findings and identifying possible significance in terms of risk assessment and diagnosis.

In an earlier review Felthous and Kellert (1987) proffered several sources for inconsistent findings on whether childhood cruelty to animals is associated with serious aggression against people at a later age: 1) Variations in definitions of animal cruelty, 2) Variations in definitions of aggression, 3) Variations in methods of data collection, and 4) Variations in thoroughness of interviews designed to identify animal cruelty. Here the authors briefly review earlier studies and then focus on studies conducted since this early review, examining these potential sources of discrepant results in particular, with the aim of summarizing current understanding of any possible relationship between animal cruelty in childhood and later aggressive or antisocial conduct. The studies are organized into the following groupings: 1) Those that began with a group of subjects having been identified as having been cruel to animals; and 2) Those that assigned subjects to groups based on presence or absence of aggressive or antisocial conduct.

Early Studies: General: In an earlier review Felthous and Kellert (1987) observed that more controlled studies did not support an association between cruelty to animals in childhood and later aggression against people than those that did. However, the studies that supported this association were characterized by animal cruelty that was recurrent, aggression that was serious, diffuse and recurrent, and data collection by a thorough, structured interview of the subjects. The authors cautioned that future studies that attempt to relate a single act of cruelty to a single act of personal aggression, regardless how serious, would be expected to miss this association.

Studies of Subjects Identified as Cruel to Animals: Although numerous studies tested a relationship between cruelty to animals in youth and later physical aggression against people, only a few of these involve subjects already identified and grouped as having been cruel to animals. Here the authors briefly summarize those studies that attempted to examine subjects identified as having been cruel to animals with special attention given to the definition of animal cruelty, the definition of aggressive or antisocial conduct, method of data collection, thoroughness of the probe for cruelty, and findings of special interest.

Studies of Aggressive Subjects: A more common approach has been to identify subjects who are aggressive in some way and then attempt to determine whether cruelty to animals is associated. For purposes of this inquiry review was limited to those studies that controlled for aggression. Here it is found that the definition of aggression and the criteria for assignment to the aggressive group has much to do with whether an association is established. The survey is further limited to studies conducted since the literature review of 1987 (2), remembering that the most salient point of that review was that animal cruelty was associated with recurrent aggression, not a single act regardless how violent.

Conclusions: Firm conclusions must await replication studies, which apply the same definitions for animal cruelty and for aggressive and antisocial behaviors, and which apply comparable methodologies. Today research supports the association between substantial animal cruelty in childhood (severe and recurrent) and personal, physical aggression against people at a later age. Cruelty, thusly defined, may present as one of a constellation of behaviors diagnostic of conduct disorder in childhood or adolescence and a historical sign of antisocial personality disorder or psychopathy in adulthood. Cruelty to animals can represent a manifestation of several psychological deficits implicated in antisocial personality disorder.

Animal Cruelty, Antisocial Personality Disorder, Aggression

I21 Righting a Clinical Wrong – Custody Orders Should Include Both Parents in the Mental Health Treatment for Children of Divorce

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The goal of this presentation is to educate the forensic community of the problem of how common "joint legal custody" orders do not serve the best interest of a child receiving psychotherapy, and to recommend an alternative.

Custody orders enumerating parental powers to consent for mental health treatment of minors need to better incorporate optimal standards of care with children of divorce.

In common judicial practice, unless stated to the contrary, orders of joint legal custody usually give either parent the right to consent to mental health treatment of the child.

This judicial practice is short sighted. It often results in clinicians working with the child and presenting parent, instead of involving both parents in the child's therapy. The resulting treatment can be suboptimal, and severely limit the psychotherapist's understanding of the child's life, stresses, family dynamics, and parental strengths and weaknesses. Custody orders should specify that both parents be included in consenting and participating in the child's mental health assessment and treatment.

Custody, Psychotherapy, Judicial

I22 The Case of John B. Crutchley "The Vampire Rapist" From the Perspective of the Neuropsychiatric Developmental Model

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The goal of this presentation is to inform the forensic community about the use of a biopsychosocial model, which includes a neurodevelopmental component, to study a case of vampirism.

Clinical vampirism is often associated with sexual behaviors that at times may also be of forensic psychiatric significance. Unfortunately, most cases of criminal clinical vampirism have not been well documented. In this article, the authors present the case of John B. Crutchley, for whom there is a substantial amount of biographical information. Mr. Crutchley is a man who, in June 1986, pled guilty to one count of kidnapping and two counts of sexual battery as a second degree felony. His crimes were associated with the rape of a young woman along with vampiristic behavior. In this presentation, the authors provide an overview of the life history of Mr. Crutchley. The Neuropsychiatric Developmental Model (NDM) is introduced. NDM is a paradigm that takes into account four important behavioral dimensions, namely: 1) a neuropsychiatric developmental perspective; 2) a sexual perspective that encompasses paraphilic behavior and sex drive; 3) a component involving aggression; and 4) personality psychopathology, including psychopathy. The NDM also takes into account environmental components that can potentially interact with the previously mentioned components. The case of Mr. Crutchley as a function of this model is analyzed.

John Crutchley came from an intact family comprised of three children. Both his brother and sister completed higher education. He was considered to be highly intelligent but did poorly in school. He was able to attend college and considered to be gifted in the computer field. John B. Crutchley was age 39 at the time of the index arrest. He was also married and had a child. At that time as a computer engineer he had a high-level security clearance because of his work with government contracts.

At the time of the crimes, Mr. Crutchley engaged in removing the victim's blood, draining her of 40 to 45 percent of her total blood volume. She was able to escape and seek medical care but was considered lucky to survive the ordeal. Mr. Crutchley probably drank some of the victim's blood and it is possible that he may have drunk human blood prior to 1985. He also remained a suspect in the killing of several women but was never charged for these crimes. In 2002, Mr. Crutchley's body was found in his cell. Analysis of the death scene an autopsy results were consistent with autoerotic asphyxial death.

The NDM uses diagnostic categories from the American Psychiatric Association's current nosologic system, the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR); however, the NDM can use other nosologic systems. In this presentation the authors make primary use of DSM-IV-TR criteria. 1) The neuropsychiatric developmental model involves exploration of developmental factors from three perspectives. First, consideration is made to determine whether or not pervasive developmental or autism spectrum psychopathology is present. Then, the person is also evaluated for personality disorder psychopathology. Finally, a search for other biological factors and neurodevelopmental psychopathologies is undertaken. 2) The person is then evaluated from the perspective of paraphilic psychopathology, sexual dysfunction and from perspectives that

conceptualize sexuality from both biological and psychosociocultural perspectives. 3) The affected person is then evaluated for organism based constitutional parameters that define aggressive behavior from a variety of viewpoints that include psychological, psychiatric, and criminological factors. 4) The construct of psychopathy is taken into account by considering not only a DSM-IV-TR perspective but also psychologist Robert Hare's concepts of psychopathy as well as other approaches that may be well suited for analysis of a specific person. 5) Finally, the above components are analyzed as functions of ecological factors that may take into account the physical, environment, the social environment, life-span dimensions, and historical factors. The concept and analysis of stress is encompassed in this aspect of the NDM.

John B. Crutchley's vampiristic behavior and its association with serious serial sexual criminal behavior is briefly considered. The place of NDM in the context of previous efforts to understand the genesis sexual criminal behaviors along with ideas for future research is outlined and briefly discussed.

Forensic Psychiatry, Violence, Vampirism

Questioned Documents

J1 The Use of an Electrostatic Detection Device (EDD) to Identify Class Characteristics on Documents Produced by Printers and Photocopiers

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The goal of this presentation is to determine if it is feasible to use an electrostatic detection device (EDD) to examine questioned documents for class characteristics from printers and/or photocopiers after a document has been printed or copied.

The use of an electrostatic detection device (EDD), first marketed by Foster and Freeman, Ltd., of England as ESDA (Electrostatic Detection Apparatus), is an invaluable tool that provides forensic examiners with a method to examine indentations in a document. Since ESDA is a non-destructive examination (with exception to a brief humidifying process) that is highly sensitive and capable of creating a permanent record of results, its use in forensic laboratories is ubiquitous. As well, the ESDA technique is well documented in the literature and numerous articles have been published exploring parameters affecting quality and methods of enhancing results. After conducting a literature search, the author found limited references with regards to detecting physical impressions left on a document subsequent to being produced on a printer or photocopier. Printing devices and photocopiers are fast becoming a rampant resource for criminals, and their forensic identification can be critical to an investigation. Examinations such as chemical analysis of colorants and the identification of trash marks are essential tools for the forensic examiner, but new techniques to identify a machine model or group of models are essential. The market is inundated with inkjet printers, laser printers, and photocopiers, but many of these office machine systems are built by various manufacturers, or their hardware design (e.g., "rolling" and "grabbing" mechanisms) have been changed over the years due to technological advances.

In this study, ESDA was used to examine documents produced using various printers and photocopiers to determine if class characteristics could be employed to determine the make and/or model of the machine. As well, the author attempted to ascertain the feasibility of identifying individual characteristics to compare documents produced by the same machine.

ESDA, Printers, Copiers

J2 The Faces of Ink Jet: As Seen Through the Eyes of a Forensic Document Examiner

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The goals of this presentation are to explore the latest of ink jet technology and to demonstrate that technological advancements have improved print quality but not precluded the forensic document examiner from identifying an ink jet product.

Forensic document examiners are routinely asked to determine the printing processes on various types of documents. Ink jet is a digital print technology that has been commercially available for a couple of decades and has been examined by the forensic document examiner for equally as long. As technology advances and costs decline, good quality color ink jet printers at the home and office are becoming the norm. It is a challenge, if not an impossible task, for a forensic document examiner to stay abreast of industry changes and innovations. The technology of stimulating ink to form a droplet that is directed onto a substrate is divided into two methodologies: continuous and drop on demand. The science of ink jet can be further subdivided into a dizzying array of applications including: binary deflection, multiple deflection, hertz, piezoelectric, thermal, acoustic, and electrostatic. The wide range that exists in the industry has various pros and cons. These differences may distinguish one company or model from another, but does it change the visual product? The science of ink chemistry adds another factor to the diversity of ink jet print devices. Additionally, with varied types of paper commercially available, individuals are using ink jet technology on everything from photographs to checks. The science of ink jet technology can be discussed at length; however, what it comes down to for the forensic document examiner is: "Does ink jet still look like ink jet?"

When examining an ink jet document under magnification a forensic document examiner expects to see the following characteristics: absorption and bleeding into the paper fibers, over spray, stepped edges, and a lack of embossing. The questions this paper will address are: "Has technology changed the appearance of ink jet on paper?" and "Does a change in paper significantly change the appearance of ink jet?" Photomicrographs of ink jet print products on various types of paper surfaces will be displayed and their visual appearances described and discussed. Though the minutia of ink jet technology is constantly evolving, the basic principle remains the same. It can be easily deduced that if the basic principle changes it would become a different print process. Though the quality of the printed product has improved significantly over time, it is believed that forensic document examiners can still recognize an ink jet product under their microscopes.

Inkjet, Document Examination, Digital Printing

J3 Design and Security Features in the New Euro

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Background on the new European currency and its security features are discussed.

The Treaty of Rome in 1957 established a common European market as an objective to increase prosperity. A monumental part of that objective was realized when, on January 1, 2002, twelve Member States of the European Union converted from their own individual currencies to the new euro – the largest monetary changeover in history. Included in the turnover are Belgium, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, The Netherlands, Austria, Portugal, and Finland. Even though they are members of the European Union, Denmark, Sweden, and the United Kingdom do not participate in the common currency. The change has not been without controversy, but is expected to be a uniting force in Europe as well as the rest of the effected world. Since its introduction, the euro has enjoyed a near one to one parity with the U.S. dollar and has recently traded slightly higher during the troubled U.S. financial markets.

As of February 28, 2002, old notes and coins were to be withdrawn from circulation. To replace them, 8 new coins are currently being offered in denominations of 1 and 2 euros and 50, 20, 10, 5, 2 cents, and 1 cent. The observance of these coins will have the Member States own motif but will not limit usage within the participating nations. Seven new notes are offered in denominations of 500, 200, 100, 50, 20, 10, and 5. The notes do not feature a national side, but will depict bridges, windows, and gateways representing Europe's architectural heritage.

With the new notes and coins come security features similar to U.S. currency in addition to some new ones. This paper will discuss the latest security features found in the new currency such as foil, printing, watermarks, holograms, and minting methods. Additionally, some background on the euro's implementation and development will be given as well as the economic impact of this historic event since January 1.

Design Features, Security Features, New Euro

J4 Questioned Document Examination in Turkey

Nevzat Alkan, MD, Istanbul Tip Fakultesi, Adi Tip Anabilim Dali, Istanbul, Turkey; and Firuz Koc, Istanbul University, Aldi Tip, Istanbul, Turkey*

The attendee of the presentation will learn to about questioned document examination applications, education, and criminal laboratory settings in Turkey.

Questioned document examination is a field of forensic sciences that performs examinations on printed or written documents creating legal arguments or providing evidence. This area of expertise started in the early 1930s in Turkey. Government questioned documents laboratories are divided into three groups in Turkey. The first group is in the police criminal laboratories, the second group is in the gendarme, and third of group is in The State Institute of Forensic Medicine. Despite the presence of private and individual experts in Turkey, there are no private document examination laboratories possessing developed technical equipment.

In this study all three group laboratories and private experts in Turkey briefly discuss the professional work, procedures of specialization in document examination, and the workload of laboratories. Today the equipment of Turkish document laboratories meet rather high standards and it is hoped that, in the near future, training, expert systems, and other related document examination procedures meet the same up-to-date standards in Turkey.

Questioned Document Examination, The State Institute of Forensic Medicine, Turkey

J5 Microscopic Comparison of Printed Matter From the Commonly Available Printing Devices in Document Examination

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This paper presents a comparative study of various printing devices and its document examination.

For a forensic document examiner the document examination of printed text matter plays an important role in giving an opinion on a questioned document. Use of image processing comparison microscope, as a tool to identify and compare the usual and unusual characteristics of the printed text matter, will help as an additional parameter in the examination of questioned documents. The present paper attempts to identify and compare the characteristic features observed in the printed text matter available from ten (10) different printing devices commonly used in office documentation and general use. The characteristic defects and unusual physical features of the texts from the ten devices, e.g. inkjet printers, laser printers, dot matrix printers, electronic typewriters, ordinary typewriters, facsimile copy printers, screen printing, offset printers, Photostat (heat type & inkjet type) machines, and Photostat (color) machines, were studied using the Leica digital image processing comparison microscope. Such study would also link the part of the document to that of the original and also for identifying the source of the printing devices of a questioned document.

Comparison Microscope, Documents, Printing Devices

J6 Development of a Web Site Database of Dyes Commonly Used in Pen Inks

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A web site is currently under development (supported by the National Institute of Justice) that provides laser desorption mass spectrometry (LDMS) and thin-layer chromatography (TLC) data on pen inks. The web site specifically focuses on experimental data from techniques used to analyze the colorants in pen ink. The goals of this presentation are to show how to access the web site and discuss detailed information that can be obtained.

Methods: Dyes in pen inks of various manufacturers and colors are being identified using a combination of TLC, LDMS, and photodegradation. The results are being made available to the scientific community through a web site. A PerSeptive Biosystems matrix-assisted laser desorption/ionization (MALDI) time-of-flight mass spectrometer was utilized to analyze ink samples directly from paper. Samples are mounted on a modified MALDI plate. The instrument utilizes a pulsed nitrogen laser that desorbs and ionizes the dyes from the ink samples. The instrument is capable of analyzing positive and negative ions. Both ion modes were utilized for each ink sample. Several TLC solvent systems were evaluated for maximum dye separation, and the specific solvent system is posted on the web site for each pen ink sample. Several light sources were evaluated for implementing photodegradation of ink in order to assist in dye identification.

Results: Included on the web site are three methods of analysis that include TLC, LDMS, and photodegradation. TLC is a simple analytical technique commonly used in forensic laboratories to separate dye components in pen ink and identify the color of each dye. For a given pen, the thin-layer chromatogram will be shown on the web site. LDMS has been used successfully to analyze a variety of ionic and neutral dyes or pigments used in inks, directly from paper. The web site will present positive and negative ion mass spectra of pen inks on paper. Dyes selectively absorb the UV laser light forming positive and/or negative ions for MS analysis. Generally, LD mass spectra only contain peaks that correspond to the intact dye, thus obtaining molecular weight information for the dye is easy. LDMS spectra and TLC chromatograms compliment one another, and the relationship will be established on the web site. The dyes that constitute the TLC colored bands can be specifically linked to the peaks in a LD mass spectrum. The identity of the ink dyes will be established, and be made available on the web site. Once the identities of the dyes in pen ink are known, a variety of other methods, such as high performance liquid chromatography (HPLC) or UV-Vis spectrophotometry could be implemented by forensic examiners for analyzing their particular questioned document.

TLC and LDMS provide limited information (color and molecular weight of the dye, respectively). These methods alone may be insufficient to determine the identity of the dye. LDMS analysis frequently requires additional experiments to characterize the dyes. Laser

desorption is a desorption/ionization technique that does not induce dye fragmentation, thus limiting the information that can be obtained from the mass spectrum. The efficiency of the desorption process leads to difficulty in characterizing dyes. The authors have been developing and using photodegradation methods combined with LDMS to identify the structure of the dye.

The web site will also provide information on the variability that can be encountered in pen inks of the same brand. Generally, most blue and black ballpoint pens contain Crystal Violet as the prominent dye in the ink, but these are just a small class of pens that are used daily. In fact, pen manufacturers may use a combination of dyes and the resources for colorants are unlimited. It should also be noted that the dyes used in a specific brand of pen ink vary. Batch-to-batch dye variations have been seen to occur in BIC Round Stic® ballpoint pens with red ink. To show the variation in ink composition, six BIC Round Stic® pens were collected from random sources (increasing the variability in batch composition), and the dye(s) in the ink of each pen were examined by LDMS. There are distinct differences in the LDMS spectra that differentiate among pen inks of the same brand. The spectra of the six pen inks could be generally classified into three categories.

Conclusion: The goal is to provide a searchable database that could assist investigators in making possible links between ink samples and pen types. Through the web site, one could select a dye or a molecular weight, and search the database to determine which pens have been found to contain these dyes.

Ink Analysis, Mass Spectrometry, Web Database

J7 Characterizing Inks on Intact Documents Using Attenuated Total Reflection Infrared Spectroscopy

John F. McClelland, PhD, Jeffrey S. Sweterlitsch, PhD, and Roger W. Jones, PhD, Iowa State University, Ames Laboratory, Ames, IA*

The attendee will learn details of an infrared spectroscopy approach to characterizing and identifying inks on intact documents.

Inks are complex mixtures of dyes, resins, and other proprietary additives in a volatile vehicle. When ink is written on paper, the presence of the pulp, pigments, binders and other components of the paper substantially increase the chemical complexity of the complete sample. Often, visual inspection or thin-layer chromatography provides sufficient information to answer the questions arising in a particular case, but both of these approaches make use of only a small portion of the potential information available from such chemically complex materials. Infrared spectroscopy has long been used for the analysis of complex materials because the infrared portion of the spectrum is particularly information rich. However, the physical nature of ink written on paper has usually led scientists either to remove the ink from the paper or to perform microspectroscopy using an infrared microscope. The application of attenuated total reflection (ATR) spectroscopy to *in situ* ink characterization without the complexity and expense of an infrared microscope is presently under study. This approach should require less examiner time and document damage compared to other techniques. In ATR, the spectrometer beam passes through an infrared-transmitting crystal so that it reflects off the surface of the crystal. The sample is pressed against the crystal at the point where the beam reflects. The resulting spectrum is akin to that from conventional transmission spectroscopy. ATR accessories are available commercially that have sensing areas as small as 250 µm wide, so an intact document can be positioned on the ATR sensing crystal such that only the region within an ink line is analyzed. The probe depth of ATR generally does not exceed 3 µm, so the spectral contributions of the ink are emphasized in an ATR spectrum from an intact document, although the paper spectrum is still present. Proper subtraction of the spectrum of blank paper from that of the document produces a spectrum sufficiently characteristic of the ink that it can be used for identification purposes.

Methods are under development for reliably acquiring analytically useful spectra from ink on intact documents using a commercial ATR accessory with a silicon crystal. The details of this method will be discussed. Sample alignment has proven critical to attaining high-quality, reproducible spectra. In addition, many papers are spectroscopically highly variable across their surface on the scale of the ATR sampling area, so a consistent method of sampling, as well as a consistent method of subtracting the blank-paper spectrum are necessary for the difference spectra to be analytically characteristic of the ink. Simple "by eye" subtractions are not sufficient. Techniques for searching spectral libraries are being explored to determine the best approaches for using collections of reference ATR ink spectra to identify inks *in situ*. Small libraries of ATR-based ink spectra have been built up and successfully used to identify ink on intact documents. Libraries based both on the ink-on-paper spectra directly and on the difference spectra after subtracting off the paper contributions are being examined.

Ink, Documents, ATR Spectroscopy

J8 Voter Fraud: The Petitioners' Alliance vs. The Birmingham Waters Works Board

Richard A. Roper, PhD, Forensic Document Examiner, 7956 Vaughn Road, #141, Montgomery, AL*

The goal of this presentation is to present a case which illustrates that in a document examination, there may be matters beyond the initial request, such as the signature(s) of a notary public which can strongly influence the outcome of a case.

As a result of a shift in the political alliances in the city of Birmingham, AL, the assets of the Birmingham Water Works became the subject of a petition for a citizens' referendum to privatize the Water Works as opposed to returning the assets to the control of the Water Works Board. The assets of the Water Works had previously been given to the City, for a token amount, to be sold off for privatization. The Waters Works Board later attempted to buy back the assets, thus the formation of the Petitioners' Alliance.

An initial petition drive failed to obtain the required number of valid and verified Birmingham voter signatures and, so, a second petition drive was conducted. At the completion of the second drive, there were sufficient valid voter names verified by the Probate Judge; however, after inspection of the pages of the petition, attorneys for the Water Works Board believed that some of the voter signatures to be forgeries and, therefore, contested the petition process. Approximately 600 petition pages were submitted for handwriting examination.

Forgeries were identified which varied from signatures in the name of 2 or 3 members of a family to some entire petition pages. More significantly, though, improper actions on the part of one particular notary public, whose wife was also a petition circulator, were also identified. While the notary did indeed legally notarize some of the petitions, most of the petition pages notarized in his name were identified to be signed either by his wife or his daughter, rendering the legal validity of those pages in great dispute.

While the matter was later settled, it was interesting that there appeared to be some reluctance by the court to invalidate non-genuine signatures executed by other family members.

Voter Fraud, Document Examination, Forgeries

J9 What is the Real Question? Is the Writing Genuine or Is It, and the Document Fabricated? Some of the Hazards Encountered in Examining Photocopied Documents

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After attending this presentation, the participants will be familiar with some of the problems encountered in the examination of photocopied documents.

Advances in office machine technology have made document duplication, creation, and alteration very easy. While computers, laser printers, and photocopiers are used for legitimate purposes in the business world to create and duplicate documents, a few people use them to fabricate fraudulent documents. With increasing frequency photocopied and computer generated documents are being give to document examiners for analysis. A primary reason is because they are often presented as the best available evidence since the original document no longer exists,

This paper discusses some of the issues the writers have dealt with in the examination of photocopied documents. The two major areas to be discussed are document fabrication and the identification of handwriting and hand printing on a photocopy. Determining the suitability of handwriting for comparison purposes is absolutely essential before a meaningful examination and comparison can begin. By its very nature the photocopy process causes some degradation in the quality of handwriting and other features of the document or item being copied.

It cannot be assumed that what is on a photocopy is also on the original document. Nor is it possible to determine what generation copy is being examined. These factors alone should be sufficient cause to exercise the up-most conservative approach to evaluating what is on the document, but all too often examiners reach conclusions that are not supported by the evidence. This paper will give some very practical reasons, based on actual case work, why an examiner should adopt an ultra conservative approach and word the results of his examination to account for the fact that he is NOT examining the original document.

Questioned Documents, Photocopied Documents, Examination of Documents

J10 Quantifying Handwriting Individuality

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Methodology for quantifying individuality using a given set of measurements in general and with handwriting attributes in particular will be presented. Software to compute handwriting attributes and results of measuring individuality with a statistical sample of handwriting exemplars will be described. The impact of the results of the study on questioned document examination and planned future work will also be described.

Document Analysis, Feature Extraction, Handwriting Individuality

J11 Handwriting Individuality Research: Consideration of Issues Attendant to Empirical Data Generation

Duayne J. Dillon, DCrim, Document Services, P.O. Box 488 Court Station, Martinez, CA*

This paper suggests that the collection of empirical data to support the proposition of handwriting individuality is not a simple task and a report of a narrowly focused study illustrates this view.

The impetus for the research reported in this paper results from the recent criticism of handwriting identification and handwriting experts that has appeared in print and as attempted court testimony. A brief historical background of handwriting identification and its use in the American court system precedes an evaluation of its criticism and critics.

Special focus is directed to the critics' claim of the lack of empirical evidence supporting the scientific validity of the identification process and special abilities of handwriting experts. Existing empirical evidence is described and the limited university level research is discussed.

An effort is made to dispel the erroneous impression implied by critics, that meaningful research on the habit patterns of writers and the intercomparison of such patterns among writers is a reasonably undertaking. This first necessitates a discussion of the individuality and variation encountered in personal handwriting and factors influencing their development.

Proposed research designs to study writer individuality and variation attempts to ascertain the frequency of occurrence of specific elements (also termed characteristics) in the pattern of writing. A few of these elements include segments of letterforms, connecting strokes between letterforms and proportions within and among such forms. This type of design implies that there are a finite number of such elements and that number is of manageable size. Ideally, once the frequency of each element is determined in the study population a researcher would then determine the independence of each element. Having completed these two segments it is proposed that a statistical value of the concurrence of a number of the same elements in two writings can be determined. Past research in other areas of forensic science has produced the ability to determine the statistical significance of examinations of other types of physical evidence. In the case of handwriting individualization the search for this "prized" statistical significance will likely prove to be more elusive. Personality experience with both interwriter and intrawriter differences suggests to the author that among the many hurdles to first be overcome before successful research is the issue of what has been described as

The author's study of the handwriting of 500 different individuals is described and the results presented. The implications of the findings of this study on proposed lines of research are examined and examples of potential problem areas are explored.

The problems of acquiring acceptable writing standards, representative populations, and finally adequate population sizes are explained.

Handwriting identification was one of first forensic sciences to be utilized in the American justice system and apparently the first to receive positive comment in a U.S. Supreme Court decision. The earliest American practitioners of handwriting identification were individuals whose positions in commerce or education required them to make judgments about handwritten material. Some of those who demonstrated such skill were occasionally called upon to offer their opinions on handwriting, particularly signatures, in issue before the courts. These part-time examiners appear to have relied upon on a high degree of spatial cognition. The advent of the twenty century saw the publication of the first American books on handwriting identification and their authors, particularly Albert S. Osborn advocated a more organized an objective approach to handwriting identification.

Examiners who benefited from these texts and other early articles initiated the type of apprenticeship training that provided the declarative and procedural knowledge necessary in the development of those examiners who represent the beginnings of the profession of questioned document examinations.

The continuing history of handwriting identification has not been without controversy, for there have been individuals and groups of examiners who based their opinions on concepts and theories outside of mainstream standards. These controversial divergences have provided the topic for relevant published articles. Until recently there has not been any organized effort to dispute the concept of handwriting identification and the proposition that individual experts have the requisite skills to determine the authenticity of handwritten material.

Today's critics pronounce handwriting identification to be unscientific and handwriting experts to possess no greater skill in their specialty than as might be found in the general public. Interestingly, not only is this small group of faultfinders not scientific community but also is composed of law school faculty members devoid of academic preparation in science, and credentials in the study of expertise.

Handwriting, Individualization, Research

J12 Harbor Pilots, Handwriting Examinations, and the Scientific Method

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The educational objective of this presentation is to suggest methods and applications that may increase the scientific presentation of handwriting evidence and provide possible solutions to issues of validation and statistical uncertainty. To present a method for creating electronic work notes for handwriting examinations.

Several events over the past 13 years, including the Risinger et al. article [1], Starzepyzel trial [2] and the MacVeigh bombing trial [3], have raised questions about the scientific validity of the century-and-a-half-year old forensic discipline of handwriting examination.

For any subject to attain the coveted status of science three conditions must be met, reproducibility, reproducibility, and reproducibility [4]. The often used axiom, "... examiners of questioned handwriting are trained professionals who are confident that their conclusion in a given case is the same as the conclusion that would be given by any other similarly trained professional examiner..." implies that handwriting examination conclusions are reproducible and therefore scientific. Consequently different examiners with the same training should make the same observations and arrive at the same conclusions when looking at the same handwriting evidence. The numerous occurrences of opposing handwriting experts in court would suggest otherwise. What are the reasons for similarly trained experts arriving at different conclusions? Do they apply the same standard handwriting examination procedures when looking at the same evidence? Are the standard handwriting examination procedures so often described in the literature [5,6,7,8,9] and referred to in handwriting training programs scientifically valid?

This presentation will describe a method to generate electronic handwriting work notes with embedded images of observations, thereby verifying the application of standard handwriting tests when assessing and comparing handwriting evidence. The scientific validity of these standard tests will be discussed together with reference to software programs (i.e., Limbic Systems) that may help to capture hard-to-illustrate observations (i.e., pen lifts and intersecting strokes).

The inclusion of images of observations for every handwriting tests applied to the evidence is synonymous with recording keeping methods used in conventional scientific investigations. Using this approach the handwriting report and accompanying work notes are presented in a more scientific framework. The results of all tests applied to the evidence are described with supporting images. This confirms that the appropriate test was administered as well as showing the results upon which the conclusion is based. This approach to recording handwriting examinations may help to reduce the occurrence of opposing handwriting conclusions in the courtroom and establish that standard handwriting tests results are reproducible. The scientific validity of handwriting examinations and the statistical uncertainty associated with handwriting examination conclusions will be discussed with reference to handwriting search data bases such as the Forensic Identification System for Handwriting (FISH) developed by the Bundeskriminalamnt [10].

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Handwriting, Validation, Scientific Method

J13 The Document Examiner's Role in Deciphering Handwriting of a Severely Impaired Writer

Brian S. Lindblom, BA, 309-311 Richmond Road, Suite 309, Ottawa, Ontario, Canada*

The goals of this presentation are to illustrate the use of Write-On Software to aid in the decipherment of a university student's master exam. The student has a severe form of writing impairment.

Sometimes in a professional capacity experts are presented with a case that, on first inspection, does not immediately appear to fall within the scope of one's expertise. This paper describes one such example.

The author was asked to analyze an illegible handwritten university exam produced by a post-graduate student with dysgraphia. The disability is defined as an impairment of the ability to write generally caused by a brain dysfunction or disease. It manifests itself as a difficulty in automatically remembering and mastering the sequence of muscle motor movements needed in writing letters or numbers. The handwriting is distorted or incorrect – letterforms are inappropriately sized and spaced, as well as being poorly organized on the line and on the page. In addition, words are misspelled or used improperly, despite thorough instruction. This disorder is a processing problem that causes writing fatigue and interferes with the communication of ideas in writing. It is out of harmony with the writer's intelligence.

As a consequence, faculty members could not read this version of the exam and requested that it be typed for grading. Ultimately the professor came to question the integrity of the transcript. The task was

to determine if the written text was accurately represented in the transcript. To aid in this assignment, Write-On© Handwriting Comparison Software was utilized.

Write-On© is a computer program that provides an efficient method to assess natural variation by allowing the user to search for all instances of a given letter or word within a document. A typewritten transcript must be linked to scanned copies of the handwritten pages. Searches can then be conducted for specific letter strings and the results illustrated in an occurrence chart.

Also submitted was a second exam that had originally been handwritten by the student and then transcribed by a university staff member. This sample exam was used to learn the student's handwriting style and to assess how consistent the writing of repeated words was.

No evidence was found amongst the pages examined to indicate that the answers as seen in the transcript were not representative of the handwritten version. It warrants mentioning that without the aid of the specimen exam it would have been much more difficult, perhaps not even possible, to learn the student's handwriting.

The approach taken in this case has many similarities with a standard handwriting comparison. However, the objective was to decipher not to authenticate. As with any handwriting comparison, assessment of the natural variation, in this instance from one repeated word to the next, was critical to interpreting content. This methodology could also be applied in other files where legibility is an obstacle. Three such examples include interpreting a doctor's progress notes, resolving the content of a holographic will, and deciphering the interview notes of a journalist.

Dysgraphia, Document Examination, Impaired Writer

J14 *Daubert* Update for Questioned Documents Examiners

Larry A. Olson, Southwestern Association of Forensic Document Examiners, Internal Revenue Service, CID, National Forensic Laboratory, Chicago, IL*

This presentation will involve a panel to acquaint forensic document examiners (FDEs) with the most recent issues in presenting scientific testimony in court (especially FDE testimony). The panel will be divided into five parts:

- A brief background of the Supreme Court's decision in *U.S. v. Daubert* regarding scientific testimony, as well as additional decisions which have shaped questioned document testimony
- A brief introduction to the persons who have criticized FDE testimony in print and in the courtroom, including some of their typical arguments
- A discussion of the most recent writing regarding the reliability of forensic document examination
- The experience of FDEs who have recently testified in *Daubert* hearings
- A question-and-answer period

***Daubert*, Questioned Documents, Courtroom Testimony**

J15 ABFDE Test Validation Project and Pilot Testing

Howard A. Birnbaum, Jr., BS, Arizona Department of Public Safety, Questioned Document Unit, 2310 North 20th Avenue, Photnix, AZ; and Thomas Haladyna, PhD*, Arizona State University, West, Phoenix, AZ*

Pilot testing is a necessary component of test validation as outlined in the Forensic Specialties Accreditation Board's (FSAB) Standard for Accrediting Forensic Specialty Certification Boards. The Board has made the decision to pursue FSAB accreditation, and in order to properly validate its written test, a pilot testing process needs to be established.

Approximately 60% of ABFDE diplomates completed a Survey of Professional Practice that was distributed in August 2002. As a result of the surveys, topics have been selected on which multiple-choice test questions are being prepared. Diplomates who have already completed the testing process have volunteered to prepare the questions from which 250 will be selected for the pilot test to be given at AAFS meeting in Chicago. Validated questions will be included in a proof of questions from which items for the live test(s) will be selected.

Participation as a pilot test take is voluntary. The test will be administered by Dr. Thomas Haladyna from Arizsona State University, West, with the assistance of ABFDE Director Howard Birnbaum.

ABFDE, Test Validation, Accreditation

K1 Urinary Excretion of α-Hydroxytriazolam Following a Single Oral Dose of Halcion®

Dong-Liang Lin, PhD, Tsun-ying Huang, BS, Hsiu-Chuan Liu, BS, and Rea-Ming Yin, BS, Institute of Forensic Medicine, Taipei, Taiwan (ROC)*

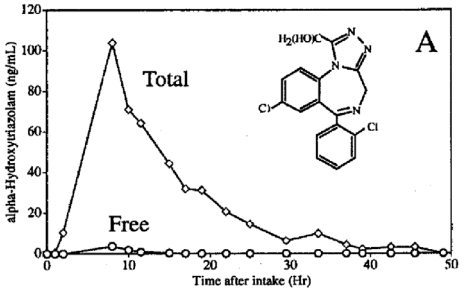
The goals of this presentation are to establish an effective procedure for analysis of a-hydroxytriazolam and to characterize human urinary excretion following of this compound following a single oral dose of triazolam.

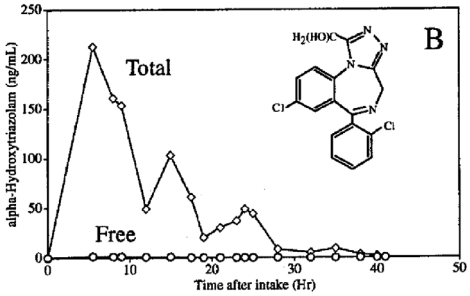
Triazolam is a very short-acting triazolobenzodiazepine with sedative hypnotic properties. Urinary excretion following an oral dose of this drug includes approximately 2% parent compound and 70% α-hydroxytriazolam glucuronide [1]. Approved for medicinal use in Taiwan, it is also controlled at the same level (Level III) as Flunitrazepam. Alleged misuses *of* this substance have been associated with case specimens submitted to this laboratory.

In this study, urine specimens were screened by TDx® followed by sample preparation (without and with enzymatic hydrolysis) and GC-MS protocols for quantitative determination *of* free and total α-hydroxytriazolam. Enzymatic hydrolysis was carried out by mixing the specimen with *Helix pomatia* β-glucuronidase for 2 hr at 56°C. The mixture was then adjusted to pH 9.5, extracted with ethyl acetate, dried, and derivatized using MSTFA. Deuterated α–hydroxytriazolam was used as the internal standard. Confirmation test was carried out using a HP 5973N GC-MSD equipped with a 30-m HP 5MS fused silica capillary column under the following conditions: Injector and interface temperature 260°C and 280°C, respectively; column oven temperature initiated at 150°C for 1 min, then programmed to 300°C at 20°C/min, and held at the final temperature for 6.50 min. Data acquisition included full-scan 50-500 amu) and selected-ion-monitoring *of* the following ions: *m/z* 415, 417, and 430 for α-hydroxyttiazolam; *m/z* 419, 421, and 434 for a-hydroxytriazolam-d_4-. Standard criteria were used to confirm the presence *of* the analyte prior to its quantitation.

The overall protocol achieved the following results when applied to the analysis of 2-mL drug-free urine specimens fortified with 10-200 ng/mL a-hydroxytriazolam: Recovery, 95%; interday and intraday precision ranges, 1.50-3.52% and 0.93-4.71%, respectively; linearity, $r^2 > 0.99$; limits of detection and quantitation, 0.05 and 0.1 ng/mL, respectively.

This protocol was applied to the analysis *of* urine samples collected from two volunteers (A and 13) taking one oral dose of Halcion® (0.25 mg triazolam). Excretion profiles *of* free and total α-hydroxytriazolam are shown in Figure 1. Free α-hydroxytriazolam is detectable, but at very low levels (<5 ng/mL). Peak excretion of total α-hydroxytriazolam occurs at approximately 5-10 hr following the drug intake. Total α-hydroxytriazolam is excreted at detectable levels approximately 2-35 hr following an oral dose *of* 0.25 mg triazolam. Total free and conjugated α-hydroxytriazolam excreted by A and B are 0.61% and 31.6%; and 0.36% and 57.2% *of* the dose, respectively.





Urinary excretion profiles of two volunteers taking one oral dose of Halcion® (0.25 mg triazolam).

Fraser AD, Bryan W, Isner AF: Urinary screening for a-OH triazolam by FPIA and EIA with confirmation by GOMS; *J Anal Toxicol* 16:347-350! 1992.

Halcion®, α-Hydroxytriazolam, Drug Excretion

K2 Polydrug Fatality Involving Metaxalone

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The attendee will learn how an overdose of Metaxalone, a skeletal muscle relaxant, can cause or contribute to death.

Metaxalone (Skelaxin®) [5-(3,5-dimethylphenoxymethyl)-2-oxazolidinone] is a widely used, orally administered, centrally acting skeletal muscle relaxant. It is prescribed widely for acute, chronic, traumatic, and inflammatory musculoskeletal disorders since its introduction in 1962. Metaxalone is available as 400 mg tablets with the recommended dose being 2 tablets three to four times a day.

Since its introduction, little has been reported concerning the toxicity of metaxalone in humans. A review of the literature revealed no reported cases of fatal overdose with metaxalone as a sole agent or in combination with other drugs, though it has been detected and considered non-contributory in a few case studies. In this report, the authors discuss the first reported case of a fatality in which metaxalone is felt to have played a major role.

Citalopram (Celexa®) is a selective serotonin reuptake inhibitor used to treat depression. It is administered at an initial dose of 20 mg daily, taken orally, and may be increased to 40 mg/day. Citalopram has been studied previously in fatalities and has been reported previously in a drug overdose cases. It was also detected in this case.

A 29-year-old female with a history of depression and recent ethanol abuse was found dead in a hotel room. She was discovered after she did not check out by the appropriate time. The police entered the secured room by cutting the security chain on the door. The decedent was lying on the bed. The death scene investigation found bottles of prescription drugs. Two prescription bottles for forty 400 mg tablets of metaxalone were found with directions to take one tablet four times a day. One bottle was prescribed approximately seven months prior to death and was empty. The other was prescribed approximately six

weeks prior and contained 21 tablets. Also, an empty liter wine bottle was on the nightstand. Otherwise the scene was unremarkable. No suicide note was found.

The adult decedent weighed 71 pounds and was 41 inches in length, consistent with a history of dwarfism. Postmortem examination revealed the presence of multiple subacute superficial incised wounds involving the left anterior wrist. The larynx and trachea had small amounts of edematous fluid. Particulate white granular debris was present within the duodenum and proximal half of the small bowel. The remainder of the gross and microscopic examination was unremarkable.

Urine samples were routinely screened using Syva EMIT. Samples of blood, gastric contents and liver were routinely prepared with an alkaline extraction, then analyzed and quantitated by gas chromatography-mass spectrometry. Metaxalone, citalopram, ethanol, and chlorpheniramine were identified in the postmortem samples. The concentration of metaxalone in femoral vein blood was 39 mg/L. The heart blood concentration was 54 mg/L. Femoral vein blood concentrations of citalopram and chlorpheniramine were 0.77 mg/L and 0.04 mg/L, respectively. Ethanol levels were 0.13 g/dl in vitreous and 0.08 g/dl in heart blood. Other tissue samples including brain, liver, gastric, and duodenum contents were also analyzed and were positive for metaxalone and citalopram.

The authors consider the metaxalone concentrations toxic and potentially fatal based on communications with the pharmaceutical laboratory that performs C_{max} testing for therapeutic levels of metaxalone. This laboratory reports the therapeutic level to be 4.0 mg/L in plasma under fasting conditions. The metaxalone levels in this case far exceeded this level. The citalopram concentrations found in this case were lower than those reported in fatal cases for this drug alone. Chlorpheniramine levels were also lower than those considered toxic or fatal. However, the additive central nervous system effects of toxic levels of metaxalone with citalopram, ethanol, and chlorpheniramine, also central nervous system depressants, likely caused death. Death was officially ascribed to polydrug overdose/abuse with metaxalone felt to be a major contributor. This represents the first reported case to the authors in which a metaxalone overdose significantly contributed to death.

Metaxalone, Citalopram, Overdose

K3 Interpretation of Postmortem Diphenhydramine Concentrations

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The goals of this research were to determine postmortem subclavian blood therapeutic concentrations of diphenhydramine and to compare them to reported therapeutic concentrations in living individuals. Attendees will be provided additional evidence that strict reliance on data from antemortem therapeutic concentrations to interpret postmortem blood concentrations may be risky and may lead to erroneous conclusions.

Diphenhydramine is a widely used over the counter therapeutic agent, appearing in a large number of cough and cold formulations, sleep-aids and anti-allergy medications. A recent study in Maryland identified diphenhydramine as the non-prescription therapeutic drug accounting for the most drug intoxication cases in the 1990s. Diphenhydramine continues to be frequently detected as an incidental finding in cases where death is due to other causes. Nevertheless, interpretation of diphenhydramine in these cases may have forensic relevance. A previous study in this office using heart blood specimens suggested concentrations less than 1.0 mg/L might be associated with therapeutic use.

Since the drug is alkaline extractable and has a volume of distribution of 3-4 L/kg, there is a potential for postmortem redistribution of the drug. In fact, there are a number of studies in the scientific literature that indicate postmortem redistribution of diphenhydramine does occur. To reduce the interpretive problems of postmortem redistribution, it has become common to analyze a drug from a peripheral site, such as femoral or subclavian blood instead of or in addition to heart blood. As a result, the previous study was revisited to determine whether a modification of the postmortem therapeutic range is necessary if a peripheral blood specimen is used.

Heart blood and subclavian blood specimens were quantitated for diphenhydramine in 38 cases where the medical examiner ruled that the presence of diphenhydramine was an incidental finding. Diphenhydramine was quantitated by gas chromatography-nitrogen phosphorus detection following an alkaline extraction and was confirmed by full scan electron ionization gas chromatography-mass spectrometry. A single point calibrator at a concentration of 0.8 mg/L was used for quantitation. With each batch, two blood controls at concentrations of 0.2 and 1.0 mg/L were analyzed. The limit of quantitation was 0.04 mg/L and the assay was linear to 2.4 mg/L

Thirty-four of the 38 cases had a blood concentration less than 1.0 mg/L. The average and median heart blood concentrations were 0.67 mg/L and 0.26 mg/L, respectively; the average and median peripheral blood concentrations were 0.73 mg/L and 0.25 mg/L, respectively. One case had a heart blood concentration of 9.0 mg/L and a peripheral blood concentration of 10.6 mg/L. This case was a pedestrian who died of multiple injuries. If this case is excluded, the average heart blood concentration was 0.45 mg/L and the average peripheral blood concentration was 0.46 mg/L. The average heart blood to peripheral blood diphenhydramine concentration ratio was 1.11 and the median ratio was 0.96 (range 0.27-4.34). Seventy one percent of the cases (27 of 38) had ratios between 0.7 and 1.3. The differences between the heart blood and the peripheral blood concentrations were not statistically significant. The authors conclude that the postmortem therapeutic range for diphenhydramine for a peripheral blood specimen such as subclavian blood is similar to the range established for heart blood. As a result, there are not significant interpretive differences between postmortem heart blood and subclavian blood diphenhydramine concentrations. These concentrations are slightly higher than what is reported in studies conducted in living people where concentrations up to 0.3 mg/L are reported following therapeutic use. Therefore, this study provides additional evidence that strict reliance on data from antemortem therapeutic concentrations to interpret postmortem blood concentrations may be risky and may lead to erroneous conclusions.

Diphenhydramine, Postmortem, Therapeutic

K4 False Low Bicarbonate Level With Propofol Infusion and Hypertriglyceridemia

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The goals of this presentation are to: 1) explore the association of Propofol with fatal metabolic acidosis, 2) use the Henderson-Hasselbach equation to resolve discrepancies in acid-base analysis, and 3) recognize interfering substances that may give rise to false lab results.

A 72-year-old male who was admitted with respiratory distress and confusion was found to have a right upper lobe lung mass and hypercalcemia. His measured CO_2 level on the 1st and 2nd days of hospitalization were 25 and 23 mmol/L, respectively. On the 2nd day, he was intubated for worsening respiratory status, administered levofloxacin for

presumptive pneumonia, and administered Propofol for sedation. His arterial blood gases after intubation showed a pH 7.38, PCO_2 38, PO_2 143 and his measured CO_2 26 was mmol/L. Over the following 4 days, his measured CO_2 progressively decreased to 8 mmol/L with an anion gap of 419, negative ketones, and normal serum lactate with no corresponding significant changes in his arterial blood gases. On the 7th day of hospitalization, he received lipid infusion with total parentral nutrition. A grossly lipemic serum specimen showed a CO_2 level of 3 mmol/L. Propofol was discontinued. Four hours later, a 2nd lipemic specimen showed, after ultracentrifugation to remove the chylous material, a CO_2 level of 21 mmol/L. A lipid panel showed a triglyceride level of 4426 mgldL. The patient's condition continued to deteriorate and he died later on the 7th day. At autopsy, the cause of death was poorly differentiated small cell carcinoma in the right upper and middle lung lobes with liver and lymph node metastasis.

Propofol® is a short-acting anesthetic agent. It is a hydrophobic compound, which is formulated in a lipid emulsion (Intralipid) to facilitate intravenous use. Several cases have been reported in which an association between the use of Propofol and a clinical presentation of metabolic acidosis, cardiac dysrhythmias, and lipemia has been suggested. Some of these cases were complicated by fatality. Most of these fatal cases involved children who were ventilated for laryngotracheobronchitis. The cause of metabolic acidosis in these cases was not determined. It was also suggested that the Intralipid in the Propofol preparation might interfere with lactate metabolism in the liver causing accumulation of lactate and acidosis.

In this case, there was a consistent, progressive decrease in the measured serum bicarbonate level during Propofol infusion. However, the patient acid-base status, as simultaneously measured by arterial blood gases did not show a corresponding change that would match the very low level of serum bicarbonate. There was also a marked hypertriglyceridemia that may be related to both Propofol infusion and lipid infusion for nutritional support. After ultracentrifugation of the serum, the measured bicarbonate level in the supernatant returned to the patient's baseline value prior to Propofol and lipid administration. That bicarbonate value was consistent with the patient's acid-base status measured by arterial blood gases. Ultracentrifugation removes the chylous material from serum. It may also remove Propofol from serum since it's a hydrophobic compound. Neither Propofol nor hypertriglyceridemia have been reported as a potential interfering substance with serum bicarbonate assays. In most of the previously reported cases, metabolic acidosis, dysrhythmias, cardiac failure, and death have been related to Propofol by exclusion of all other causes. No conclusive evidence has been reported to prove or disprove this association. This is the first report suggesting that low bicarbonate level associated with Propofol infusion may be largely due to an interfering substance or substances with the bicarbonate assay. Further studies are needed to determine the role of Propofol and hypertriglyceridemia in serum bicarbonate measurement.

Propofol, Fetal Metabolic Acidosis, Bicarbonate

K5 Death Attributed to Intravenous Oxycodone

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The authors will present the first case of death caused by intravenous oxycodone at the Provincial Toxicology Centre.

Oxycodone is a semisynthetic narcotic analgesic derived by chemical modification from codeine. It produces potent euphoria, analgesic and sedative effects, and has a dependence liability similar to morphine.

A 34-year-old Caucasian male was pronounced dead in hospital. A full autopsy was performed approximately 24 hours after death. Autopsy findings included acute bronchitis and bronchiolotis, and recent puncture sites in left arm, pulmonary edema, mucous plugging of small airways, and cerebral edema. Specimens were collected for toxicological analysis.

Blood (central) and urine specimens were initially subjected to a thorough qualitative analysis. Screening was performed for illicit drugs including morphine and cocaine by radioimmunoassay. Basic drugs were screened for by liquid-liquid extraction followed by GC-NPD and GC-MS electron impact detection. Acidic and neutral drugs were screened for by liquid-liquid extraction followed by HPLC-DAD. Volatiles were assayed by GC-FID. Qualitative analysis identified methadone, cocaine/benzoylecoginine (BE), and oxycodone. The methadone concentration was quantitated by GC-NPD and found to be 0.034 mg/L (0.11 umol/L) in blood. Quantitation of cocaine/BE was performed by GC-MS. Neither cocaine or BE were detected in blood, and no cocaine was detected in urine; however, BE was detected in urine at 0.11 mg/L (0.38 umol/L). This suggests remote cocaine useage. The methadone level was considered to be insufficient as the cause of death.

Oxycodone was assayed in biological specimens as follows: briefly, to 1 mL of specimen standards and controls 100 uL of prazepam solution (internal standard, 1.0 ug/L) and 1 mL of saturated sodium carbonate solution was added, and extracted into 5 mL n-butyl chloride. The extract was concentrated under nitrogen, reconstituted with 100 uL of methanol, and 1 □L was injected into an Agilent model 6890 gas chromatograph coupled to a NP Detector using a 30 m HP-5 capillary column (Agilent). Separation was achieved isothermally at 250°C. The concentration was measured by comparison of peak height ratio of the drug to that of prazepam against a standard curve. Since prazepam is not used therapeutically in Canada and extracts efficiently under the above conditions, it was chosen as the internal standard. Linearity was observed from 0.010 mg/L up to 0.50 mg/L. Samples with concentrations exceeding the linearity were diluted.

Elevated concentrations of oxycodone were found in blood 0.27 mg/L (0.86 mmol/L). The usual adult oral dose is 2.5-5 mg as the hydrochloride salt every 6 hours, although patients with moderately severe pain may take 10-30 mg every 4 hours. Published pharmacokinetic studies involving oxycodone show that plasma concentrations are generally less than 0.100 mg/L. For example, the peak plasma concentrations in 12 patients receiving a 10 mg oral dose averaged 0.030 mg/L. There is little reported on the lethal levels of oxycodone in blood when administered intravenously. For oral oxycodone alone, a minimum lethal level of 5.0 mg/L has been suggested, and fatal concentrations involving oxycodone and at least one other depressant drug have been reported at 0.60 mg/L. Although the concentration of oxycodone in this case was lower, it is well known that for other opiates the minimum lethal level can be considerably lower when administered intravenously than when orally administered. The cause of death in this case was ascribed to oxycodone administered by intravenous route.

Oxycodone, Intravenous, Fatality

K6 Validation and Application of the PE TMX 110 Autosystem for Packed Column Analysis of the Confirmation of Volatiles in Death Investigation

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After attending this presentation, the attendee will be knowledgeable in method validation for volatiles by headspace gas chromatography. Documentation of linear dynamic range, precision, and carryover of volatile headspace methods on two instrumental systems

will allow the attendee to become familiar with each system. Additionally, the audience member will know how the new TMX HS 110 Autosystem compares to the older HS101 system. Data that supports the validation of the newer TMX HS110 system for use in postmortem work will demonstrate the utility of the automated headspace approach to the audience.

Headspace Gas Chromatography has been widely applied to the determination of alcohol in postmortem specimens. In 2001, the Wayne County Medical Examiner's office (WCMEO) performed 3,572 headspace confirmation analyses on multiple samples from 3175 cases. In order to facilitate this workload automated headspace autosampling is utilized within the postmortem laboratory. The authors report here on the validation of the Perkin Elmer TMX-HS110 system for use in this application.

Validation of the TMX-HS110 system was performed by direct comparison against an existing Perkin Elmer HS101 automated system. All analyses were performed under isothermal conditions on a 6' X 1/8" OD stainless steel Carbopak B 60/80 mesh 5% Carbowax 20-M column at 80°C. The injection needle and transfer line was maintained at 110°C on each instrument. Thermostat temperatures of 60°C were utilized to heat samples before headspace injection. Injection ports and flame ionization detectors (FID) were maintained at 130°C. The chromatographic flow rate of the nitrogen carrier was set at 20 mL/min on each instrument, with the fuel gases hydrogen and compressed air set at 40 and 400 mL/min respectively. Purge flows on these instruments were set to values between 5-12 mL/min.

The headspace autosampler programs were consistent on each system. Thermostat time was 15.0 min, pressurization was 0.5 min, injection time 0.08 min, and withdrawal time 0.20 min. Cycle time was 7.0 minutes and each vial was vented 1 time.

All samples were prepared for analysis by diluting 0.100 mL of specimen, calibrator or control with 1.00 mL of an aqueous n-propanol internal standard solution prepared at 0.160 g/dL concentration. All patient specimens were run in duplicate. Each batch was ran by single point calibration at values of 0.1531, 0.1580, 0.1580, and 0.1562 g/dL for ethanol, methanol, acetone and isopropanol, respectively, on both analysis systems. All standards and controls were prepared in aqueous solutions. In all cases of instrumental comparison studies the same vial set was ran on each instrument in the same sequence. Linearity studies were carried out over a range of 0.007 - 1.5 g/dL for each analyte. Precision studies were performed on both systems n = 5 at up to 5 concentrations over the linear range studied. Carryover was evaluated up to a concentration of 1.531, 1.580, 1.580 and 1.562 g/dL for ethanol, methanol, acetone and isopropanol, respectively.

Turbochrom chromatographic software was validated in parallel on the existing HS 101 analyzer against an existing LCI 100 data acquisition system on the HS 101-headspace analyzer. Data was collected simultaneously on the same sample set by both systems. Subsequent studies and comparisons between the two Headspace/ Chromatographic systems were performed using the Turbochrom chromatographic software.

Finally, three routine batches of patient samples were evaluated on each system. In each case the calibration sequence and sample vial sequence was identical. Analysis of the vial set was first on the HS 101 instrument (reference method), followed by analysis of the same vial set on the TMX HS110 system. In all linearity, carryover, precision and comparison studies, data reduction was performed by the Turbochrom software package using identical integration parameters.

Results of whole blood proficiency studies over an eight-year period demonstrated under the instrumental analysis conditions demonstrated consistency between mean target ranges and results obtained on the HS 101. A correlation coefficient of 0.9979 with a slope of 1.026 for n = 169 was defined. Additionally, each batch analysis includes a reanalysis whole blood sample ran as an in-house control which must meet reporting criteria (within 0.02 g/dL of original result).

Results of the data reduction system comparison between the LCI 100 and Turbochrom software packages on data collected from the HS 101 analyzer demonstrated correlation's of 0.9999 or better for ethanol, methanol, acetone and isopropanol. Standard deviations on this comparison ranged from 0.2 - 5.4 %. From this it was concluded that data reduction from each of these systems resulted in equivalent data.

Correlation between the data on both instruments was 0.999 or better for each analyte**.** Linearity, LOD (relative retention times (RRT) within 2% of expected value and signal to noise >/= 10:1), LOQ (RRT within 2%; concentration within 20% of target value) and ULOL data for both instrument systems was determined to be equivalent and is summarized on Table 1:

Table 1: Linear ranges for headspace method, LOD, LOQ and ULOL; Ethanol, Methanol, Acetone, Isopropanol (n = 2 at each concentration).

ANALYTE	RANGE g/mL	LOD g/dL	LOQ g/dL	ULOL g/dL
Ethanol	0.0076 - 1.531	0.0076	0.0076	1.531
Methanol	0.0079 - 1.580	0.0079	0.0079	1.580
Acetone	0.0079 - 0.395	0.0079	0.0079	0.395
Isopropanol	0.0156 - 1.562	0.0078	0.0156	1.562

Carryover evaluations of ethanol, methanol, acetone and isopropanol were determined over the linear range defined on Table 1. Carryover is noted to occur at specific concentrations documented on Table 2 at levels of 0.004 g/dL or less for all analytes.

Table 2: Carryover concentration ranges for ethanol, methanol, acetone and isopropanol.

ANALYTE	CONCENTRATION INJECTED g/dL	CARRYOVER g/dL
Ethanol	1.531	0.0018
	0.765	0.0013
	0.382 and below	None
Methanol	1.580	0.0039
	0.790	0.0018
	0.395	0.0012
	0.316 and below	None
Acetone	1.580	0.0002
	0.790 and below	None
Isopropanol	1.562	None

Precision studies performed over the linear range of the assay (n = 5 at each concentration) demonstrated accuracy within 10% of target values. All RT values were within 2% of target values. Within batch CV values over the ranges evaluated were less than 1.00, 3.60, 1.40 and 5.10 % respectively for ethanol, methanol, acetone and isopropanol. Between run, CV values as determined by ethanol controls distributed over the range of 0.050 to 0.500 gm/100 demonstrated values of 2.60 % or less. All values were within 10% of target concentrations.

Direct batch to batch comparisons (batch size n = 73, 97, and 94) between each analytical system was run on each of three separate occasions by 2 analysts. Correlation's between each set of data demonstrated linear relationships with slopes of 0.96 or better and correlation coefficients of 0.9995 or better. Differences between ethanol values on each of the two systems were at mean values of less than 1% with overall standard deviations of the mean value at 6% or less.

The data presented in this study demonstrate that the TMX HS110 system and the HS 101-headspace analyzer produce equivalent data. These instruments under the conditions defined can be used interchangeably. The WCMEO postmortem laboratory currently uses both of these systems in confirmation of alcohol findings.

Headspace Analysis, Ethanol, HS 101, TMX HS110

K7 Optimizing HPLC Separation of Antidepressant Drugs Through Stationary Phase Selection

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The goal of this educational presentation is to enhance the understanding of the separation mechanisms involved in the HPLC analysis of toxicologically relevant antidepressants.

Treatment of primary depression has traditionally been accomplished using tricyclic antidepressant drugs. Over the past five years, several new antidepressant drugs have entered the marketplace and are now some of the most widely prescribed medications.

Analysis of antidepressant drugs is typically accomplished using reverse phase HPLC combined with UV detection. While the analysis of individual compounds is relatively easy, testing for antidepressants as a class or group of drugs in a clinical setting for therapeutic drug monitoring is sometimes complicated by poor or incomplete resolution of all these compounds.

Fourteen antidepressant drugs were analyzed on three different reverse phase columns. Conditions were optimized for each stationary phase for best resolution and shortest analysis time. Chromatograms illustrating the different retention mechanisms of these reverse phase columns will be shown.

Antidepressants, HPLC, Stationary Phases

K8 Amphetamine and Methamphetamine Excretion Following Administration of Multiple Doses of the Drug Gewodin®

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Following this presentation, individuals will be able to assess urine levels of amphetamine and methamphetamine for consistency with use of this medication.

Several drugs are known to be metabolized by the body to methamphetamine and/or amphetamine that are subsequently excreted in the urine. Such drugs raise concerns with interpretation of positive amphetamine drug testing results. Gewodin (Geistlich, Wolhusen, Switzerland) is a multi-ingredient medication used for pain relief. The drug contains acetominophen, caffeine, isopropylphenazone and famprofazone. The drug is available in European countries, such as Germany but is not marketed in the U.S. Famprofazone acts as an analgesic and is the component metabolized to methamphetamine and amphetamine.

Two tablets (50 mg of famprofazone) were administered orally to five volunteers with no history of amphetamine, methamphetamine or famprofazone use. Six hours following the initial dose, a second dose was administered to each subject. This was followed on the second day by administration of two additional doses, effectively administering additional doses of the drug at six, 24 and 30 hours after the initial dose. Urine samples were collected pre-dose and then ad lib after the initial dose and continued for up to seven days following the last (fourth) dose of the drug. Urine pH, specific gravity, and creatinine values were determined on all samples as was the concentration of amphetamine and methamphetamine. Drug concentrations were determined by gas chromatography/mass spectrometry (GC/MS) following liquid/liquid extraction and derivatization with heptafluorobutyric anhydride.

A previous study using a single 50 mg dose of famprofazone showed peak concentrations for amphetamine ranged from 148 - 2,271 ng/mL and 614 - 7,361 ng/mL for methamphetamine with peak concentrations of both compounds 3 - 14 hours post-dose. Using a cutoff of 500 ng/mL, all five subjects in that study had individual urine samples that tested with some of the positive samples being detected over 48 hours post-dose. The current study found peak concentrations of 5,327 - 14,154 ng/mL for methamphetamine and 833 – 3,554 ng/mL for amphetamine. Positive samples were seen for several days following the last administration of the drug.

Interpretation of results is a critical part of forensic drug testing due to the potential repercussions to an individual. As demonstrated by the current study, a positive amphetamine test does not necessarily indicate illicit drug use. Evaluation of results with regard to those found in this study will assist in determination of the possible use of this medication as the source of methamphetamine and amphetamine, particularly when multiple administrations of the drug are alleged.

Famprofazone, Amphetamine, Methamphetamine

K9 The Analysis of LSD in Urine by Quadrupole GC/MS

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The goals of this research project are to determine a fast, sensitive method for the analysis of LSD in urine

A method has been developed by which LSD in urine is analyzed by the ThermoFinnigan Trace DSQ dual stage quadrupole GC/MS. The first quadrupole is a small, bent set of rods that greatly reduces interference from neutral noise, one of the main causes of high background and hence poor sensitivity. The main analytical rods follow the bent quadrupole. The detection and analysis of LSD can be particularly difficult do to the low detection limits required for this drug. One percent or less of the parent LSD is excreted in urine and LSD dosages are in the low microgram level, therefore a method of analysis needs to reach the low pg/ml levels of detection. This is accomplished using a strong derivatizing agent, N-Methyl-N-(trimethylsilyl)trifluoroacetamide (MSTFA), and a single ion monitoring experiment on the DSQ mass spectrometer. A calibration curve from 10 pg/mL to 500 pg/mL was run on the Trace DSQ system. A series of spiked samples in urine matrix were then extracted with solid phase extraction tubes to verify the application of the method. The collected drug was then derivatized with MSTFA and injected into the Trace DSQ system. Two microliters were injected into a split/splitless injector with a 5mm internal diameter. The volume of this liner allows for a greater injection volume without any back flash and contamination of the system. Due to the low levels required for this analysis, a full scan analysis cannot be used. Single ion monitoring allows the quadrupole to analyze one ion at a time and therefore increase the sensitivity of the analysis. The DSQ mass spectrometer was programmed for a multi ion SIM experiment. Three ions were selected, one ion for quantitation and the other two for confirmation. This paper shows that this method is able to reach the low levels required for the routine analysis of LSD in urine.

LSD, GC/MS, SIM

K10 Training in Gas Chromatography

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The participants will know the training program for gas chromatography in the Forensic Toxicology Laboratory, Office of the Medical Examiner, Cook County.

The Office of the Medical Examiner, Cook County hired recent college graduates as analysts in the forensic toxicology laboratory.

Training began with quantitation of drugs using gas chromatography (GC) with nitrogen phosphorus detector (NPD) and/or flame ionization detector (FID). Each trainee was assigned to his/her own Agilent 6890 GC. Each trainee was trained initially on either GC/NPD or GC/FID. Diphenhydramine, with dexbrompheniramine as the internal standard, was used for the GC/NPD training. Acetaminophen, with aprobarbital as the internal standard, was used for the GC/FID training.

Our program is as follows:

(1) Overview of the laboratory procedures including specimens accession, limited access storage areas, chain of evidence, case assignment, batch number system, standard/control, specimen extraction, GC analysis, result reporting and review.

(2) Operation of the Eppendorf pipets.

(3) Operation of the analytical balance.

(4) Calibration of the Eppendorf pipets.

(5) Explanation of the extraction theory, the extraction procedure and the internal standard method.

(6) Observation of the performance of a liquid/liquid extraction.

(7) Preparation of trainee's standard and control solutions.

(8) Operation of the pH meter.

(9) Preparation of trainee's buffer solution.

(10) Math test, which covered the dilutions and the arrival of extraction final concentrations.

(11) Supervised extraction of the compound of interest, with the trainee's standard and with the laboratory's standard, each in triplicate spiked in water.

(12) Explanation of the GC theory.

(13) Demonstration and practice of the GC turn on procedure, the GC performance check and the GC turn off procedure.

(14) Instruction and practice on the creation of a GC method.

(15) Instruction and practice on the preparation and running of a GC sequence, using the batch previously extracted in step 11.

(16) If good recovery and good reproducibility were achieved, the trainee would learn how to complete the paper work, otherwise, the process was repeated until satisfactory.

(17) Trainee was required to duplicate the good recovery and good reproducibility from a second batch of step 11, with minimal supervision.

(18) To extract and load on GC a batch consisting of the compound of interest, with the trainee's standard and control, as well as the laboratory's standard and control, each in duplicate spiked in water, with no supervision. Good recovery and good reproducibility were the completion criteria.

(19) To extract and load on GC a batch consisting of the compound of interest, with the laboratory's standards as calibrators, and the trainee's standards as samples. Water was the matrix. Completion criteria were acceptable calibration and the results of the samples within +/- 20% of the expected value.

(20) The trainee was required to duplicate step 19.

(21) To extract and load on GC a batch consisting of the compound of interest, with the trainee's standards and controls spiked in water. Completion criteria were acceptable calibration, acceptable positive control (+/- 20% of the expected value) and acceptable negative control (no presence of the compound of interest).

(22) The trainee was required to duplicate step 21.

(23) To extract and load on GC a batch consisting of the compound of interest, using the trainee's standards and controls spiked in water, as well as negative blood spiked with the trainee's standard in one concentration in triplicate, as samples. Completion criteria were acceptable calibration, acceptable positive control (+/- 20% of the expected value), acceptable negative control (no presence of the compound of interest), and 2 out of 3 bloods acceptable (+/- 30% of the expected value).

(24) The trainee was required to duplicate step 23.

(25) To extract and load on GC a batch consisting of the compound of interest, with the trainee's standards and controls spiked in water, as well as negative blood spiked with trainee's standards in three different concentrations, each in duplicate as samples. Completion criteria were acceptable calibration, acceptable positive control (+/- 20% of the expected value), acceptable negative control (no presence of the compound of interest), and all 3 bloods acceptable (duplicate results within +/- 10% of their average).

(26) The trainee was required to duplicate step 25.

(27) Successful completion of duplicate sets of 4 unknowns using the trainee's standards and controls spiked in water.

(28) To extract and load on GC a batch consisting of the compound of interest, with the trainee's standards and controls spiked in negative blood. Completion criteria were acceptable calibration, acceptable positive control (+/- 20% of the expected value) and acceptable negative control (no presence of compound of interest).

After successful completion of the above program, the trainee was certified to use the GC with the specific detector she/he was trained on. The newly certified analyst would be assigned to do case work. Initially, the assignment would consist of the quantitation of a single compound. Gradually, the difficulty of the quantitation would increase. All of their work was to be reviewed by themselves, a supervisor and the chief toxicologist.

Cross training between the two GC detectors involved step 13 and the successful completion of step 21, using laboratory standards and controls. The analyst was trained on GC trouble-shooting and maintenance as the situations presented themselves. They included, but not limited to, maintenance on injector port, column, detector, gas line trap, ChemStation disk, as well as handling chromatography separation problems.

After they gained more experience on the GC quantitation, they would be trained on how to do a dual column GC screening procedure. All GC analysts were trained, and their work reviewed by one person. This was intended for consistency and continuity.

Each GC analyst was paired with a GC/MS analyst. The GC/MS analyst would confirm/rule out the positive GC result quantitated by her/his partner. The GC/MS analyst would explain the GC/MS result, therefore, served as a mentor to her/his GC partner. This was intended for inspiration and possible GC/MS training in the future.

Gas Chromatography, Training, Toxicology

K11 Parameters Optimization Associated With the Analysis of Methylenedioxymethamphetamine (MDMA) and Related Compounds in Biological Matrices

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The learning objectives of this presentation are to characterize and evaluate parameters that are pertinent to the analysis of methlenedioxymethamphetamine (MDMA) and related compounds in biological specimens.

With increasing report on MDMA abuse and required analysis, a systematic evaluation on parameters associated with the analysis of MDMA and related compounds is undertaken, including methylenedioxyamphetamine (MDA), amphetamine (AM), and methamphetamine (MA). Parameters studied included (a) three solid-phase adsorbents; (b) five derivatization reagents; and (c) four deuterated internal standards.

Ions resulting from the use of various derivatization reagents that are potentially useful for selected-ion-monitoring (SIM) for qualitative

and quantitative determination of MDMA, MDA, MA, and AM are listed in Tables 1 and 2. TMS- and TCA-derivatives do not generate adequate number of qualified ion-pairs as required in common SIM practice. Among those generating adequate number of qualified ion-pairs, HFB-derivatives appear to produce higher ion intensities (ionization efficiencies). Some of the ion-pairs selected from the HFB-derivatives have low relative intensities in their respective spectra; however, this unfavorable factor appears to be adequately compensated for by the enhanced ionization efficiency and desirable limits of quantitation and detection still can be achieved.

HFB-derivatives of the analytes and internal standards were used to evaluate the effectiveness of internal standards. Ions adapted to designate MDMA/MDMA-d_5, MDA/MDA-d_5, MA/MA-d_8, and AM/AM-d_8 are: *m/z* 254/258, 162/167, 254/261, and 240/243. Integrated SIM intensities of these ions are used for further statistical analysis. In this study, four sets of standard solutions containing all four compounds at five low concentrations (2, 5, 10, 20, and 40 ng/mL) were prepared with all four internal standards (10 ng/mL). Another four sets with analytes at higher concentrations (100, 250, 500, 1000, and 2000 ng/mL) were also prepared (internal standard concentrations = 500 ng/mL). The first set of the four was first used as the calibrators for the calculation of analyte concentrations in the other three sets. The same process was followed by using the second, the third, and the fourth sets as the calibrators. This same process was applied to both the low and the higher concentration sets. In these calculations, MDMA-d_5 and MDA-d_5 were sequentially used as the internal standards to calculate the concentrations of MDMA and MDA. Similarly, MA-d_8 and AM-d_8 were sequentially used as the internal standards to calculate the concentrations of MA and AM. Statistical methods were then used to determine whether analyte concentrations resulting from the use of different internal standard were statistically different. Relevant statistical data are shown in Table, while the interpretation of these data are summarized in Table 4. Further studies are currently in progress to further understand the performance characteristics exhibited by the AM/MA and the MDMA/MDA pairs. These characteristics will be evaluated along with what has been observed [1] in an earlier study on the barbiturate system.

1. Liu RH, McKeehan AM, Edwards C, Foster GF, Bensley WD, Langner JG, Walia AS: Improved gas chromatography/mass spectrometry analysis of barbiturates in urine using centrifuge-based solid-phase extraction, methylation, with d_5-pentobarbital as internal standard; *J Forensic Sci* 39:1501–1514; 1994.

MDMA, MDA, Internal Standard

K12 Putting an Ecstasy Test Kit to the Test

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The learning objective of this presentation is to evaluate the reliability of the DanceSafe™ Ecstasy Testing Kit.

There has been a significant rise in the use of the club drug MDMA (3,4-methylenedioxymethamphetamine), or Ecstasy, over the past few years. Coupled with this increase in use is a rise in emergency room visits and deaths attributed to the drug. Unfortunately, many Ecstasy users feel that MDMA is a safe drug and that the problems associated with its use primarily result from contamination with other chemicals or wholesale substitution of MDMA with more dangerous drugs. As a result of this widespread belief and the media attention in the U.S., there is an ongoing effort among harm reduction organizations to provide colorimetric test kits to differentiate between substituted and authentic Ecstasy. Until recently, these kits consisted only of the Marquis reagent, a reagent routinely used by law enforcement agencies and crime laboratories. In an attempt to resolve the ambiguity in interpreting results when using the Marquis reagent as a single test, some organizations such as DanceSafe™ (www.dancesafe.org), have recently updated their test kit by adding two additional colorimetric tests, the Mecke and Simon's reagents.

As with most colorimetric methods, the interpretation of these qualitative tests is highly subjective. The danger here is two-fold. First, the users of the test are typically young and generally inexperienced with the testing procedures. Second, the tests themselves cannot reliably differentiate MDMA from other chemically-related phenethylamines, as well as other drugs.

The MDMA test kits containing the Marquis, Mecke, and Simon's reagents were purchased from DanceSafe and evaluated in a controlled laboratory setting utilizing three independent analysts. Thirty-nine tablets obtained for this portion of the study were street-grade Ecstasy tablets currently held as evidence in cleared cases from the Alachua County (Florida) Sheriff's Office and from the Forensic Toxicology Laboratory at the University of Florida. Using the instructions provided by DanceSafe, the Marquis reagent was judged alone and in combination with the Mecke and Simon's reagents. The identities of the tablets were confirmed by gas chromatography/mass spectrometry (GC/MS) operated in full-scan mode.

All three analysts generally agreed on the final identity of the tablets, although they did not agree on the colors observed. Two testers recorded four negative results, and one tester recorded 3 negative results, and 1 weakly positive result. Based upon GC/MS analysis, all 35 positive samples contained MDMA; however 8 were adulterated with other drugs including caffeine, ephedrine/pseudoephedrine, amphetamine, diazepam, and paramethoxymethamphetamine (PMMA). The four samples that tested negative were identified by GC/MS as alprazolam, ephedrine/pseudoephedrine with guaifenesin, ephedrine/pseudoephedrine with caffeine, and a tablet containing no identifiable drug (considered weakly positive by one tester).

Because the tablets held in evidence were known to contain controlled substances, and hence represented a biased selection, a follow-up evaluation was conducted. This part of the study consisted of two testers who were professionals knowledgeable in the field of toxicology, but inexperienced with the practical use of test kits. The testers were given the DanceSafe Test Kit and eight blinded samples. When tested, samples containing codeine, dextromethorphan, dihydrocodeine, ketamine, MDMA (2 each), morphine and d-norpropoxyphene produced many false positive and false negative results.

In addition to the disagreement between testers' conclusions and the inadequacy of the test results themselves, participants in all tests noted numerous problems with the kits. These problems included the inconsistency between the color charts provided in the instruction booklet and the actual colors observed during testing, the variation in the intensity of the color changes, and the variation in the rate of the reactions. It is also important to correlate these findings with the reality that these tests were designed for untrained personnel in an uncontrolled environment. Some potential issues include the lack of control samples provided for comparison, the lack of optimal lighting, the ambiguity in the written directions provided with the kits, the mental state of the user when reading the tests, the leakage of the cap seals after use, and the unpredictable drop times often leading to impatience and chemical spills. The latter issue creates an obvious danger from the reagents themselves because each one contains toxic and/or corrosive substance(s). Finally, accidental mixing of the reagents can be extremely hazardous.

In conclusion, these color tests are inadequate for use as harm reduction tools, especially in the hands of inexperienced users. If the goal of harm reduction is to reduce or minimize the risks associated with drug use, on no occasion in this study did the findings lead to avoidance of a contaminated drug. These tests have the potential to provide a false sense of security, encouraging the consumption of tablets whose composition is in question. There are potential consequences of ingesting a preparation containing a toxic ingredient, yet thought to be "pure" MDMA. Further, occasions occurred where the test reagents themselves caused injury to the tester or damage to the surroundings. While these types of tests may have a place in the hands of experienced personnel for forensic purposes, a decision on whether or not to ingest a tablet should not be made solely on the basis of these tests.

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Ecstasy, MDMA, DanceSafe Test Kit

K13 Oxycodone-Related Deaths in Delaware

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Attending this presentation will enable the participant to learn about: 1) the action of oxycodone; 2) a sensitive method for the analysis of oxycodone; and 3) the concentrations of oxycodone in postmortem specimens.

Oxycodone is a semisynthetic opioid analgesic derived from codeine that is indicated for the management of moderate to severe pain. Trade names for oxycodone containing preparations include Roxicodone, Percodan, Percocet, Roxicet, and Tylox. More recently, oxycodone has become available as a time release preparation (Oxycontin). The effects of oxycodone include euphoria, analgesia and sedation and it has a dependence liability similar to morphine. The typical adult dose (immediate release formulations) is 2.5-5 mg every 6 hours, although doses of 10-30 mg every four hours may be used for more severe pain. Extended release formulations are generally administered in doses of 10-80 mg every 12 hours. Therapeutic concentrations have been reported up to about 100 ng/mL.

The number of oxycodone-related deaths in Delaware has increased over the past 2 years. As a part of this study, blood and tissue specimens were analyzed for the oxycodone related deaths received from January 2001 through July 2002. Specimens were analyzed for oxycodone solid phase extraction (SPE) followed by gas chromatography-mass spectrometry. Briefly, the sample preparation procedure included deproteination, derivatization with hydroxylamine, SPE and derivatization

with BSTFA. Quantitation was performed using a 6-point calibration curve with d3-oxycodone as the internal standard. The limit of quantitation for oxycodone was 20 ng/mL. The heart blood, peripheral blood and liver oxycodone concentrations from 8 of these cases are summarized in the table below.

Case 1: A 29-year-old white female with a history of spinal fusion reported to the ER in a confused, emotionally labile state that progressed to somnolence and a coma. She received medical clearance from the ER to be transferred to a psychiatric hospital. She remained comatose and was found dead in her bed the next morning at the psychiatric facility. Thirteen "OC 40" pills were recovered from her gastric contents.

Case 2: A 57-year-old white female was found dead in bed at home. She had an extensive cardiac history.

Case 3: A 42-year-old white male was found unresponsive on the kitchen floor after an evening of heavy drinking at a bar the night before. He reportedly was offering "Oxycontin" tablets to other patrons at the bar.

Case 4: A 45-year-old white male was found dead on a couch. He had a history of alcohol and cocaine abuse. No cause of death was determined at autopsy.

Case 5: A 29-year-old white male was found dead in bed after an evening of playing games and drinking. His history included a renal transplant 2 years earlier, hypertension and diabetes mellitus.

Case 6: A 59 black female was found unresponsive in bed. She had reportedly not been feeling well for 3 weeks and refused to go to the hospital. She had a history of Hepatitis C, cirrhosis and mental status changes.

Case 7: A 50-year-oldwhite female complained of shortness of breath prior to collapsing and becoming unresponsive. She had a history of obesity and hypertension.

Case 8: A 39-year-oldwhite male who was found dead in bed. He had a history of chronic pain and had been diagnosed with Guillain-Barre neuropathy. His body was embalmed prior to examination.

The overlap between non-fatal and fatal oxycodone concentrations in the cases summarized above, as well as in additional oxycodone-related cases received at the State of Delaware OCME, has made interpretation somewhat complex. However, these data suggest that low concentrations of oxycodone in combination with alcohol and/or other drugs can cause death. In addition, the analysis of peripheral blood and tissue specimens demonstrated that postmortem redistribution did occur in some of the oxycodone-related cases.

Oxycodone, Postmortem, Distribution

K14 Evidence of Single Exposure to GHB Through Hair Analysis by GC/MS/MS

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The goal of this presentation is to demonstrate that by using segmental hair analysis and tandem GC/MS, it is possible to document a single exposure to GHB in a case of drug facilitated sexual assault.

Gamma-hydroxybutyric acid, or GHB is a substance naturally present within mammal species. Properties of neurotransmitter or neuromodulator are generally given to this substance. GHB is therapeutically used as an anaesthetic, but can be used for criminal offences (date-rape drug).

It appears that the window of detection of GHB is very short in both blood and urine, and therefore its presence very difficult to be documented after a rape case.

In order to document a single exposure, the interest of hair was investigated.

Hair was collected 1 month after the allegated event, in order to sample the corresponding period after regular growing.

After decontamination with dichloromethane, the hair shaft was cut into 3 mm segments. They were overnight incubated in 0.01N NaOH in presence of GHB-d_6, followed by neutralization and extraction in ethyl acetate under acidic conditions. GHB (parent ion m/z 233, daughter ions m/z 147 and 148) was tested by GC/MS/MS (Finnigan TSQ 700) after derivatization with BSTFA + 1% TMCS.

Responses for GHB were linear in the range 0.2 to 20 ng/mg. From 3 independent calibrations, the correlation coefficients ranged from 0.989 to 0.998.

The within-batch precisions were 11.8, 10.4 and 8.9 %, as determined by analyzing 8 replicates of 5 mg of hair obtained from the 3 subjects with GHB concentrations at 0.66, 1.30 and 2.45 ng/mg, respectively.

The extraction recovery (n = 3) was determined to be 81.8 %. The limit of detection of GHB was 0.1 ng/mg, using a 5 mg sample. This limit of detection can be improved by using a larger amount of hair. The limit of quantitation was the first point of the calibration curve, that is 0.2 ng/mg, below the endogenous levels.

Physiological concentrations (n=24) were in the range 0.5 to 12.0 ng/mg, with no influence with hair color.

Mean measured concentration were 2.21 +/- 0.57 and 2.47 +/- 0.69 ng/mg for males and females, respectively. The same results were obtained between hair samples of different colors (black, n=10 : 2.37 +/- 0.68 ng/mg; brown, n=6 : 2.21 +/- 0,71 ng/mg; blond, n=8 : 2.44 +/- 0.39 ng/mg).

No variation of concentrations was observed along the hair shaft in controlled subjects, excepted for the proximal segment, due to an incorporation through sweat.

A controlled human administration of 25 mg/kg to a volunteer demonstrated that a single exposure to GHB is detectable in hair after segmentation.

In a case of rape under influence, a clear increase of the corresponding segment (about 2.4 ng/mg) in time was observed, in comparison with the other segments (0.6-0.8 ng/mg). Hair color of the victim was brown and the result was not challenged by the rapist, who was arrested several days after the assault.

This study demonstrates that a single exposure to GHB in a case of sexual assault can be documented by hair analysis when collected about 1 month after the crime.

Fig: Hair segmentation in a case of GHB facilitated sexual assault
* : approximate time the assault occurred

GHB, Rape, Hair

K15 Rapid Screening of Psychotropic Drugs, Metabolites in Body Fluid and in Adulterated Liquor by Ion Mobility Spectrometry

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Rapid analysis and detection of diazepam and its metabolite in body fluids, which is of forensic importance, could be used in direct case/criminal examinations in forensic laboratories.

The misuse of psychotropic drugs by people is a common phenomenon. Diazepam is a drug belonging to the class of 1,4-Benzodiazepins. Its extensive use in therapeutics as a sedative, hypnotic, tranquilizer and muscle relaxant drug has also led to its misuse as a street tranquilizer and liquor adulterant. Owing to the synergetic action of diazepam when it is taken in combination with alcohol, it has recently come to replace chloral hydrate as an adulterant in alcoholic liquors. Diazepam is covered under the narcotic drugs and psychootroppic substances act (2), and its use in alcoholic liquors is prohibited. Samples of such abuse cases are frequently been submitted to labs for identification of tranquilizer with the aim to give correct treatment to the patient and law enforcement agencies to reach at the conclusion and putting the case to courts of law. The law enforcement agencies in the field are finding it difficult to identify diazepam and its over dosage in liquor adulterant cases on the spot and therefore have to necessarily send the exhibits of body fluids and the adulterated country liquor bottles on the spot and therefore have necessarily send the exhibits to forensic science laboratory for analysis. A wide literature survey was conducted on the field identification of diazepam. Diazepam can be detected using Cobalt (II) thiocynate acidified with orthophosphoric acid resulting the formation of intense emerald green colour. All this exercise requires rapid, sensitive and accurate analysis by the analyst.

Keeping this in view, the authors have developed and described the method based on "Ion Mobility Spectrometry" to detect diazepam and its major metabolite Desmethyl diazepam (nordiazepam) which is present in liver, kidney of viscera of the dead body. The Used urgent need for the development of simple, presumptive field and screening techniques useful for law enforcement officers and mobile forensic science laboratories, for the detection of diazepam and its metabolite. The technique "Ion Mobility Spectrometry" has been developed and detected in the form of Plasmagram which was reported in this communication. It can be used for the identification of various drugs such as Cocaine, Herion, methaqulone, etc., as well.

Tranquilizer, Ion Mobility Spectrometry, Diazepam

K16 A Rapid Method for the Determination of Benzodiazepines in Postmortem Blood by HPLC-MS-MS

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Attendance at this presentation will enable the participant to learn about a new method for the qualitative determination of benzodiazepines in postmortem blood specimens by HPLC-MS-MS. This method is a comprehensive screen for these drugs and it is rapid, robust and reproducible over a wide range of concentrations.

The Forensic Toxicology Service offers a National screening and quantification toxicology service to Coroners and Forensic Pathologists, as well as to Police Forces. As a result, screening for benzodiazepines is required in a large number of postmortem specimens followed by quantification of those detected. Benzodiazepines remain the U.K.'s most commonly abused prescription drugs. Examples include diazepam (Valium), lorazepam (Ativan), nitrazepam (Mogadon - "moggies") and temazepam ("jellies," "egg"). In order to be able to offer a more rapid, reliable and robust method for their identification and quantification, a method for heir analysis by HPLC-MS-MS using a minimal amount of postmortem blood has been developed.

The analytes of interest are extracted from postmortem blood as follows: in a 2mL polypropylene tube 100□L of the blood specimen is added, 250□L of phosphate buffer (pH 7.0), 100□L of prazepam (1mg/L) as internal standard and 1mL methyl tert-butyl ether (MTBE). The contents are then mechanically mixed for 5 minutes and centrifuged for 1 minute at 12000 rpm. The top, organic, layer is then transferred to a clean 4.5mL polypropylene tube and evaporated to dryness using a Savant SpeedVac SC200 coupled to a Savant RT 4104 refrigerated condensation trap. The residue is reconstituted in 250□L of 80% methanol, vortex mixed for 20 seconds and transferred to a polypropylene auto-sampler vial. 10□L of the sample is then analyzed by HPLC-MS-MS. The total run time on the HPLC-MS-MS for each specimen is less than 4 minutes.

The analytical column used is a 15cm x 4.6mm (id) Supercosil LC-18-DB (5□m particle size) ODS column maintained at 50ºC using a Perkin Elmer series 200 column oven. Isocratic solvent delivery is achieved using a Perkin Elmer series 200 pump set at 1 mL/min. Sample injection, 10□L, is performed by a Perkin Elmer series 200 auto-injector. The mobile phase consists of methanol/water (85:15, by volume) supplemented with ammonium acetate solution to achieve a final concentration of 2 mmol/L.

Detection is by tandem mass spectrometry (HPLC-MS-MS), using a Sciex API2000 triple quadrupole mass spectrometer (Applied Biosystems). A turbo ion spray (heated electrospray) source heated to 300°C is used to introduce the sample into the mass spectrometer. A post-column splitter (10:1) is installed just before the ion spray interface. The mass spectrometer is operated in positive ionization, multiple reaction mode (MRM, MS-MS), with the resolution set to unit resolution (±0.5m/z). High purity air is used as the nebulizer gas and high purity nitrogen as the collision gas.

The Applied Biosystems Sciex Analyst software is used to control the HPLC-MS-MS, record the output from the detector, integration of peak areas and calculation of peak area. In assays requiring quantification, the Analyst software is used to calculate the peak area ratios, produce the calibration line using $1/x^2$ weighed through zero regression and to calculate the concentration of each analyte.

A reference mixture of control substances made in drug-free human blood is extracted and run with all unknown samples as part of every assay. These reference concentrations were selected as they approximate the lower levels of the respective substance in blood following their therapeutic intake, as noted from the literature. The table below presents

compounds contained in the current reference mixture, their respective final concentrations, together with the target masses used for their identification.

Drug Name	Concentration (mg/L)	Q1 m/z	Q3 m/z
Alprazolam	0.05	308.9	280.9
Chlordiazepoxide	0.50	299.9	227.1
Chlordiazepoxide Lactam	0.30	286.8	180.1
Citalopram	0.05	325.2	109.1
Clobazam	0.10	300.9	259.0
Desmethylclobazam	0.20	286.9	245.0
Desmethyldiazepam	0.20	271.0	165.1
Diazepam	0.10	284.9	153.9
Lormetazepam	0.05	345.0	289.2
Lorazepam	0.05	320.8	275.0
Loprazolam	0.05	465.2	111.3
Nitrazepam	0.05	281.9	236.0
Oxazepam	0.10	287.0	156.1
Prazepam (Internal Standard)	N/A	325.1	271.1
Temazepam	0.40	300.9	255.0

The method has performed satisfactorily for samples from cases involving either therapeutic use or overdose with these agent. Due to the high sensitivity of the instrument used, acute overdoses require reconstitution in a larger volume of solvent prior to injection. The limit of detection for the chosen analytes was better than 1/10th of the respective lower therapeutic level as analyzed in the reference mixture. The limits of detection and quantification can be improved by increasing the injection volume, from 10□L to 50 or even 100□L, if required. Following the general screen by the method described herein, the remaining extracts are analyzed by a different HPLC-MS-MS method for benzodiazepines with lower concentration ranges such as flunitrazepam.

The method described here is rapid (total run time on the HPLC-MS-MS is less than 4 minutes for each specimen), reproducible and robust and can be applied in forensic toxicology laboratories for the screening of benzodiazepines, a family of sedative hypnotic drugs commonly used and abused worldwide.

Forensic Toxicology, Benzodiazepines, HPLC-MS-MS

K17 Screening Postmortem Whole Blood for Oxycodone by ELISA Response Ratios

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The goal of this presentation is to demonstrate screening of postmortem whole blood for oxycodone using the ratio of the oxycodone immunoassay response to the response for the specimen obtained with an opiate immunoassay.

A number of cases of diversion of OxyContin® and related prescription opiate narcotics for illegal use and abuse have been in the national press this past year. As a result of the popularity of these drugs, oxycodone may be increasingly encountered in driving, abuse and overdose cases. Oxycodone and related semisynthetic thebain derivatives may be missed by general opiate screens which are weakly cross-reactive with the C6-oxy opiates and by confirmation procedures which use GC/MS Selected Ion Monitoring (SIM) parameters set for morphine and codeine. Immunoassay response ratios can be used to identify which opiate positive specimens may contain oxycodone or related opiates. By dividing the response of a second oxycodone-directed immunoassay by the specimen response in a general opiate screen immunoassay, a relative immunoassay response ratio is obtained. Oxycodone-involved cases can be indicated by response ratios above an empirical cutoff threshold. This elevated ratio indicates which specimens should be confirmed for oxycodone, oxymorphone, hydrocodone and/or hydromorphone in addition to the confirmation for morphine and codeine.

Forty-eight specimens, which were negative for opiates, and one hundred sixty seven postmortem whole blood specimens, which were positive for opiates, including sixty-six specimens known to contain oxycodone, were assayed. Specimens were diluted 1:5 with assay buffer and analyzed by both the Neogen Oxymorphone/Oxycodone ELISA and the Neogen Opiate Group ELISA (Neogen Corporation, Lexington KY). Both immunoassays are microtiter plate-based ELISAs using horseradish peroxidase-labeled drug and anti-drug antibody immobilized to the microplate wells. Spiked whole blood calibration standards, specimens, the manufacturer's EIA standard, and negative and positive synthetic urine based controls were run on each plate. For the Opiates Group ELISA, standard concentrations were 0, 1, 5, 10, 20, 50 and 100 ng/ml morphine. For Oxymorphone/Oxycodone ELISA, the spiked standard concentrations were 0, 1, 5, 10, 20, 50 and 100 ng/ml oxymorphone. Diluted drug-enzyme conjugate was added to the microtiter plate wells and the mixture incubated at room temperature for 45 minutes. After incubation the plate was washed five times with wash buffer (phosphate buffer with Tween 20) using a Bio-Tek Elx50 Microplate Strip Washer (Bio-Tek Instruments, Highland park, Winoski, VT) to remove any unbound sample or drug-enzyme conjugate. K-Blue® substrate (tetramethylbenzidine (TMB) plus hydrogen peroxide) was added and after a 30-minute substrate incubation, the reaction was halted with the addition of Red Stop Solution (a non-acid peroxidase stop solution). The test was read using an Elx800 Universal Microplate Reader equipped with a 650 nm filter (Bio-Tek Instruments, Highland Park, Winoski, VT).

Calibration curves were plotted as log concentration vs the logit of the ratio of the mean absorbance at each concentration divided by the mean absorbance of the zero standard (B/B_o). The oxymorphone or morphine equivalents were estimated from the calibration curve using the ratio of the mean absorbance of the specimen to the mean absorbance of the zero standard.

The oxymorphone equivalents in ng/ml from the Oxymorphone/Oxycodone ELISA were divided by the morphine equivalents in ng/ml from the Opiates ELISA to obtain an Oxycodone/Opiates Response Ratio. This ratio was compared to the GC/MS data for all specimens and for opiate positive specimens.

Sensitivity, the true positive rate, was calculated from the tally of true positives and false negatives determined by comparison of the GC/MS findings as: Sensitivity = TP/(TP + FN). Specificity was calculated as: Sensitivity = TN/(TN + FP). Because sensitivity and specificity are probabilities, the standard error (SE*p*) is equal to SE*p* = square root [p(1-p)/n]. Receiver Operating Curves (ROC) were obtained by plotting the sensitivity at each putative response ratio cutoff vs. (1 - specificity) at that cutoff value. The positive predictive value was calculated as fp/[fp + (1-f)(1-q)] where f is the prevalence in the population to be tested, p is the sensitivity and q is the specificity.

Specimens containing oxycodone produced large responses in the Oxycodone-directed immunoassay and positive but weaker responses in the general Opiate Group immunoassay. The median response ratio for oxycodone-containing specimens was 12.9; the mean was 33.7. The

median response ratio for all opiate positive specimens **not** containing oxycodone was 0.055 and the mean was 7.3. ROC analysis was used to find an optimum response ratio cutoff value and to determine the probability that a specimen with this ratio would contain oxycodone or a related C6-oxy opiate. The optimum relative response ratio was 2.0. Specimens with a relative response ratio of 2.0 or higher had a greater than 50% probability (positive predictive value) of containing oxycodone. The sensitivity of the ELISA response ratio for the presence of oxycodone at a response ratio cutoff of 2.0 was 89.4% ± 3.8% and the specificity was 88.1% ± 3.2%.

The Neogen Opiates Group ELISA has a crossreactivity of 730% for codeine relative to 100% for morphine, 228% for hydrocodone, 35.6% for hydromorphine, 5.2% for oxycodone and 0.22% for oxymorphone. The Neogen Oxymorphone/Oxycodone ELISA has a cross-reactivity of 400% for oxycodone and 100% for oxymorphone, 30.8% for hydrocodone and 12.3% for hydromorphone; the crossreactivity with codeine is only 5.3% and for morphine 1.7%. The oxymorphone/oxycodone immunoassay has sufficient selectivity to identify OxyContin®- and other oxycodone-involved cases by using the ratio of the relative response to the Neogen Opiate Group ELISA result. Neither assay had a response within the calibration curve range with the negative whole blood specimens. However, some decomposed specimens caused false positive results with the ELISA assays. In conclusion, the Neogen Oxymorphone/Oxycodone ELISA can be used as a second immunoassay to identify which opiate-positive specimens should be confirmed for oxycodone.

Oxycodone, ELISA, Response Ratio

K18 Ultra-Fast Determination of Metformin in Plasma by Hydrophilic Interaction Chromatography: Application in a Fatal Case of Metformin Self-Poisoning

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The learning objective of this paper is to present an ultra-fast and accurate method for the determination of metformin in plasma by hydrophilic interaction chromatography on a special stationary phase. This paper will present the toxicological results, together with the clinical data in a fatal case of lactic acidosis due to a self-poisoning by metformin. The authors will demonstrate that assay of this biguanide in plasma may contribute towards the differential diagnosis of the acidosis.

Metformin (1,1-dimethylbiguanide, hydrochloride or p-chlorophenoxyacetate salt) is an oral hypoglycemic agent, widely used in France and Europe in the treatment of type II non-insulin dependent diabetes mellitus. This medication is considered safe if not used in the presence of contraindications. Daily oral doses range from 200-1500 mg as metformine base and even at doses higher than 85 g at once, no hypoglycemia was observed. The main adverse effect at high dose is an extremely severe lactic acidosis. Describe here a fatal case of metformin self-poisoning with a severe lactic acidosis and a special ultra-fast analytical method by HydrophILic Interaction Chromatography (HILIC) with photodiode array detection.

Case report: A 42-year-old Caucasian male was admitted to hospital for confusion and acute abdominal pain. He has a ten-years history of non-insulin dependent diabetes mellitus and received metformin therapy. However because of inadequate glycemic control under biguanide in this mentally deficient patient, metformin was stopped one year ago and insulin therapy was used, together with ibuprofen and tiaprofenic acid. At the admission, the patient was conscious but confuse and he argued attempting suicide with an unknown amount of metformin. He suffered of oliguria, important dehydratation, hypothermia, hypotension, renal failure and lactic acidosis with normal glucose (pH 6.88, bicarbonate 2.9 mmol/L, lactate 27 mmol/L, creatinine 163 □mol/L, glucose 16.4 mmol/L). The treatment consisted in a mechanical respiratory support, correction of fluid deficits, treatment of hypothermia and correction of acidosis by hyperventilation. Despite these intensive care, the patient developed an acute respiratory distress syndrome, anuria and shock. He died 34 hours after admission. A blood sample was obtained just before death.

Analytical conditions : Metformin is a very little polar molecule and so is very difficult to extract by classical organic solvents and to assay by reverse phase liquid chromatography (HPLC) because of a short retention time on octyl or octadecyl hydrophobic phases. HILIC was chosen to perform a fast and accurate method to determine metformin in plasma, because this method is well suited for the separation of little polar molecules. The HILIC column (200 x 4.6 mm) contains a poly(2-hydroxyethylaspartamide)-silica stationary phase (PolyHydoxy Ethyl A, PolyLC, USA)with 5□m particules. Mobile phase was acetonitrile : phosphoric acid (65 ; 35, v/v) at pH 2.8, with a flow-rate at 1.5 mL/min. Metformin was detected by a diode array detector at 234.6 nm (Waters 996). Extraction of metformin from plasma was very easy and fast, just adding 15 □L diluted perchloric acid to 250 □L plasma in order to precipitate the proteins.

Results and discussion: The mean retention time of metformin is 2.90 +/- 0.24 min. The linearity of the method is very good from 0.1 to 400 □g/mL (r^2 = 0.99). The limit of detection is 0.02 □g/mL, the limit of quantification is 0.1 □g/mL. Recovery from plasma is excellent, reaching 99.5%. The authors verified that there is no analytical interference between metformin and other oral hypoglycemic medications (glibenclamide, glicazide, glipizide and benfluorex) : they are all eluted in the solvent front between 1.1 and 1.3 min.. Intra-day and inter-day variabilities are higher at low concentrations (cv = 20% at 0.25 and 1 □g/mL) than at higher concentrations (cv = 2% at 50, 200 and 400 □g/mL). Plasma metformine concentration was 188 □g/mL. International literature syas that therapeutic blood concentrations range from 0.75-3 □g/mL and toxic concentrations from 5-250 □g/mL. However, the prognosis of metformin poisoning mainly depends on the concurrent pathology and administration of other medications: that is what was observed in this patient (dehydratation and two non-steroidal antiinflammatory drugs

Conclusion: The best HPLC analytical solution for the determination of polar xenobiotics is to use polar stationary phase eluted with an aqueous-organic mobile phase (HILIC). This technique appears to be well suited to determine metformin in plasma and it was applied in a fatal case of metformin intoxication. The developed method is ultra- fast (less than 20 min) and accurate. As far as the symptoms of biguanide poisoning are non-specific, diagnosis of metformin intoxication may be improved by a rapid determination of the drug in blood.

Metformin, Hydrophilic Interaction Chromatography, Poisoning

K19 Analysis of Barbiturates by Fast GC: A Preliminary Study

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The goal of this paper is to present information on an evaluation of a fast gas chromatographic method developed for the analysis of barbiturates.

Fast gas chromatography (GC) has the potential to be a very useful tool in toxicological analysis by shortening retention times and increasing the overall rate of analysis. The most common techniques for achieving fast GC analysis include shortening of the GC column, raising the GC oven temperature, and increasing the GC oven ramping parameters. With these simple techniques in place, drugs can be analyzed more efficiently.

In the present study, a fast GC method was developed for the analysis of amobarbital, butalbital, pentobarbital, phenobarbital and secobarbital. The barbiturates were isolated from 1.0 mL of whole blood using CleanScreen® solid-phase extraction (SPE) cartridges (ZSDAU020) manufactured by United Chemical Technologies, Inc. Following elution from the SPE cartridge, the extracts were dried under a gentle stream of nitrogen at 40°C and reconstituted in a dilute methanolic solution (0.02 M) of trimethylanilinium hydroxide.

The extracts were analyzed using a Hewlett-Packard 6890 Series gas chromatograph equipped with a nitrogen-phosphorus detector. The inlet and detector temperatures were set at 250°C and 330°C, respectively. Helium was used as the carrier gas at a flow rate of 0.1 mL/min. Automated injections of 0.5 mL, at a split ratio of 31:1, were made onto an Agilent Technologies DB-5 (10 m x 100 mm x 0.1 mm) GC column. The initial oven temperature of 120°C was held for 0.25 min., then ramped 30°C/min. to a final temperature of 320°C for 0.75 min. The total run time was 7.67 min. These oven parameters were achieved by reducing the internal GC oven volume with the aid of an oven insert, as well increasing the GC power supply voltage to 220 V, from the standard 120 V.

A five-point calibration curve was prepared in drug-free whole blood in a range of 2.5 mg/L to 25 mg/L. Quantification was performed with barbital as the internal standard fortified at a concentration of 10 mg/L. In order to assess the intra- and inter-run accuracy and precision of the assay, control samples were prepared at 7.5 mg/L and 12.5 mg/L and assayed five-times each in three separate experiments. Finally, a correlative study utilizing specimens previously assayed by a conventional GC method was conducted.

Under the fast GC conditions described, all barbiturates eluted from the GC column within 5 min.; the total GC cycle time was 9-10 min. This increase in throughput had no effect on chromatographic performance and analyte resolution. The results of the validation studies demonstrated excellent accuracy and precision with %CV values in the range of 15% or less and % accuracy values in the range of 90% or greater. Further, correlation was good between the conventional GC and fast GC methods.

While the fast GC method has distinct advantages, mainly improved efficiency, some limitations do exist. First, poor resolution between some analytes was evident. For example, under the conditions described, butalbital and butabarbital, and hexobarbital and caffeine, _co-eluted. Similarly, high concentrations of caffeine interfered with the quantitation of phenobarbital. Another potential limitation of the fast GC method is the decreased capacity of a narrow bore GC column which may lead to column overload and reduced range of analyte linearity.

In conclusion, fast GC has great potential to become an efficient method for routine toxicological procedures in forensic toxicology laboratories. Because this method reduces the GC cycle time by nearly two-fold, it significantly increases laboratory throughput.

Fast Gas Chromatography, Barbiturates, Solid-Phase Extraction

K20 A Tale of Two Drugs in Southwestern Virginia: Oxycodone and Methadone

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The objective of this presentation is to provide forensic toxicologists and pathologists with statistical drug-related case data for a five year period from 1997 to 2001 for the drugs oxycodone and methadone. To understand patterns of oxycodone and methadone misuse and abuse and become familiar with factors responsible for absolute and relative changes in case statistical profiles over time.

The problem of prescription drug misuse and abuse contributes to significant morbidity and mortality in Southwestern Virginia. Opiate and opioid drugs are in great demand by misusers and abusers. Beginning in 1999 the Toxicology Section of the Virginia Division of Forensic Science (DFS) Western Laboratory together with the Office of the Chief Medical Examiner (OCME) for the Western Region noted a dramatic rise in drug-related fatalities involving oxycodone. The trend continued through 2000 and 2001. Investigative information, drug paraphernalia recovered from death scenes, decedent history and witness statements chronicled in a substantial number of cases implicated involvement of the sustained release formulation of oxycodone (OxyContin®). OxyContin®, a single-drug entity designed for sustained release over a 12 hour period, is easily compromised by abusers to achieve a powerful morphine-like high. The drug is diverted and supplied to abusers by a number of means: Illegal prescriptions by unscrupulous physicians ("pill mills"), illicit black market sales, pharmacy thefts, fraudulent prescriptions, "doctor shopping," and diversion from sources in Mexico and Canada.

Methadone, a drug traditionally used as a heroin substitute for treating addiction, exhibited a similar increase in frequency in Western District postmortem cases over the same time period. Methadone is also prescribed in the treatment of chronic pain syndromes. The data suggests a hypothesis of a classic "supply and demand" scenario. Intense interdictive efforts by law enforcement, attention by legislative officials and widespread media attention curbed "supply" of oxycodone, but not "demand." Additionally, physicians cognizant of the controversy substitute methadone for the treatment of chronic pain syndromes formerly managed with oxycodone, more specifically, OxyContin®.

The data presented includes: the total number of Western Region drug-related deaths, cases in which oxycodone and methadone were determined to be significant in terms of cause of death and statistics in which oxycodone and methadone were determined to be present in the blood and postmortem tissues of decedents. Retrospective review of information in the DFS database and information derived from the database of the OCME for the Commonwealth of Virginia constituted the methodology of the study. OCME, Western Region certified 519 drug deaths from 1997 to 2001. Thirty-four percent (n=175) of the certifications identified oxycodone (n=82) or methadone (n=93) as being significant to the cause of death. The three-year period 1999 to 2001 illustrated increases in the total number of drug deaths and deaths attributed to oxycodone and methadone. Deaths attributable to oxycodone or methadone represented the following proportions for the period 1999-2001: Thirty-one per cent, thirty per cent and fifty-eight per cent, respectively. OCME, Western Region conducted 676 autopsies in the most recent calendar year (2001), certifying 23 per cent as drug-related (n=155). Fifty-eight per cent (n=90) identified oxycodone or methadone as primary agents in establishing cause of death. All cases

were initially screened by FPIA (Abbott TDx™) and a basic drug screen using solid phase extraction (SPE) followed by GC-NPD and/or GC-MS. Methadone was quantitated using a basic drug SPE and GC-NPD or SIM GC-MS. Oxycodone was quantitated by forming oxime/TMS derivatives and SIM GC-MS. Mean blood methadone concentrations during the 1997-2001 period were 0.28 mg/L (n=6), 0.29 mg/L (n=8), 0.36 mg/L (n=19), 0.47 mg/L (n=22) and 0.65 mg/L (n=50), respectively. Mean blood oxycodone concentrations during the 1999-2001 period were: 0.61 mg/L (n=21), 0.37 mg/L (n=27) and 0.62 mg/L (n=39), respectively.

Conclusions from the data indicate serious public health concerns posed by the misuse and abuse of prescription drugs, particularly opiate and opioid drugs such as oxycodone (OxyContin®) and methadone. Southwestern Virginia's experience in this regard is similar to reports of abuse in other geographical regions of the U.S. An initial trend in the misuse and abuse of oxycodone, principally in the form of OxyContin®, followed by alarmingly widespread misuse and abuse of methadone resulting in remarkable drug-related mortality. The potential or likelihood of abusers seeking other opiate and opioid drugs (e.g., heroin, hydrocodone, fentanyl and hydromorphone) when "supply" of oxycodone and methadone is curtailed is a disturbingly high probability.

Oxycodone, Methadone, Abuse

K21 Evaluation of Ephedrine, Pseudoephedrine, and Phenylpropanolamine Concentrations in Human Urine Samples and a Comparison of the Specificity of, DRI® Methamphetamine and Abuscreen® Online Abuscreenâ Online Screening Immunoassays

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The purpose of this study was to evaluate the ability of two amphetamine-like screening reagents to exclude ephedrine (EPH), pseudo ephedrine (PSEPHE), and phenylpropanolamine (PPA) from producing false positive screening results. The study also sought to characterize the prevalence and concentration distributions of human urine samples containing EPH, PSEPHE, and PPA that produced positive screening results for the amphetamine drug class.

Two immunoassays were evaluated DRI® amphetamines and Abuscreen® Online amphetamines. Reagents were run according to manufacturer specifications using a Hitachi Modular DDP system. Approximately 27,400 randomly collected human urine samples from Navy and Marine members were screened. All assays were calibrated using a single point, qualitative cutoff standard with the manufacturer recommended compound at the department of defense cutoff (500 ng/ml). Samples were prepared by solid phase extraction after the pretreatment with sodium periodate and addition of d11 AMP, d14 MTH, d5 MDA and d5 MDMA as internal standards for the determination of AMP, MTH, MDA and MDMA. For the determination PSEPH, EPH, and PPA (in samples which did not confirm for the presence of AMP, MTH, MDMA or MDA) a similar solid phase extraction was utilize with out pretreatment with sodium periodate and with n-ethyl-benzylamine used as the internal standard. GC/MS was used for the analysis of all samples as previously described [stout et al JAT 2002 26:XX-XX]

As previously reported, one thousand one hundred and four samples screened positive by the DRI AMP kit of which 1.99% confirmed positive for the presence of AMP, MTH, MDA or MDMA. For the Online reagent 317 screened positive of which 7.94% confirmed positive for AMP, MTH, MDA or MDMA. Eight hundred and thirty three of the non-confirming samples were confirmed for the presence of EPH, PSEPH and PPA, all contained PSEPH. The mean PSEPH concentration was 126,000 ng/ml with a range of 5,700 ng/ml to 2,500,000 ng/ml. Consistent with the relative reported cross reactivities, concentrations of samples positive by DRI only were less than those positive by both Online and DRI (DRI mean for 574 samples of 84,000 ng/ml and for 258 Online positives of 218,000 ng/ml $p<0.05$). PPA was present in 28% of the samples with a mean concentration of 18,000 ng/ml and a range of 285 ng/ml to 448,000 ng/ml. EPH was present in 30% of the samples with a mean concentration of 64,000 ng/ml and a range of 437 to 859,000 ng/ml. In 76% of samples where PPA was present it was present in concentrations greater than 10% of the PSEPH concentration. In all but 4 samples (2%), when PPA was present, so was EPH. When compared to the entire screened sample set, PSEPH was present in approximately 3%, EPH in 0.9% and PPA in 0.8% of the samples.

The results indicate that cross reactivities for EPH, PSEPH and PPA are greater than reported for these reagents. While the reagents may produce fewer false positives due to PSEPH at a cutoff of 1000 ng/ml, at a 500 ng/ml cutoff a substantial number of false positive screening results were obtained. This indicates that continued work is necessary to improve the specificity of amphetamine screening reagents particularly if lower cutoff concentrations are to be used.

The distribution of concentrations indicates that very large concentrations of EPH, PSEPH and PPA are common. The presence of PPA was striking in its prevalence in light of the removal of PPA containing over the counter products. Also PPA was present in concentrations far in excess of what would be expected from reported metabolism of PSEPH to PPA (approximately 1%). This suggests either a continued commercial source of PPA containing products or PPA as a possible substantial contaminant of some EPH and PSEPH containing products.

Immunoassay, Ephedrine, Pseudoephedrine

K22 Elimination of Ketamine and Norketamine in Urine of Nonhuman Primates After a Single Dose of Ketamine

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Upon completion of this presentation, the attendee will understand the principles of extraction and detection of ketamine (KET) and norketamine (NKET) in urine using NCI-GC-MS, 2) concentrations of KET and NKET in nonhuman primate urine after a single dose of the drug.

The general anesthetic ketamine (Ketalar®, Ketaject, Vetalar) (KET) is used in human and veterinary medicine for induction of anesthesia for short surgical procedures and routine veterinary procedures. It has also been identified as a so-called "date-rape" drug for the purpose of "drugging" unsuspected victims and raping them while under the influence of the drug. Its illicit use by teenagers in rave parties has also been reported. The objective of this paper was to study elimination of KET and its major metabolite norketamine (NKET) in urine collected from five nonhuman primates which received a single dose of KET, and to study elimination patterns to determine how long after drug administration, KET and metabolite can be detected. The data are of great

importance to law enforcement agencies and the forensic toxicology community in order to determine how long after sexual assault the urine samples can be collected from the victim to successfully prosecute the perpetrator. The aim of this study was: 1) to develop and validate highly sensitive NCI-GC-MS method for the simultaneous quantitation of KET and its major metabolite NKET in urine, 2) to analyze urine samples collected from nonhuman primates which received a single dose of KET, for NKET and KET.

Method: Urine was collected from five stumptail macaques (*Macaca arctoides*), four females (8-19 kg) and one male (17 kg) caged individually. All animals received a wash-out period of six months prior to the experiment. One urine sample was collected from each animal before KET administration. All monkeys received a single dose (5 mg/kg, IM) of KET. Urine samples were collected from each animal for 18 hours every day (excluding weekends) up to 24 days and once every four days up to 35 days.

Extraction: All urine samples (2 ml) were extracted from urine using HCX solid phase extraction columns. Five point standard curves for KET and NKET were prepared by spiking aliquots (2 ml) of negative urine. The range of the standard curves was 20-1,000 ng/ml for KET and 50-5,000 pg/ml for NKET. In addition, two levels of control urine preparations were analyzed (100 pg/ml and 1,200 pg/ml for NKET, and 40 ng/ml and 750 ng/ml for KET). To all standard, control and study samples, internal standards (D_4 NKET 1,000 pg/ml), 0.1 M acetate buffer (pH 4.5, 1 ml) and crude β-glucuronidase solution (50 ml) were added, and samples were incubated for 1.5 hours at 37°C. After incubation 1.93 M acetic acid (1 ml) and deionized water (10 ml) were added. An analytical column was conditioned with methanol (3 ml) deionized water (3 ml) and 1.93 M acetic acid (1 ml), the sample was added and the column was washed with deionized water (3 ml), 0.1 N HCl (1 ml) and methanol (3 ml). The final elution from the extraction column was achieved using methylene chloride:isopropanol:ammonia (78:20:2:, v/v/v, 3 ml). All extracts were evaporated to dryness in the stream of nitrogen, dissolved in ethyl acetate (50 ml) and transferred to autosampler vials. Dried samples were derivatized (30 min, 60°C) using HFBA (50 ml). HFBA was evaporated under vacuum and the dry residue was dissolved in ethyl acetate (25 ml).

Analytical Procedure: A Hewlett-Packard GC-MS instrument (6890 GC and 5973 MSD) operating in chemical ionization mode was used for the analysis. The column was an HP5-MS (30 m length x 0.2 mm i.d. x 0.25 mm film thickness) and the collision gas was methane maintained at an ion gauge pressure of 3.9×10^{-4} Torr. The injector temperature was 240°C, the transfer line was 280°C and the source and quadrupole were kept at 200°C and 106°C, respectively. The oven was held at 60°C for 1 min then ramped at 30°C/min to a final temperature of 310° where it was held for 3 min. The injection volume was 1 ml. The monitored ions for KET derivative were *m/z* 226 and 357, for NKET *m/z* 383 and 399, and for D_4 NKET *m/z* 387 and 403.

Results: In two monkeys KET was detected in urine up to three days after drug administration (7,070-32 ng/ml), in one up to four days (13,500-65 ng/ml), in one only on day 1 and 2 (4,000 and 70 ng/ml, respectively), and in one animal ten days after KET injection (35,000-22 ng/ml). NKET concentrations in urine ranged from 1.75 mg/ml to 63 pg/ml and it remained in urine throughout the entire 35-day study period in four out of five animals. In one monkey NKET was detected up to 31 days after KET administration.

Date-Rape Drugs, Ketamine and Norketamine, Urine, NCI-GC-MS

K23 Impaired Drivers in the Canton Bern (Switzerland) With Benzodiazepine Detections

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The learning objective of this presentation is to demonstrate that several benzodiazepines alone are causing a safety problem on the roads of Bern in comparison to people who overuse/abuse alcohol or illicit drugs.

The vast majority of DUI problems continue to come from the overuse/abuse of alcohol alone. Cannabis alone, or combined with alcohol, is the second commonest problem and it is growing. Misusers/abusers of opiates, cocaine, and amphetamines constitute the next group. This laboratory many DUI of drug cases in which benzodiazepines alone are causing driving impairment.

Methods: in this part of Switzerland protocols and procedures have been developed to aid the police initially to recognize the possibility that a person is DUI of drugs (Police report of suspected inability to drive safely) and then, to initiate a chain of events to ensure that secure forensic evidence is acquired. For DUI of drug cases the next step is the medical examination. The MD takes two blood and one urine sample and fills in the report of medical examination. In the laboratory the urine screening is performed by EMIT or in special cases by GC-MS. Alcohol is determined in the blood sample by head-space GC-FID. The quantitative determination of drugs in the blood samples is performed by GC-ECD (benzodiazepines), GC/MS (opiates, THC, THC - COOH, cocaine, EME, BE), GC-NPD, or HPLC-DAD (basic drugs). The results are reported to the legal authorities.

Using DUI cases to provide a "snapshot" of the more general drug abuse scene drug misuse/abuse is often a matter of street "fashion" with drugs of misuse changing according to whim. This is particularly true of the benzodiazepines, which are seldom misused alone. Rather they are almost invariably misused by people who misuse/abuse other drugs or alcohol. DUI cases of people who abuse benzodiazepines in combination with heroin or methadone to survive from one opiate dose to the next is observed; Cocaine or amphetamine users to get down from their high; "Self-medicators" – they use benzodiazepines to calm their anxieties. The benzodiazepines may or may not be legitimately prescribed. "Self-medicators" may combine benzodiazepines with alcohol, despite specific warnings not to do so.

DUI, Benzodiazepines, Switzerland

K24 Liquid Codeine: New Drug, Same Old Song

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The goals of this presentation are to increase the awareness of the presence and high abuse statistics of liquid codeine, e.g., cough syrup, and to emphasize the need for laboratories and law enforcement agencies to analyze for this drug and track its abuse, respectively.

There has been a significant rise in the manipulation of liquid codeine from its licit pharmaceutical use to a new drug of abuse. Its abuse has received great popularity in recent years for young minorities in the Harris County area. Songs have been written encouraging such

practices. The trend is most evident among African-American males. the laboratory has noted this trend based upon physical evidence and biological samples received from various law enforcement agencies and forensic pathologists, respectively.

The liquid codeine submitted to the Controlled Substance Laboratory has increased approximately two hundred fifty percent in both 2000 and 2001 as compared to the total for 1999. Liquid exhibits are received as bulk pharmaceutical containers, individual prescription bottles, or diluted in a variety of soda flavors. Over 90% of the typical abusers or possessors are African-American males who range in age from 16-40 years old.

In addition to this increase of confiscated drugs, the Toxicology Laboratory has witnessed an increased presence of codeine with promethazine in specimens submitted for suspected driving under the influence (DUI) and death investigation cases. Three deaths are described and two alleged DUI cases presented to the Medical Examiners Office in Harris County, TX within eight months of time.

The first postmortem case is a 29-year-old African-American male who was found dead in his recording studio. According to friends, he had been drinking cough syrup and possibly using other illegal drugs. The decedent was last seen alive in the early morning hours when everyone fell asleep. Toxicological analysis revealed codeine present at 1.74 mg/L in the blood. Phencyclidine was also present in the blood and urine. The cause of death was ruled a codeine overdose with mixed drug intoxication.

In the second case, a 61-year-old white female was found dead in her home by her daughter. She had made prior suicide attempts and was reportedly depressed. A large bottle of alcohol was found half empty near her body. Toxicological analysis of blood found toxic levels of codeine present at greater than 20.0 mg/L. The cause of death was ruled as codeine toxicity.

In the third case, a 16-year-old Hispanic male was reportedly playing "Russian Roulette" at a party at a friend's house and shot himself with a revolver he had displayed earlier. Friends asserted that he appeared to have been drinking before he arrived. Toxicological analysis revealed codeine present at 1.29 mg/L in the blood. Ethanol was also detected in the blood, urine and vitreous humor.

The abuse of codeine has also risen in driving under the influence cases. In the first case, a 19-year-old white male was stopped for a routine traffic violation. The officer detected an odor of marijuana. He also noticed the defendant to be unsteady, having red eyes and slurred speech. Laboratory analysis of urine identified codeine, promethazine, marijuana metabolite and alprazolam.

In the second DUI case, a 22-year-old black male was seen driving a badly wrecked vehicle when an officer tried to pull him over. He was evading arrest and committed several moving violations. The defendant fled on foot carrying a soda bottle with liquid, and smelled of marijuana. Laboratory analysis of the liquid confirmed positive for codeine, while analysis of the urine detected codeine, promethazine, marijuana metabolite and alprazolam.

As this laboratory system continues to analyze for codeine and other related drugs, it is noted that a substantial abuse pattern in the greater Houston area during a relatively short period of time. In accordance with the toxicological cases presented, there is a tendency of abusing other drugs in addition to codeine. Knowing the behavioral and toxicological effects of liquid codeine, the community and law enforcement agencies must be educated about the prevalence of this unsuspecting cough syrup. The authors recommend that crime laboratories incorporate standardized drug screening to include liquid codeine for drug or alcohol related incidents.

Opiates, Liquid-Codeine, Harris County Medical Examiner Office

K25 The Toxicological Significance of Tramadol in Death Investigation and Impaired Driving Cases

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After attending this presentation the participant will be able to assess the toxicological significance of a positive finding of Tramadol (Ultram®). Tramadol is a synthetic opioid-receptor agonist that exerts additional effect by inhibiting the reuptake of norepinephrine and serotonin. It has been used in the United States since 1995. Clinically it is used to treat moderate to severe pain. It is reported to have minimal abuse potential, and only mild side effects. Tramadol taken alone has been reported to be a relatively safe drug. However, due to its mode of action it could be potentially lethal when taken in excess or taken together with drugs acting on the same neurochemical or metabolic pathway.

This work was conducted as part of an assessment of the increasing incidence of analgesic drugs in the death investigation casework in the State of Washington between 1995 and 2000. Drug concentrations were assessed relative to accepted therapeutic ranges, and compared to concentrations encountered in drivers arrested for apparent impaired driving. Patterns of drugs found in combination with tramadol were assessed to identify possible pharmacokinetic and pharmacological interactions.

To perform this assessment, we obtained toxicological data from all death investigation cases in which tramadol was present, and matched it with public health data listing the certified cause and manner of death (n=72). All cases were tested at the Washington State Toxicology Laboratory for alcohol and screened for general drugs of abuse. Confirmation and quantitation of tramadol and other drugs was performed by gas chromatography/mass spectrometry. Additionally, investigative and autopsy data were obtained from the three largest counties in the state, and were used to examine the circumstances of death, and pathological features associated with a subset (n=40) of these cases. The toxicological data from a series of DUI cases occurring over the same period (n=39) were also considered This was used as a control group (living subjects) to assess postmortem drug concentrations and drug combinations. Literature on clinical trials of tramadol was also reviewed to assess normal patterns of prescribing and blood concentrations.

We observed a significant upward trend in the number of deaths certified in Washington State, involving tramadol, increasing from 5 cases in 1995, to 24 cases in 2000. The concentrations observed in death investigation cases ranged from <0.05 to 22.2 mg/L (mean: 2.06 mg/L, standard deviation: 4.02, median: 0.68mg/L). Toxicological literature states the therapeutic range to be 0.28-0.50 mg/L. For comparison, concentrations in suspected impaired drivers ranged from <0.05 to 5.36 mg/L (mean: 0.45 mg/L, standard deviation 0.94, median:0.15 mg/L). The most frequently observed manner of death was accidental (44%, 84% of which were "drug caused deaths") followed by natural (21%) suicide (18%, 77% of which were "drug caused deaths") and undetermined (12%, 92% of which were "drug caused deaths").

Tramadol was invariably ingested in combination with other drugs. In our data set there were no cases in which the cause of death was attributed to tramadol alone. Almost seventy percent of the cases were classified by the Department of Public Health as death attributed to drug(s). In those cases, other drugs were present in every instance. Morphine was the drug most frequently taken in combination with

tramadol, closely followed by amitriptyline, its metabolite nortriptyline, nordiazepam, acetaminophen, trazodone, and carisoprodol. Over half of the decedents (66% of the "drug caused deaths" and 55% of the non-drug caused deaths) were taking an antidepressant in conjunction with tramadol. Similar patterns were observed in the drivers in whom antidepressants were present in 38% of cases. There were several cases in which death was attributed to the combination of tramadol with other drugs affecting the reuptake of serotonin. These included tricyclic antidepressants, and the selective serotonin reuptake inhibitors (SSRI's) fluoxetine, and sertraline. As tramadol itself inhibits serotonin reuptake, this raises the possibility of a serotonergic crisis (e.g. serotonin syndrome) contributing to the actual mechanism of death. Another concern is a metabolic interaction between tramadol and amitriptyline, which are both metabolized by the cytochrome P4502D6 enzyme. This combination may contribute to an elevation of tramadol concentrations even with therapeutic administration.

Our data show that tramadol does appear to be a fairly safe drug when taken alone, and that patients can survive concentrations in considerable excess of the accepted therapeutic concentration, albeit with significant apparent psychomotor effects on motor skills. Patterns of prescribing of tramadol still appear to include the co-administration of drugs that may have significant metabolic or pharmacological interaction, and these should be carefully considered when interpreting postmortem toxicological data.

Tramadol, Drug Interaction, Postmortem Toxicology

K26 Simultaneous Determination of the Nerve Gases GB (Sarin) and VX and the Vesicant HD (Sulfur Mustard)

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The goal of this presentation is to present methodology for rapidly detecting exposure or contamination from the chemical warfare or potential terrorist agents, GB (sarin), VX, and HD (sulfur mustard).

The U.S. as a signatory to the Chemical Weapons Convention plans upon destroying the domestic stockpile of chemical warfare agents stored at six different sites by 2007. Some of these storage sites, such as the Pine Bluff (Arkansas) Arsenal, have substantial populations living near the demilitarization facility. In the unlikely event that an accidental release occurs, monitoring of persons potentially exposed and environmental contamination will be necessary for assessing effects on public health. The nerve gases GB (sarin) and VX are two of the chemical warfare agents currently scheduled for destruction. These toxic gases are relatively easy to synthesize and have previously been used for terrorist activities in Japan. Additionally, it is known that several rouge nations supporting terrorist activities also possess these nerve agents. The vesicant (blistering agent) HD in addition to being in U.S. stockpiles slated for destruction is also known to be in the possession of some rouge states. Therefore, having an assay for detection of these chemical agents becomes important in any forensic investigation following an incident.

GB and VX hydrolyze in the environment and are metabolized in humans by essentially identical pathways. These organophosphates form a common end product, methylphosphonic acid (MPA) which if identified would indicate that either of these agents was utilized. More specific identification was ascribed by determination of the immediate precursors to MPA, either isopropylmethylphosphonic acid (IMPA) or ethylmethylphosphonic acid (EMPA) derived from GB and VX, respectively. HD also undergoes environmental hydrolysis and human metabolism in identical manners and forms thiodiglycol (TDG) and thiodiglycol sulfoxide (TDGS). Therefore, an analysis method that can detect MPA, IMPA, EMPA, TDG, and TDGS can be utilized for multiple matrices by modifying the pre-analytical work-up.

A GC-MS method was developed that simultaneously detects MPA, IMPA, EMPA, TDG, and TDGS as their respective silylated derivatives in a 10-minute analysis. For urine analysis, 100 □L of a 1,000 ng/mL aqueous solution of d_7-IMPA and d_8-TDG was added as internal standards to 3 mL of urine. Calibrators containing 3.1, 6.3, 12.5, 25, 50, and 100 ng/mL of MPA, IMPA, EMPA, TDG, and TDGS in laboratory workers' urine were used to determine replicate urine specimens to which 0, 10, and 80 ng/mL of these hydrolysis compounds were added. Following addition of the internal standards, 1 mL of 5% HCl was added followed by extraction with 3 mL 9:1 $CHCl_3$:Isopropyl alcohol and centrifugation to separate the organic layer that was evaporated to dryness under nitrogen at 50°C. To the resultant residue was added 30 □L BSTFA and 70 □L ethyl acetate followed by heating at 75°C for 15 min. GC-MS conditions were as follows: injection volume 1 □L; injector port 180°C; interface 280°C; column, HP-1 (12m x 0.2 mm i.d.); oven program 50°C for 4 min, 40°C/min, 280°C for 0.25 min; helium flow 0.5 mL/min; SIM mode with 50 ms dwell; and EM 400 volts above daily tune. Retention times and ions (where *q* is the quantitative ion) were: EMPA, 6.02 min, *m/z* 153 (*q*), 154, 137; d_7-IMPA 6.15 min, *m/z* 154 (*q*), 171, 155; IMPA, 6.17 min, *m/z* 153 (*q*), 195, 169; MPA 6.39 min, *m/z* 225 (*q*), 226, 227; d_8-TDG 7.81 min, *m/z* 119 (*q*), 183, 168; TDG 7.83 min, *m/z* 116 (*q*), 176, 130; TDGS 8.64 min, *m/z* 166 (*q*), 117, 267.

The LOQ of the developed method was 3.1 ng/mL for all the analytes of interest and the LOD was 1.5 ng/mL. Because exposure of humans to the nerve gases and vesicant constitute unethical experimental paradigms, validation of the method will require the determination of a baseline levels of the compounds in a substantial number of non-exposed humans. TDG is known to occur at low levels in human urine as a by-product of dietary habits. Once a background-level for all the analytes is determined, a level of 2SD above the mean could be used for indicating exposure.

Nerve Gases, Vesicant, Urine Analysis

K27 A Fatality Due to Lorazepam and Morphine Intoxication During Long Term Therapy

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The objective of this presentation is to report the concentration and distribution of both lorazepam and morphine in various specimens collected from a single fatality after documented chronic high dose treatment with both drugs for 17 days.

Content: A 48-year-old male was brought to the emergency room complaining of chest pain/discomfort due to an alleged assault he had sustained. Hospital records failed to document evidence of the assault, a CT scan of the chest showed a "spot" on the lower lobe of the left lung that was described as a small pulmonary contusion. He was subsequently admitted to hospital, intubated and dosed IV with morphine, lorazepam and propofol to sedation with plans to biopsy the lung for possible pathogens. The patient had a history of active HIV with a low CD_4 count. The hospital also documented pneumonia. The patient was on HIV medications and arrived at the hospital alert and talking. Multiple biopsies, tissue cultures and other studies with special stains failed to yield the pathogens usually seen in AIDS such as pneumocystis carinii and cytomegalovirus. Antibiotics were administered for the pneumonia and the patient remained on a ventilator for the entire course of his hos-

pital stay. The original doses of morphine and lorazepam began at 2 mg per hour for both drugs and increased over the term of his hospital stay (37days) until they reached 20 mg IV per hour where they remained for his last 17 days of life. The orders regarding the increase of both drugs were to "titrate to sedation" or "to any signs of discomfort." The family had agreed to sign a do not resuscitate order, and on the last hospital day the patient was extubated and died approximately 5 hours later. Prior to extubation the dose of both lorazepam and morphine was not discontinued nor was it decreased. At autopsy the deceased was cachectic at 126 pounds and 6 feet in height. Autopsy findings were unremarkable as no cause of death could be determined, and no evidence of recent or remote blunt trauma was observed. Specimens obtained at autopsy were evaluated for the presence of drugs and alcohol. Positive toxicology results are listed in

Table 1.

	Femoral Blood	Bile	Kidney	Spleen	Vitreous Humor
Lorazepam	5.8 mcg/mL	44 mcg/mL	39 mcg/g	12 mcg/g	1.0 mcg/mL
Morphine	1.6 mcg/mL	6.6 mcg/mL	1.3 mcg/g	0.5 mcg/mL	
Metoclopramide	QNS	Positive	TNP	TNP	TNP
Trimethoprim	QNS	Positive	TNP	TNP	TNP

QNS – Specimen quantity not sufficient for analysis
TNP – Test not performed

The toxicology findings were remarkable for the presence of free lorazepam and free morphine at markedly elevated concentrations. The cause of death in this case was acute lorazepam and morphine intoxication and the manner of death is undetermined. Free lorazepam was quantitated using solid phase extraction with subsequent derivatization with MTBSTFA with 1% t-BDMCS and EI-GC/MS analysis in SIM mode. The LOD for lorazepam is 12.5 ng/mL with a linear range up to 400 ng/mL and a %CV of less than 10. The free morphine was quantitated by liquid:liquid extraction with subsequent derivatization with MSTFA and EI-GC/MS analysis in SIM mode. The LOD for morphine is 12 ng/mL with a linear range up to 1000 ng/mL. This case raises serious ethical concerns about the practice of comfort care for those patients who are not immediately terminal.

Lorazepam, Morphine, Fatality

K28 Dihydrocodeine-Related Deaths: A Ten-Year Review

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The goal of this presentation is to present a retrospective analysis of dihydrocodeine (DHC) related deaths in the Yorkshire and Humberside regions of the U.K. over the ten-year period 1991-2000, to determine the fatal concentration of the drug in such deaths and to compare the results with experience in the published literature.

DHC is a semi-synthetic opioid drug similar in structure and biotransformation pathway to codeine. It is licensed for use in the U.K. as an analgesic and antitussive drug but over recent years it has found increasing popularity as replacement therapy for heroin and morphine addicted patients, and amongst illicit drug users. Its increasing use in the treatment of opioid drug addiction is thought to relate to its short half-life (4 hrs), less severe withdrawal symptoms and relative lack of potency in comparison with methadone. In common with codeine, some of the DHC metabolites are pharmacologically active, and may contribute to the development of tolerance. Relatively few studies have been published with respect to the pharmacology and toxicology of DHC, although recent literature from the UK and continental Europe points to a general increase in drug deaths in which DHC has been a significant contributory factor. There has been a wide range in the reported DHC levels in these cases, thought mostly to be due to the synergistic effect of other drugs, varying degrees of tolerance and the genetic control of some metabolic steps.

The postmortem records of all cases in which DHC was detected on toxicological analysis were reviewed for the period 1991-2000. A total of 250 such deaths were identified and the vast majority of these cases were suspected overdoses where a full screen was routinely performed. DHC was detected in the blood in trace amounts in 12%, within quoted therapeutic levels in 47%, higher than therapeutic levels in 12% and potentially fatal levels in 29% (n = 72). In those fatalities where DHC was considered the sole or major contributor to the cause of death, the mean age was 42 years (range 16- 73 years) and there was a male predominance. The range of DHC concentrations in these fatalities was 0.4- 68.7 mg/L (mean 9.7), and in over half of the cases the concentration was less than 10 mg/L. DHC was detected in combination with alcohol and/or other drugs in all such cases and of the 70 cases where analysis of blood alcohol was performed, the level ranged from 6- 481 mg/100ml. Of the other drugs detected, the most commonly encountered were, not surprisingly opioids (63 cases). The effect of other drugs with central nervous system-depressant qualities, and the development or loss of tolerance has made a quantitative assessment of a 'fatal' DHC level problematic, and similar problems beset any analysis of opioid related deaths, nevertheless, the striking feature of this review was the marked increase in cases where DHC was detected over the study period, and, concomitantly, in the number of cases were death was attributable, at least in part, to DHC toxicity. A significant influence on these figures has no doubt been the increasing prevalence of the drug amongst illicit drug users and its increased prescription by individual physicians. The numbers of cases appear to have reached a plateau by the end of the decade, but nevertheless remain high. In fact, due to the 'targeted' nature of toxicological screening in the jurisdictions covered by this study, the true incidence of DHC-related deaths is most probably significantly under-reported, particularly with respect to road trauma, where blood alcohol is the only analysis performed in many cases.

In conclusion, this study shows that DHC has assumed increasing prominence in drug overdose deaths over the past decade. Possible over-prescription, poor supervision and increasing prevalence amongst illicit drug users are all causes for concern.

Dihydrocodeine, Opioids, Autopsy

K29 Fatal Ethylene Glycol Intoxication in the State of Maryland for the Last Seven Years

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The goals of this presentation are to present the audience with the most recent trends in the state of Maryland regarding ethylene glycol (antifreeze) intoxication, and to describe the distribution of calcium oxalate crystals in different tissues.

The state of Maryland OCME has investigated ten deaths caused by ethylene glycol (EG) intoxication in the past seven years. This incidence, in a state with a population of about 6 million people, is comparable to that of the whole country, where 40 to 60 deaths caused by EG intoxication are recorded yearly. Most cases involved intentional ingestion by adults with psychiatric illnesses, mainly depression and ethanol dependence.

EG is a relatively nonvolatile (odorless), slightly sweet tasting liquid utilized for its thermal properties, in antifreeze and coolant solutions. It has a half time of three hours and is metabolized by the liver to three major compounds: glycoaldehyde, glycolic acid and glyoxilic

acid. Oxalic and formic acids are formed in smaller amounts. Glycolic acid is the main compound responsible for the metabolic acidosis. Oxalic acid binds calcium and precipitates into calcium oxalate in tissues. As little as 100 ml EG are usually lethal in adult humans. EG has been responsible for fatal and non-fatal accidental poisoning of subjects following contamination of the water supply. An antidote for ethylene glycol poisoning, Fomepizole (Antizol, Orphan Medical Inc.) was approved by FDA in December 1997. It inhibits the formation of toxic metabolites.

Methods: The selected cases studied at the OCME were death was due to EG intoxication in a seven year period, and reviewed the clinical and demographic characteristics of the subjects, together with the scene investigation and autopsy findings, including toxicology and histology. Ethylene glycol may be determined in tissues by calorimetric method. The gas chromatographic method was used in the study. Both, the gas and liquid chromatography, such as High Performance Liquid Chromatography (HPLC) are more specific methods for quantitation of ethylene glycol and glycolic acid and confirmation of the diagnosis.

Results: There were eight men and 2 women, aged 13 to 73 years. Scene investigation suggested the possibility of EG ingestion, and this was confirmed by toxicologic analysis performed at the Medical Examiners Office or hospital (7 cases), and microscopic findings and scene investigation (3 cases). All cases indicated oral ingestion, and the manner of death was ruled as suicide in six cases. The manner of death was ruled as undetermined in four cases due to lack of a strong evidence for a suicidal attempt. Less than half of the suicide cases wrote a note of intent (comparable to the experience with other methods of suicide). Five subjects had clinical depression and four were ethanol abusers as well. One subject had schizophrenia. Autopsy showed nonspecific findings, with brain swelling present in some individuals. EG level in blood ranged from 0 mg/dl to 1700 mg/dl (mean = 266.91 mg/dl, median =43.9 mg/dl). Calcium oxalate crystals were visualized in the histologic sections of the kidney in all subjects. Similar crystals were seen in sections of the brain and rarely of lung and other tissues in some individuals.

EG Intoxication is an uncommon but recurring method of suicide. EG is a toxic, inexpensive and easy to obtain material. In the experience, EG is rarely, if at all, involved in domestic accidental deaths in either adults or children. Although the presence of oxalate crystals in the kidney has been reported in the literature, the presence in the brain and other tissues has not been so widely recognized.

Ethylene Glycol, Calcium Oxalate, Intoxication

K30 Gabapentin, A Novel Adjunctive Agent: Case Review of Twenty-Two Postmortem Toxicology Investigations

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This presentation will discuss the clinical uses and role of gabapentin in postmortem forensic toxicology.

Gabapentin (Neurontin) is indicated as an adjunctive antiepileptic drug (AED). It has been in clinical use since 1993 for the treatment of complex partial seizures. Although conventional AEDs such as carbamazepine, phenytoin and valproic acid continue to be the mainstay of clinical management, new generation therapeutics like gabapentin have emerged as useful adjuncts with low interaction potentials and improved tolerability. Gabapentin is not metabolized and does not bind to plasma proteins. Elimination of unmetabolized drug occurs via the renal route which likely accounts for the lack of hepatic drug interactions that are common to some of the other new anticonvulsant drugs (felbamate, lamotrigine and topiramate).

Gabapentin is a novel antiepileptic agent that binds to voltage-dependent calcium channels. However, the exact mechanism of action is somewhat elusive. Gabapentin was originally indicated for the treatment of partial epilepsy, but recent investigations into the adjunctive potential of gabapentin have resulted in more widespread use for other disorders including pain management, psychiatric illness and bipolar disorder. A review of the literature indicates potential uses for movement disorders, migraine prophylaxis and cocaine dependence.

Since the 1990s, gabapentin emerged as an alternative chronic pain treatment. It is used for the management of diverse symptoms associated with neuropathic pain in combination with other therapeutic agents. In particular, gabapentin is reported to increase the analgesic effect of morphine, indicating a pharmacodynamic interaction. Morphine pharmacokinetics are apparently unaffected, but gabapentin concentrations are reported to increase when used in combination with the opiate, indicating a pharmacokinetic effect.

The pharmacodynamics of gabapentin are not well understood, but studies have shown that in combination with morphine, it blocks dopamine release from the nucleus accumbens, and as a result, may have some clinical utility for the treatment of opioid dependence. There have been relatively few reports of drug interactions or toxicities associated with gabapentin. However, the correlation between blood concentration and clinical efficacy is unclear. This, in combination with the increased use of the drug as an adjunct for the treatment of nonepileptic disorders warrants further pharmacological investigation.

A total of twenty-two medical examiner cases involving gabapentin were reviewed. Postmortem blood concentrations ranged from 3 – 130 mg/L and all but one case involved multiple drug use. Case histories and toxicology results were consistent with adjunctive therapy for seizure and pain management. Common combinations included concomitant use of gabapentin with opiates (n=14), selective and nonselective serotonin reuptake inhibitors (n=13) and benzodiazepines (n=11). The majority of cases were attributed to accidental death. Case histories and toxicological findings are reviewed.

Gabapentin, Postmortem Toxicology, Blood

K31 A Case of Fatal Difluoroethane Intoxication

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Attending this presentation will enable the participant to learn about the analysis of difluoroethane and its tissue distribution in a postmortem case.

1,1-Difluoroethane (DFE, halocarbon 152A, Freon 152) is a colorless, odorless gas that is used as a cooling agent, in aerosols and in the manufacture of other chemicals. Inhalation of DFE can produce coughing, shortness of breath, pulmonary edema, headache, dizziness and loss of consciousness. The intentional abuse of DFE for its intoxicating effect has been reported.

A case was received at the State of Delaware Office of the Chief Medical Examiner involving the intentional abuse of DFE. The decedent was a 34-year-old white male found in a prone position in a concrete drainage culvert with a head injury and his face partially submerged in water. An empty can of dust-off was found under the decedent's leg. Further investigation of the scene revealed a Walkman, cigarettes and 13 empty cans of cleaning duster spray. At autopsy, mul-

tiple specimens were collected including heart blood, brain, liver, bile, urine, gastric contents and vitreous humor. Specimens were stored in sealed polypropylene specimen cups at 4°C until analysis. In addition, a 10-mL aliquot of heart blood was sealed in a 20-mL headspace vial and frozen until analysis for DFE. Routine toxicological screening of heart blood and urine for alcohol and drugs of abuse yielded negative results.

It was learned from the decedent's father that the decedent had a long history of drug and alcohol abuse and for about the past year he had been abusing inhalants. Two different brands of cleaning duster spray were found at the scene, one containing DFE and the other containing 1,1,1,2-tetrafluoroethane (TFE). Analysis of DFE and TFE standards and the decedent's heart blood by gas chromatography-mass spectrometry indicated only the presence of DFE in the decedent's heart blood. Multiple postmortem specimens were analyzed for DFE by dual column (Restek BAC1 & BAC2) headspace gas chromatography with flame ionization detection. Quantitation was performed with a 9-point calibration curve ranging from 0.8 mg/L up to 204 mg/L DFE using n-propanol as an internal standard. A stock DFE standard was prepared by weighing DFE into 5 mL of methanol in a sealed 20 mL headspace vial. After determination of the methanol-air partition coefficient for the DFE in the vial, the concentration of the stock standard was calculated. Calibrators were prepared by spiking blank blood with the stock standard. Quality controls at concentrations of approximately 4, 40 and 400 mg/L were included with each batch. Blood, vitreous, urine, bile and gastric contents (0.1 mL) were diluted with internal standard solution (1.0 mL) and sealed in a 20-mL headspace vial. Tissue specimens were homogenized with internal standard solution and added to a 20-mL headspace vial. The concentration of DFE in the various specimens analyzed are summarized in the table below:

Specimen	DFE (mg/L or mg/kg)
Heart Blood	413
Vitreous Humor	342
Brain	133
Liver	91
Bile	256
Urine	104
Gastric Contents	272

Interpretation of the quantitative results for DFE is made difficult by the lack of published clinical or postmortem data for DFE. In a single published case report, blood concentrations of 78 mg/L and 35 mg/L DFE were reported in a driver and a passenger involved in a fatal automobile accident [1]. The presence of high concentrations of DFE in the decedent's heart blood and tissues and the evidence collected at the scene in this case suggest that the decedent was inhaling DFE from the cleaning duster spray close to the time of his death. It is suspected that he lost consciousness due to his intoxication with DFE, causing him to fall and strike his head, ultimately landing with his face submerged in water. The cause of his death was ruled inhalation of difluoroethane complicated by blunt force head injury and drowning. The manner was ruled undetermined due to the unknown cause of the head injury.

1. Broussard LA, Brustowicz T, Pittman T, Atkins K, Presley L. Two traffic fatalities related to the use of difluoroethane. *J Forensic Sci* 1997;42(6):1186-1187.

Difluoroethane, Analytical Toxicology, Postmortem

K32 Coexistence and Concentration of Ethanol and Diazepam in Postmortem Blood Specimens

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The objective of this presentation is to present toxicological results from the analysis of postmortem blood specimens and to discuss the potential for toxic interactions between two of the most commonly used psychoactive drugs, namely ethanol and diazepam.

Serious drug interactions involving alcohol are not uncommon and these have accounted for many fatal poisonings. The combined effect of alcohol and barbiturates was notorious and these two central nervous system (CNS) depressants caused countless deaths by accidental overdose and by suicide. Another dangerous drug-alcohol combination arises with the pain-killer propoxyphene. Even drugs from the benzodiazepine group, such as diazepam and flunitrazepam, despite their reputation of low toxicity in overdose have been implicated in many deaths, especially when used together with a large dose of ethanol.

Notwithstanding the difficulties in interpreting the results of postmortem drug concentrations, owing to the many factors that must be considered, the authors evaluated the coexistence and concentrations of ethanol and diazepam in postmortem femoral venous blood samples. The toxicological results are discussed in relation to the pharmacology of ethanol and diazepam and the risk for toxic response when these CNS agents are taken together.

We located 234 autopsy cases when ethanol and diazepam with or without its primary metabolite nordiazepam were the only drugs present. All blood specimens were taken from a femoral vein and the analytical toxicology was done at one central laboratory, the National Laboratory of Forensic Toxicology (Linköping, Sweden). The concentration of ethanol in blood was determined by headspace gas chromatography on two different stationary phases and the mean concentration was reported with a limit of quantitation (LOQ) of 0.01 g% in routine casework. Diazepam and its metabolite nordiazepam were determined simultaneously in whole blood by capillary column gas chromatography after solvent extraction without derivatization. The GC instrument was fitted with a N-P detector and the method LOQ was 0.03 mg/L for both diazepam and nordiazepam.

The distributions of diazepam and nordiazepam concentrations in blood were markedly skewed to the right and in the vast majority of cases diazepam concentrations were within the therapeutic range of 0.07-0.42 mg/L for whole blood, according to the TIAFT listing. In this material, only 10 cases (2.5%) contained a diazepam concentration above 0.8 mg/L, which is considered the lower point of the toxic range. The highest concentration of diazepam was 2.6 mg/L. The concentrations of diazepam and its primary metabolite nordiazepam were highly correlated ($r = 0.73$, $p<0.001$). By contrast, the concentrations of ethanol and diazepam were not at all correlated ($r = -0.15$, $p >0.05$). The mean blood-ethanol concentration was 0.23 g% (median 0.25 g%), which confirms a high proportion of heavy drinkers in this forensic material. Indeed, 90 individuals (38%) had a BAC over 0.3 g%, which is approaching a dangerously high concentration even without the coexistence of another CNS depressant drug. Cases with blood-diazepam >0.8 mg/L were investigated in detail by checking the cause of death according to the pathologists report. Several instances of traumatic deaths were observed so the drug-alcohol combination cannot be considered as the cause but night have contributed to the death. There were other instances of nothing remarkable at autopsy except the presence of the two depressant drugs.

Many studies have demonstrated that small doses of ethanol and diazepam impair psychomotor skills more so than either drug alone. Ethanol and diazepam both cause sedation and their pharmacodynamic

interaction involves activation of the inhibitory $GABA_A$ receptor, opening of the chloride channel to elicit a tranquilizing effect on the individual. There is no strong evidence for pharmacokinetic interaction between ethanol and diazepam. Autopsy blood-specimens submitted for analysis are always hemolyzed and often contain clots. For drugs like diazepam, which are predominantly bound (>96%) to plasma proteins, the concentration in serum or plasma will be appreciably higher than in whole blood or erythrocytes. Postmortem toxicology results should not be compared directly with clinical pharmacology reports based on the analysis of plasma or serum. The plasma/whole-blood distribution ratio for diazepam is 1.8:1 (Clarke 1982). The blood-ethanol concentration required to cause death is generally considered to be 0.4-0.5 g% but this figure can vary widely depending on different circumstances such as age of the individual, development of chronic tolerance, inhalation of vomit, positional asphyxia, hypothermia and not least the combined use of other psychoactive drugs. When trauma can be excluded and no other complicating factors exist it seems reasonable to accept a high blood-ethanol concentration and a blood-diazepam concentration within the toxic range as the cause of death. The sedative effect of these two CNS depressant drugs is additive.

Ethanol, Diazepam, Interaction

K33 Postmortem Fentanyl Levels Following Chronic Administration With an Infusion Pump

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The goals of this presentation are to report the levels of fentanyl found in postmortem tissue and fluid samples from a patient chronically administered fentanyl, intravenously (IV), via a patient controlled analgesia (PCA) infusion pump.

Fentanyl is a synthetic narcotic analgesic routinely used as an adjunct in anesthesia or for the management of chronic pain in the form of a transdermal patch (Duragesic®). More recently, clinical studies have shown that fentanyl can be used as an alternative medication in continuous infusion to patients who require high doses or become refractory to traditional opioid treatments. Fentanyl is 50-100 times more potent than morphine and has a short duration of action. Fentanyl is not to be used for acute pain and is given in therapeutic doses of 25-100 micrograms/hr for chronic pain.

A case study is presented to document the postmortem levels of fentanyl found in an individual who had a history of chronic pain. The deceased, a 62 year old female Caucasian, was found dead in bed with an IV line to her subclavian vessel attached to a PCA from which she was being administered fentanyl.

Methods and Results: Fentanyl was extracted from the samples by solid phase extraction with an elution solvent of isopropanol/dichloromethane/ammonium hydroxide (18:80:2). The extracts were analyzed by electron ionization, gas chromatography/mass spectroscopy, operating in the selected ion monitoring mode, utilizing deuterated fentanyl as the internal standard. The following ions were monitored, *245*, 146, 189, *250*, 151, 194, with a calibration curve ranging from 5-100 ng/mL.

The results of the toxicological analyses performed for fentanyl are shown in the table below. The blood was also found to contain therapeutic levels of carisoprodol, meprobamate, fluoxetine, norfluoxetine, nordiazepam, and acetaminophen. In addition, hydrocodone was present at a level of 0.34 mg/L.

Source of Sample	Aorta	Vena Cava	Liver	Vitreous Humor	IV Bag
Fentanyl Conc.	100 ng/mL	95 ng/mL	64 ng/g	5 ng/mL	42,000 ng/mL

The patient had been prescribed fentanyl, administered by continuous infusion, intermittently for two years to treat chronic back pain and pain caused by pancreatitis. The dosing regimen usually began at 60 micrograms/hr and tapered off to 40 micrograms/hr over a few weeks. At the time of death, a dose of 40 micrograms/hr was being administered. The PCA prescription also allowed for a bolus dose to be delivered at a rate of 5 micrograms/6 min, resulting in a maximum dose of 90 micrograms/hr. According to the PCA program, the dose was last adjusted three weeks prior to death. Other drugs detected during toxicological analyses were present at concentrations consistent with the prescribed dosing of the patient.

There is limited information published regarding fentanyl delivered to chronic-pain patients via continuous infusion, IV. A review of the literature shows that fatal overdoses have been reported in the range of 3-139 ng/mL of fentanyl in heart blood, with cases as high as 800 ng/mL. Corresponding liver values are generally 2-7 times higher than the heart blood. However, these results pertain to the Duragesic® transdermal patch or acute dosing of the drug by self-administered intravenous injection or oral ingestion.

The toxicological findings on the blood were high by therapeutic standards although the cause of death was not attributed to an overdose of fentanyl. The patient was not a naïve user of fentanyl, or other opioids, and the corresponding liver and vitreous fentanyl levels were not proportionally as high as the blood. The patient had previously tolerated the current dose of fentanyl, and higher. The patient also had a history of chronic respiratory illness and lupus. It is recommended by the authors that a complete toxicological analysis be performed on all available specimens, and that a comprehensive history be gathered before drawing a conclusion as to the cause of death, especially on the basis of one blood value alone.

To the authors' knowledge, this is the first reported case of postmortem fentanyl concentrations after administration via a continuous infusion pump.

Fentanyl, Infusion Pump, Overdose

K34 Alcohol Exposure in Neonates

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Attendees will learn about the analysis of biomarkers in meconium for detection of fetal alcohol exposure.

Fetal alcohol syndrome (FAS) is a devastating disorder in the newborn, resulting from heavy maternal alcohol consumption during pregnancy and is the leading cause of non-hereditary mental retardation in the neonate. Estimates of the prevalence of FAS range from 0.5 to 3 per 1,000 live births in most populations. Children with significant prenatal alcohol exposure do not always exhibit the characteristic facial abnormalities associated with FAS, but still have mental impairments just as serious. Alcohol related neurodevelopmental disorder (ARND) and alcohol-related birth defects (ARBD) describe these conditions which are estimated to affect 3-4 times as many babies as FAS. The diagnoses of ARND and ARBD require confirmation of the mother's alcohol use during pregnancy in addition to psychological or neurological assessment of the child. Self-reported maternal history of alcohol use can be helpful in diagnosis, but a laboratory test may provide the physician with critical information, especially when an accurate maternal self-report is missing. Fetal exposure to alcohol can also cause CNS dysfunction, post-natal growth problems, cardiac defects and

attention deficit disorders in the neonate. To date, diagnosis of fetal alcohol effect depends largely on maternal interview, although clinical tests are becoming more widely used.

Fatty acid ethyl esters (FAEE) are formed in the body, by esterification of ethanol with free fatty acids and trans-esterification of glycerides; and have been detected in the meconium of newborns.

This paper estimates the prevalence of fetal alcohol exposure in two populations by detecting fatty acid ethyl esters in meconium. The prevalence of FAEE's in the meconium from two separate groups of neonates using solid-phase extraction and analysis by gas chromatography-mass spectrometry in chemical ionization mode is presented.

Methods: *Extraction:* Fatty acid ethyl esters are sensitive to heat and light, and therefore, it is recommended that meconium specimens be immediately stored in amber or opaque containers upon collection, be shipped on ice and be stored frozen (-20°C). Meconium (0.5 - 1g) was allowed to thaw, and was homogenized in organic solvent. The extract was centrifuged and the supernatant passed through a solid-phase extraction cartridge. The fatty acid ethyl esters were eluted from the column, and evaporated to dryness under nitrogen at 37°C. The dried extract was reconstituted in hexane and analyzed using full scan chemical ionization GC/MS, with acetone as the reagent gas.

Analysis*:* A Varian Star 3400 bench top GC coupled to a Saturn II ion trap mass spectrometer was operated in the full scan positive chemical ionization mode. The GC column was a bonded phase fused silica (0.25 mm ID; 0.25 mm film thickness; 30 m length). The injector was operated at 250°C in splitless mode and the injection volume was 3 mL. The oven was programmed to 310°C and the reagent gas was acetone. Chemical ionization (CI) was chosen for this analysis, because electron impact ionization of these compounds yields identical fragments for the various FAEE's. In CI mode, a diagnostic ion for each compound is obtained.

Results: In the first study, seventy-three (16.7%) of the meconium specimens tested (n = 436) were considered to be positive for FAEE's. When broken down into quartiles, the mean values of total FAEE's measured were 1059 ng/g; 3133 ng/g; 6628 ng/g and 62115 ng/g. In the second study, thirty-five (11.9%) of the specimens (n = 292) were considered positive. When broken into quartiles, the mean values were 1139 ng/g; 3067 ng/g; 7674 ng/g and 50,143 ng/g. The overall FAEE profiles of the two study sets were remarkably similar.

Summary: When the total FAEE concentration is greater than 10,000 ng/g, in an adequate meconium specimen, it is likely that the newborn has been exposed to significant amounts of alcohol during pregnancy.

Meconium, Fatty Acid Ethyl Esters, Fetal Exposure to Alcohol

K35 A Case of Repeated Tramadol Poisoning in an Infant

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During this presentation, the participants will learn about the metabolism of tramadol and its incorporation into hair. The objective of this report is to show the potentials and pitfalls of interpreting results from segmental hair analysis and the use of toxicological analysis of several matrices to support an expert opinion.

In January 2001, a five-month female infant was admitted to the emergency room (ER) with lowered consciousness and convulsions. During early spring 2001, the infant had four additional admissions to ER with the same symptoms and also small pupils and respiratory depression. Besides toxicological screening at the hospital a neurological evaluation was also performed. The toxicological screening was negative and the neurological tests were normal. At this point, the lab was contacted and it was decided that in case of another ER visit, samples would be taken and sent to the National Board of Forensic Medicine for analysis. Nothing happened until November 2001 when the now 15-month-old girl was admitted to the ER with similar symptoms as before. Serum and urine samples were obtained and sent to the forensic laboratory in Linköping for analysis, and a police investigation was initiated. When the opioid tramadol together with its metabolites N-desmethyltramadol (N-dm-T), and O-desmethyltramadol (O-dm-T) were identified in the girls' serum and urine, poisoning was suspected and because of the earlier ER visits a hair sample was obtained to find out if tramadol had been administered more than once. The girl's hair had never been cut. A search for other samples taken during the spring 2001 was also initiated.

Experiment

Hair was segmented (10 mm each), washed and weighed in screw-capped glass tubes. One mL of 1 M potassium hydroxide was added and the hair sample was heated at 80° C for 10 minutes with occasional shaking. After cooling to room temperature the sample was extracted with 3 ml of a mixture of dichloromethane:isopropanol (80:20) containing 20% pentane. To serum, spinal fluid, and urine 0.1 ml of potassium hydroxide was added before the extraction.

After centrifugation for 5 minutes at 4200 *g* 2.7 ml of the organic phase was aspirated and transferred to a new 10-mL screw-capped glass tube and the sample was evaporated under a gentle stream of nitrogen at room temperature. The sample was then reconstituted in 100 □L of mobile phase, and transferred to a vial. Liquid chromatography-tandem mass spectrometry with an electrospray interface was used for analysis. The transitions monitored were 264.1/58.1 for tramadol, 250.1/44.0 for N-dm-T, and 250.1/58.1 for O-dm-T. Calibration was performed as duplicates at 5, 10, 15, 20, 50, and 75 (ng) by addition of the analytes to 20 mg drug-free hair (obtained from a laboratory employee) or 0.1 ml donor serum or drug free urine.

Results and discussion

Results from body fluids are shown in the table below and the results from segmental hair analysis are shown in the figure.

Date	Matrix	Tramadol (□g/mL)	O-dm-T (□g/mL)	N-dm-T (□g/mL)
01-01-14	spinal fluid	0.14	0.06	not detected
01-01-26	serum	0.56	0.14	0.07
01-11-19	serum	1.06	0.22	0.31
01-11-19	urine	present	present	present

The spinal fluid sample was taken during the first admission and the first serum sample was obtained during the second ER visit. Both were sent to the laboratory after the police investigation was initiated. Both samples had been stored in freezers at the hospital. The last serum and corresponding urine sample were taken during the latest ER visit and the samples were sent directly to the laboratory. All samples contained tramadol together with at least one metabolite but no other drugs (based on a neutral and a basic extraction followed by GC-NPD). Thus, tramadol might have been the cause of intoxication in all these three admissions to the ER.

During the investigation, one of the parents was suspected of having poisoned the infant on all six occasions. Before prosecuting for attempted murder, the prosecutor wanted to know if any other proof of tramadol administration could be obtained to include the three admissions in February-March when no samples were available. Hair samples from the girl were thus obtained in late February 2002, more than a year after the first ER visit.

The segmental analysis of hair showed the presence of tramadol in all segments, suggesting continuous administration of tramadol, though with changes in dose. The segments S3 and S4 represent October/November 2001 when the latest visit to ER occurred. The positive results from serum and urine taken at this time confirm tramadol

intake. Also, the positive serum and spinal fluid specimens confirm the positive hair segments S13/S12 (January/February 2001). Still, the positive segments S11-S5 may indicate yet other intoxications after the last ER visit March 1st –6th. On the other hand, the effect of dormant hair may produce positive results even though the administration of drug had stopped several months earlier. Hair that continues to grow after termination of drug intake will push the positive segments farther out and leave behind drug free hair. However, hair that stops growing at any time during intake will stay positive in the proximal segments, thus causing a "lag time" for the hair to be totally negative. This can be illustrated by examining the segment S2 representing time when the girl was in protective care and could not possibly have been given tramadol. In conclusion, the different samples and matrices together with the symptoms complement each other to strengthen the opinion that tramadol was the cause of the intoxication on all six occasions but the positive hair segments S11-S5 does not necessary indicate additional intake of tramadol during this period. Finally, the close cooperation between clinical and forensic toxicology units is of paramount importance for quick and accurate diagnosis of poisoning.

Tramadol, Hair, LC-MS-MS

K36 Pediatric Postmortem Toxicology: Involvement of Diphenhydramine in a Child Death

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After attending this presentation, the attendee will: 1) appreciate the importance of drug testing in all child deaths, (2) understand the factors which must be considered when evaluating the role of drugs in deaths of the young, and (3) possess information regarding drug concentrations in postmortem specimens from a pediatric case.

Diphenhydramine (DPH) is an antihistamine present in many medications available for the relief of allergic responses. It is also a component in combination medicines for congestion, colds and sinus headaches or as a component of itch stopping cream/gel or spray. It is available as a liquid, in chewables, tablets, caplets, capsules, and gelcaps. Recommended doses for formulations available for adults are typically 25-50 mg DPH HCl. These medications are contraindicated for children less than 12 years of age. Peak plasma concentrations in clinical adult specimens are typically <0.15 mg/L after oral administration.

Allergy medications for young children may be in liquid form and one teaspoon usually contains 12.5 mg diphenhydramine hydrochloride (HCl). The recommended dose for one formulation for a child 12-23 months with a weight of 18-23 lbs is 3/4 teaspoon or 9.3 mg DPH HCl every 4 hours. The indications for use of this drug are symptoms associated with hay fever and other respiratory allergies including sore/itchy throat, itchy/watery eyes, runny/stuffy nose, and sneezing. This case report describes the death of a young child while at the home of her childcare provider involving the administration of diphenhydramine.

A 17-month-old white female, weighing 26 lbs, was found dead in a playpen crib in an upstairs bedroom of the care provider's house. The crib contained numerous blankets and nylon carrying bags. According to the care provider the child was found unresponsive with a bed sheet tangled around her neck. CPR was initiated without success. The body was transported to the Office of the Cuyahoga County Coroner for autopsy. Autopsy findings included red petechiae over the left mastoid region and a linear transverse aggregate of red petechiae over the right anterolateral neck. Heart and femoral blood, cerebrospinal fluid, gastric contents, bile and vitreous humor were collected for toxicological analysis.

The heart blood was subjected to comprehensive toxicological testing which included volatiles by headspace gas chromatography; acetaminophen, salicylate and ethchlorvynol screening by colorimetry; acidic/neutral and basic drug screening by liquid-liquid extraction followed by GC-FID or GC-NPD with confirmation by GC/MS; benzodiazepine screening by GC-ECD; and modified opiate immunoassay screening. The only drug identified and quantitated was diphenhydramine. Due to the unusual circumstance of positive drug results in a young child and to understand issues of postmortem redistribution, the femoral blood, and gastric contents were also tested for diphenhydramine. DPH was detected at the following concentrations (mg/L): 0.49 heart blood, 0.27 femoral blood, and 0.36 mg in 20 mL gastric contents.

A search of the literature revealed little information on DPH pharmacokinetics in children and few cases of DPH detection in pediatric fatalities. Although the common side effect of DPH is drowsiness, it may also cause seizures in children. In light of the available literature and case circumstances, death due to a DPH overdose was discounted. Therefore, possible mechanisms to explain the child's death included entanglement in the bed sheet with inability to escape caused by the sedating effect of the drug or drug induced seizure with the ensuing entanglement. The cause of death was determined to be asphyxia due to entanglement by bed sheet around the neck, with other condition, recent ingestion of DPH. The death was ruled a homicide.

Pediatrics, Forensic Toxicology, Diphenhydramine

K37 Methamphetamine in Fetal and Infant Deaths in Washington State

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By attending this presentation the participant will learn about methamphetamine exposure in infants and children, and will receive guidance on how to interpret quantitative toxicological data.

Methamphetamine is a commonly abused drug in Washington State and positive methamphetamine findings in infant and fetal deaths have been increasing in recent years. Pediatric toxicology merits careful consideration, and caution in interpretation. Children cannot be treated as "small adults". Methamphetamine death in adults has been attributed to methamphetamine levels as low as 0.05 mg/L, however, this is usually in combination with other drugs or underlying disease. Pediatric methamphetamine poisonings are generally non-fatal, and amphetamine has been successfully administered to young children to treat hyperactivity disorders without adverse effects.

Several in utero deaths associated with maternal methamphetamine use have been reported but the significance of the methamphetamine concentration in these cases is often unclear, and can be controversial. In 1994, a California woman was convicted of child endangerment following the death of her two-month old infant son because she ingested methamphetamine and breast-fed her infant.

The authors reviewed fourteen cases of fetal and infant deaths with methamphetamine positive findings in autopsy blood, believed to be related to maternal methamphetamine use. Blood samples from the child or fetus was subjected to comprehensive toxicological screening including immunoassay and GC/GCMS analysis of both basic and weakly acidic fractions. Methamphetamine was detected in the basic fraction, following extraction with butyl chloride. The LOD for both methamphetamine and amphetamine was 0.02 mg/L, and limits of linearity were 0.02 - 10 mg/L for methamphetamine, and 0.02 - 5.0 mg/L for amphetamine.

The age of the infant and fetal deaths ranged from 22 weeks gestation, to 5 months old. 64% of the cases were stillbirths. The mean blood methamphetamine concentration in these pediatric death investigation cases was 0.24 mg/L (median, 0.18mg/L; range 0.04 - 0.59 mg/L) and mean amphetamine concentration was 0.07 mg/L (median, 0.06mg/L; range 0.02 - 0.16 mg/L).

A representative case was that of the death of an 8-week-old infant, found to have 0.04 mg/L methamphetamine, and < 0.01 mg/L amphetamine. The circumstances of this death were consistent with SIDS, and the family had a number of risk factors for SIDS (baby asleep on front, elevated temperature, history of child neglect, drug and alcohol use by the mother). While the methamphetamine was not clearly a cause of death in this case, it did however make SIDS (a diagnosis of exclusion) an inappropriate finding and the death was classified as undetermined in both cause and manner. No criminal charges were filed in this case. Charges were however filed in at least one other case.

As drug and chemical exposure of children in drug houses where methamphetamine is manufactured becomes an increasing concern, the authors also report the urine toxicological findings of two children exposed to methamphetamine. One 8-year-old was removed from a clandestine methamphetamine laboratory and had 0.04 mg/L methamphetamine and 0.02 mg/L amphetamine in his urine. The second child, a 1-year-old, was presented at an emergency room with signs of methamphetamine toxicity. His urine toxicology was positive for methamphetamine (15 mg/L) and amphetamine (0.9 mg/L).

Methamphetamine, Postmortem, Infants

Last Word Society

LW1 When Did He Die, Doc? An Old Case With New Significance

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The goals of this presentation are to: 1) exemplify multi-agency consultation and cooperation in the investigation of an historical case with renewed relevance, and 2) review the findings in fatal smallpox infection.

In March of 2000, a subdivision was being constructed on an old family farm in the Louisville Metropolitan area approximately 10 miles from downtown. Construction workers installing drainage pipes began encountering pieces of apparent old metal that was assumed to be old pipe. However, the final excavation for the day contained a man in a suit.

The death investigators called to the scene found an adult white male appearing to be of middle age, dressed in a suit, and in a relatively good state of preservation. Because of the metal unearthed with the body, a historical gravesite was considered. However, because of the excellent condition of the body and the fact that there was no known history of the farm family having a graveyard in that area, the body was transported to the Office of the Chief Medical Examiner for further evaluation.

Examination of the body in the autopsy suite revealed a somewhat mummified but very well preserved white male appearing to be in his 30s. The clothing may best be described as "dashing and dapper" and included fine supple black leather gloves, a black coat with a white waistcoat, a long white pleated shirt, and an elegant black silk tie with gold lettering embossed on the back which was still clearly legible. The button of the pants displayed the lettering: "JB Walker, Louisville, Kentucky." The most striking findings were on the decedent himself. The right leg displayed massive bowing deformity of the tibia and fibula consistent with chronic osteomyelitis. As the apparent funeral makeup and dirt were removed from the face and other skin surfaces, multiple raised pustular lesions were noted. Consultations were solicited from the University of Louisville Department of Archeology and the Infectious Disease Division of the County Health Department.

Review of the case with the infectious disease specialist of the County Health Department confirmed the medical examiner's suspicion of a diagnosis of fatal smallpox. Research based on the clothing and the coffin artifacts discovered with the body by archeology narrowed the time frame. The tailor, as named on the pants buttons, had been in business in Louisville from 1845 through 1870. "Bale handles" recovered from the cast iron coffin were dated as being used in the 1840s and 50s. Further detailed investigation by the archeologist regarding land ownership, wills, and death certificates led to identification of the gentleman as a 33-year-old male who had died in 1858. In accordance with state statutes, the descendants of the decedent's family were identified and notified. The developer then paid for the re-interment of the body at a cemetery of the family's choice.

This case underscores the advantages of interagency networking and cooperation. Early information from all agencies interrelated and led to further information and eventual identification of the decedent, more than 140 years after his death. Further, this case has renewed relevance in that it allows one to see first hand a case of fatal smallpox - a disease with which one must become reacquainted in this age of bioterrorism threats and possibilities.

Postmortem Interval, Smallpox, Interagency Cooperation

LW2 Last Flight of '746

Robert M. Morrow, DMD, Box 70, Walsh, CO; and Mike M. Morrow, BSME*, 870 Northwest Carpathian, Corvallis, OR*

This presentation makes use of modern mapping and computer technology to revisit a 50-year-old aircraft crash site and reconstruct final moments of the incident.

Flight '746 was a member of the 4th Rescue Squadron out of McChord Air Force base. The WWII-era SB-17 was on an air-sea rescue mission in January of 1952 in search of a Korean Airlift DC-4 that went down off British Columbia.

Flight '746, commanded by Capt. Casimir "Ky" Hybki, was a specially modified search and rescue B-17 with the ability to airdrop boats and supplies to crash victims. On the flight back to base, '746 encountered whiteout conditions and violent winds. The plane struck a ridge top in the rugged wilderness of the Olympic Peninsula and slid down into a deep ravine. Five of the eight crewmembers survived and were themselves later rescued. The official Air Force report attempted to reconstruct the crash and attributed much of the blame to pilot error.

Although the heavily vandalized main wreck site is well known to locals, the initial impact point far up the ridge has been largely undisturbed for half a century. The upper crash site was rediscovered by Mike Morrow after extensive review of all the original field notes and maps. The initial impact area was found to be in pristine condition, offering a unique opportunity to study the site with modern GPS mapping and computer analysis.

This reexamination of the entire crash site has shed new light on the actual sequence of events leading to the aircraft's breakup and offered some new insights into the validity of the pilot error conclusion. Exploration and detailed documentation of the final seconds of Flight '746 has helped the survivors and their families gain a better understanding of the entire event. Ultimately, perhaps this new perspective can change a career-ending episode into the recognition of bravery that is long overdue.

SB-17, Crash of '746, Olympic Peninsula

LW3 The Felon and the Phrenologist: A Forensic Analysis of an Executed Felon

Michael W. Spence, PhD, Department of Anthropology, University of Western Ontario, London, Ontario, Canada*

The goal of this presentation is to explore, through the example of a specific case, the potential and problems of applying modern forensic procedures to the resolution of historic questions.

Eldon house, a nineteenth century home in London, Ontario, was donated to the city of London in 1960 to serve as a heritage museum. Among its many contents was a partial human cranium that, according to family lore, was that of Cornelius Burley. Burley had been hanged in London in 1830 for the murder of a sheriff's constable who had been trying to arrest him. A local historian, Orlo Miller, investigated the find and concluded that Orson Fowler, a prominent American phrenologist, architectural philosopher, and sex therapist of the time, had taken Burley's head immediately after the execution. Fowler toured the world with it, demonstrating the principles of phrenology in America and Europe, and then finally returned it to Eldon House in the 1880s.

However, there are some glaring contradictions and gaps in this account, and there is no independent confirmation that the cranium is

indeed that of Burley. It was thus decided to re-examine this popularly accepted story, drawing on the methods and principles of forensic science.

This analysis had to overcome a number of obstacles. For one, there are virtually no data in the historic records on Burley himself, other than his age and sex and a rather detailed account of his confession and execution. In addition, the cranium is incomplete. The calvarium had been sawn off, and most of the lower facial skeleton is missing. Also, the extensive handling of the cranium over several decades raises the problem of distinguishing perimortem trauma from postmortem damage.

Despite these difficulties, the analysis was largely successful. Historic records, particularly newspaper accounts and Orson Fowler's own writings, confirmed Fowler's possession of the cranium and offered some idea of how he came to hold it. The chain of custody was established, though perhaps not with the detail that would be expected in a modern homicide investigation. The methods of forensic anthropology indicate that the "generalizing" features of the cranium, those used to assign an individual to general categories like sex and age, are consistent with what little is known of Burley. The only relevant age indicator is cranial suture closure, so the fit to Burley is indeed quite general. However, the next step in analysis offered a particularly difficult challenge. "Individualizing" characteristics, those used to identify a specific individual within the general categories of age, sex, etc., are an essential part of the identification process. Unfortunately, there is very little known about Burley that can be used to distinguish him from any other nineteenth century man of his general age. Some evidence of severe antemortem trauma is interesting, but of little help. More decisive is a perimortem fracture of the cranial base consistent with hanging. The evidence thus corroborates the family lore and the historian's account, though some particulars require change.

At the time of analysis, a descendant of Burley was researching her family history and found out about Burley, his execution, the presence of his cranium in London, and the anthropological verification of the identification. She requested the return of the cranium. After some negotiation, complicated considerably by the participation of lawyers, the cranium was returned and buried in the family plot in Michigan. However, the detached calvarium is still apparently in the possession of Orson Fowler's descendants, probably somewhere in New York State.

Hanging, Identification, Cornelius Burley

LW4 The Hand of God? Leprosy and the Journey of the Mortal Remains of Blessed Father Damien deVeuster

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This presentation is intended to familiarize the forensic community with the historical account of the life of Father Damien of Molokai and with the controversy and eventual compromise surrounding the disposition of his remains.

Forensic scientists, Catholics, and native Hawaiians are often interested in human remains from a historical and spiritual perspective. This presentation will summarize the life of Father Damien, martyr of the lepers of Molokai, his death from leprosy and the postmortem journeys of his remains. The presentation emphasizes the historical, spiritual, and symbolic importance attached to Father Damien's remains by Belgians and Hawaiians and the compromise that satisfied both factions regarding his final resting place.

Perhaps, until recently, no other human disease has invoked as much fear as leprosy, also known as Hansen's disease. An ancient disease, largely afflicting the rural poor, leprosy is found worldwide but is more concentrated in tropical and subtropical regions of the globe. It is unclear when the first cases of leprosy was diagnosed in the Hawaiian Islands. However, at the peak of the leprosy epidemic in the islands in the 1870s, 2-3 percent of native Hawaiians were infected with the disease.

The Hawaiian authorities adopted a policy of segregation. To arrest the spread of the dread disease, several hundred lepers* were isolated in 1866 on the Kaluapapa peninsula on the island of Molokai. Conditions at the colony were initially abominable. Father Damien DeVeuster, a Belgian priest from the Sacred Hearts Order, arrived at Kaluapapa in May 1873. Under his direction, shelters and hospitals were built for the sick, the dead buried, potable water piped in, orphans cared for and a port facility constructed. Law and order was restored and a sense and hope and dignity were instilled in the colony. Father Damien's ministry made him world famous. In 1885 the world learned that Father Damien had contracted leprosy. Despite his illness, Father Damien continued to work until his death on April 15, 1889, at the age of 49.

In death, as in life, Father Damien would not rest too long in one place. The surge of Belgian nationalism in the 1930s demanded the recognition of Belgian heroes. In 1935, King Leopold III of Belgium formally requested of President Roosevelt that the remains of Father Damien be returned to his homeland. On January 27, 1936, Father Damien was disinterred and his remains examined prior to their return to Belgium.

This would have been the end of Father Damien's travels had it not been for a 37-year-old French nun, Sister Simplicia Hue. She fell ill in February of 1895 with an acute and severely painful gastrointestinal condition, possibly ulcerative colitis, cancer, or diverticulitis. Knowing the end was near, Sister Simplicia prayed for intercession by Father Damien, whose picture hung next to her deathbed. On September 11, completely exhausted, Sister Simplicia became comatose. However, early in the morning of September 12, she awoke and found herself free of pain. She descended to the kitchen and ate a hearty breakfast. Sister Simplicia lived for another 32 years without any recurrence of her illness.

In 1938 the quest for sainthood formally began for Father Damien. After years of Church research, Pope Paul VI declared Father Damien venerable in 1977. In 1991 Sister Simplicia's cure was declared miraculous and Father Damien was subsequently beatified in 1995, resulting in yet another journey for Father Damien. Father Damien's right hand, the one he used for blessing his lepers, nursing the sick, anointing the dying and building his churches, was returned to Hawaii. The relic toured the Islands for seven weeks until July 22, 1995 when it was re-interred in its original grave.

The Vatican continues to ascertain the legitimacy of other miracles attributed to Father Damien. His canonization will require another miracle resulting from his intersession. In the meantime, leprosy itself remains as much a mystery as Father Damien's miracles. To this day, no one is really even certain how the disease is transmitted. Nor has anyone discovered a method to culture the bacillus outside of a living host. The advent of sulfa drugs in the 1940s allowed leprosy to be arrested in patients, but the drugs do not afford a complete cure. Those who were rendered non-contagious by treatment gradually left Kaluapapa after segregation laws were abolished in 1969. To date, a few elderly residents remain, the last living testament to a place and time that witnessed both the best and worst aspects of humanity.

*The use of the term leper is not intended to be callous or insensitive. The afflicted of Molokai have always preferred to be called lepers. They feel that to be deemed a "Hansen's patient" or other euphemisms understates the suffering they and their predecessors have endured.

Leprosy, Father Damien, Molokai

LW5 Monsieur Le Docteur Ambroise-Auguste Tardieu: Beyond the Spot

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The purpose of this paper is to restore a dear colleague to proper stature within the forensic community and to let the lessons of his life stand as an example to all.

Ambroise-Auguste Tardieu (1818-1879) was raised in Paris in an intensely artistic family. His father rose to prominence by becoming the official graveur for the French Navy by publishing treatises on military architecture and ancient history and by drawing portraits of prominent celebrities of the time. This esteemed colleague descended from three generations of renowned artists, geographers, and cartographers. Having fallen under heavy scholarly scrutiny, most of them are well known to every French school child today.

Many buildings and streets throughout the country bear the name of Ambroise Tardieu, without exception they refer to his father, not Dr. Tardieu.

Ambroise-Auguste did not follow the graphic path of his predecessors but embraced the healing arts and became a physician. He grew to be legendary for his powerful testimony in highly political and high profile court cases, but grounded the basis for his opinions on the extensive observations recorded in his impressive scholarly achievements in pathology and forensic medicine. His ground-breaking publications on forensic topics included tomes devoted to: poisoning, wounds, strangulation, asphyxiation, blunt force, forensic psychiatry, and a visionary treatment of abortion, infanticide, and child abuse. He was also a social activist of his day with contribution in social and public health related topics prevention of epidemics, studies of hazardous work environments, etc.

Reading Dr. Tardieu's textbooks of nearly 150 years ago reveals classic descriptions of the "battered child" syndrome, examples of impulse child homicides, and allusions to a new category of "escalated homicide" to be presented this year in the scientific session. His work on wounds includes descriptions of gunshot wounds, wounds of sharp force and blunt force that should be read by every student of forensics. The chapters devoted to bloodstain evidence, timing and sequence in assault, industrial accidents, mine, train, vehicular mishaps, manner of death, and the role of the physician as an expert witness are no less important. The role of wounds affecting the living and their resultant disability not only to quality of life but the ability to earn one, places Tardieu in the one of the earliest aspects where forensics serves the living and not just the dead. His work on hanging, suffocation, and asphyxiation contains detailed references to the anatomic findings and derangements of these processes, most notably the production of sub-serosal petechiae as an indicator of suffocation….the famed Tardieu Spot. How unfortunate then that many American forensic texts have expanded the definition to include the postmortem cutaneous lesions of indiscriminant origin.

In 1864 he was nominated Dean of the School of Medicine in Paris, the most prestigious in the country. Despite his cutting edge vision of the role of forensic professionals in a court of law, despite his strong commitment to the now modern notion of merging forensics of the dead to forensics of the living, little is known of Tardieu, the man and his life. Today he is known only through his anatomical tombstone, the Tardieu spot, and even this is not correct.

Although a giant in his field, a little known irony of history let him disappear from France and the medical world, and so a family of gargantuan reputation easily swallowed his name. Within two years of being one of the most beloved figures of the common man, when hundreds of people waited anxiously at a train station to shake his hand, he was to become despised and ignored by peers and public alike. His steadfastness, objectivity and social conscience collided with the complicated politics of the transition from the Empire to the Third Republic and made the end of his life a living proof of the novel named "Les Miserables."

Ambroise Tardieu, History, Forensic Medicine

Presenting Author Index

A

Abaci Kalfoglu, Ersi-I7
Adams, Holly A.-C20
Aernecke, Matthew R.-B115
Alexander, Peter-E10
Alexander, Russell T.-G2
Ali, Zabiullah-G38, K29
Alkan, Nevzat-G9, I17, J4
Allen, Eileen M.-W8
Allison, John-B99
Almirall, José R.-B132, FS4
Anderson, Daniel T.-W16
Andres, Robert O.-C35, G84
Andrews, William B.-D12
Arlotti, Ana Boza-H20
Arroyo, Luis-B84
Aschheim, Kenneth W.-F12, W24
Avon, Sylvie-Louise-F33

B

Bacon, Mary K.-W21
Baden, Michael M.-E14, E16, S3, W7
Bailey, James A.-D5
Baker, Andrew M.-G92
Baker, David W.-W20
Ballantyne, John-W2
Ballard, Kevin D.-W7
Barbian, Lenore T.-H49
Bartelink, Eric J.-H8
Bassett, Helen E.-H9
Bauer, Martin-G78
Baugh, Christopher H.-E3, E6
Baugh, David P.-E4, E6
Baylor, Michael R.-B88
Beasley, James O.-I16
Benecke, Mark-I18
Ben-Hur, David-C30
Benson, Andrew J.-B13
Berdos, Paulina-B51
Bernhard, Werner-K23
Bernstine, Edward G.-S2
Berryman, John F.-H40
Berzlanovich, Andrea M.-G11
Bever, Robert A.-W2
Beyer, Kristen R.-I16
Bienvenue, Joan M.-B39
Birnbaum, Jr., Howard A.-J15
Bishop, Megan L.-B23
Blackledge, Robert D.-B134
Bock, Jane H.-D34
Bohan, Thomas L.-C23
Boland, Cherisse E.-B4
Bomberger, Kathryne-D26
Boyuer, David-W3
Bradley, Maureen J.-B24
Brannon, Robert B.-F16
Brennan, Kelly-W20
Bresler, Scott A.-I15
Broce, Bruce-H61
Brogdon, B.G.-D39
Brosz, Helmut G.-C21
Broussard, Larry A.-W12
Brown, Gary R.-C34
Brown, Richard S.-C2
Brumit, Paula C.-F37
Budimlija, Zoran M.- B130, G32
Bukhanovsky, Alexander O.-I19
Bullard, Rebecca A.-G36
Burbrink II, Donald F.-BS7
Burch, Phillip M.-G18
Burkes, Jeffrey R.-F6, W24
Buscaglia, JoAnn-B135
Byrd, John E.-H18

C

Callery, Patrick S.-B97
Calloway, Cassandra D.-B37, B107
Campobasso, Carlo Pietro-G62
Cannon, Marie E.-G41
Caplan, Michael J.-W12, W25
Caruso, James L.-G43
Case, Mary E.S.-G88
Cellarosi, Mario J.-C4
Cengiz, Salih-B27
Cheriton, W. Ross-C16
Cherpelis, Konstantinos-F8, F9
Choi, Eupil-G95
Christensen, Angi M.-B80, H39
Chui, Paul Peng Sun-G4
Chung, Denise T.-B70
Chute, Dennis J.-G8
Ciaccio, Frank A.-W3, S1
Ciolino, Laura A.-B16
Cisneros, J. Michael-F4
Clarke, James H.-C33
Cody, John T.-K8
Cohen, Stephen K.-F27
Cook, William-W20
Corey, Tracey S.-LW1
Cotton, Robin W.-B110
Cox, Margaret-H6
Craig, David R.-C10
Crawford, Coleen-G27
Crawford, Todd R.-C8
Crews, John D.-B38
Crowley, Sharon R.-G23
Crowns, Kendell V.-G74
Curtis, Janene-H29
Cwiklik, Chesterene L.-B116

D

Darrisaw, Lora A.-G89
David, Victor A.-W23
Davis, Diane M.-D2
Davis, Joseph H.-G84
Davoren, Jon-B59
Dawidson, Irena-F29
de Castro, Lydia M.-B71
De Forest, Peter R.-B48, B129
De Haan, John D.-B76
Dean, Dorothy E.-G64
Dean, Peter-E19
DeFrancesco, James V.-B18
de Jong, Joyce L.-S1, W3
DeKalb, Meredith A.-J2
Delattre, Veronique F.-F24
Deveaux, Marc-K18
Devlin, Joanne L.-G48, H51, H59
Di Nunno, Nunzio-G3
Di Vella, Giancarlo-G57, H31
Diaczuk, Peter J.-B119
Diaz, Francisco-K27
DiFrancesco, James M.-B69
Dillon, Duayne J.-J11
Dillon, Scott E.-B78, C14
DiMaggio, John A.-H7
Dirkmaat, Dennis C.-H52, H70
Do, Paula M.-G33
Dolan, Julia Ann- B121, W18
Dold, Charles H.-S2
Dondero, Henry J.-F10, F11
Donnelly, Brian-E14, E17
Donoghue, Edmund R.-BS1, S1
Downs, JCU-W4
Drawdy, Shuala M.-H66
Drizin, Steven A.-I3
Drukier, Piotr-H21
Duceman, Barry W.-S1
Dudek, Jonathan A.-I13
Dudley, Mary H.-G6
Dugan, Kerri A.- B111, W2
Dunay, Gyorgy-G50
Dunn, Jamie D.-J6
Duval, Robert-B79

E

Eckenrode, Brian A.-B113
Edwards, Carl N.-E1, E6, E7, W20
Edwards, John S.-B123
Eng, Leslie-C27
Erikson, Carol A.-C28
Erlich, Henry-B109
Ernst, Mary Fran-D7
Ervin, Tom-W20
Esslinger, Kelly J.-G28
Estacio, Sheila M.-B130, FS5, S2
Evans, Richard J.-G26
Exline, David E.-B103, S2

F

Fallon, Peter M.-F7
Faugno, Diana-W8
Fay, Thomas Fortune-WS1

Presenting Author Index

Felthous, Alan R.-I20
Fernandes, John R.-G65
Ferraro, Chantal-G91
Filippi, John E.-F39
Finnegan, Michael-H10
Firestone, Scott R.-D18, F36
Fisher, Barry A.J.-W4
Fixott, Richard H.-F14
Flavel, Ambika-H57
Fleisher, Karen A.-B31
Fletcher, Jeremy C.-B112
Flohr, David B.-W10
Fogel, Michael H.-I14
Foldy, Seth-D35
Ford, Larry C.-B123
Forman, Lisa-FS3
Fornes, Paul-G45, G72, G73
Franck, Darren-C18
Franck, Harold E.-C22
Frasco, John F.-F2
Froede, Richard C.-WS3
Frost, Bridgette T.-J2
Frysinger, Glenn S.-D43
Furton, Kenneth G.-B13, B28

G

Garside, Diana-K33
Garza Garza, José-F1
Gelles, Michael G.-E2, E6, I9
Geradts, Zeno-D8
Germano-Presby, Joselle-B19, W23
Gestring, Brian J.-B32
Gherardi, Mirella-G35
Gibson, Benjamin W.-F12
Gill, Ingrid-E21
Gilliland, M.G.F.-G86
Gillis, Kelly E.-D4
Gillman, Thomas H.-C13
Gilmore, Kristin-G59
Gojcz, Christopher M.-S2
Goldfeder, Lara B.-G51
Golenberg, Edward M.-W2
Gordon, Ann Marie-K37
Gordon, Kellie M.-H33
Grant, William E.-H11
Green, Robert N.-W9
Greenberg, Eric W.-S2
Greenberg, Sheldon-WS1
Greenhalgh, Matthew-W17
Grgicak, Catherine-B8
Grim, Donna M.-B100
Gromb, Sophie-D24, G56
Gross, Nicole A.-B67
Grossweiler, Lisa L.-B56
Gruszecki, Amy C.-K2
Gudjonsson, Gisli H.-WS1
Gwynn, Lucas K.-D11

H

Haden, Kathryn A.-G44
Hadi, Sibte-B26
Hadley, Keith-W15
Hahn, Scott H.-F30
Haley, Robert W.-S1
Hall, Rachel C.-F22
Hammett-Staber, Catherine A.-W12
Hanson, Erin K.-B64
Hanson, Ian-H54
Harper, Albert B.-W23
Harper, Ross J.-B40
Harrington, Richard J.-H15
Harris, Howard A.-B21
Harris, Joel S.-E18, J12, W11
Hart, Kimberly A.-E24
Hashish, Hisham-K4
Hayden, Donald A.-D12
Hayes, James L.-W1
Hayes, Wilson C.-C37
Hebrard, Jacques-L2
Hefner, Joseph T.-H12
Henderson, Carol-S2
Hepler, Bradford R.-K6
Hermsen, Kenneth P.-F39
Hicks, Gretchen D.-B122
Hill, Stephen-B78, C15
Hinman, Dayle L.-D21
Hobbs, Andria L.-B102
Hobson, Deborah L.-W17
Holland, Mitchell M.-W2
Holy, Susanne-D14
Hooper, Jody E.-G49
Hopen, Thomas J.-B46
Horsman, Katie M.-B2
Houck, Max M.-B125, FS2, FS3, W14
Hoyle, Jonathan-W2
Hoyt, Constance A.-D40
Huang, Min-B140
Huffine, Edwin F.-B12
Hunter, Brian C.-G71
Hunter, Dale O.-F19

J

Jason, Donald R.-G19
Jasper, John P.-B123
Jenkins, Amanda J.-K36, W12, W25
Jensen, Robert A.-W13
Jentzen, Jeffrey M.-G21, G96, W5
Johnston, Kimberley-B128
Johnston, Sarah-G30
Jones, A. Wayne-K32
Jones, Graham R.-S2
Jourdan, Thomas H.-B20
Jufer, Rebecca A.-K31, W25
Jurgens-Toepke, Pamela M.-F17

K

Kadash, Kristy-B108
Kanaki, Katerina-G55
Kasamatsu, Masaaki-B131
Keierleber, Joseph A.-D19
Keil, Wolfgang-B92
Kelly, Christopher C.-G16
Kelly, Kevin J.-W25
Kelly, Michael T.-E14
Kenan, Joseph N.-I21
Kennedy, Kenneth A.R.-H42
Kenney, John P.-W3
Kenney, Linda B.-BS3, W11
Kerrigan, Sarah-K30
Kettelkamp, Teresa M.-S1
Kintz, Pascal-K14
Klim-Lemann, Janice W.-F43
Kline, Margaret C.-B60
Klonowski, Eva E.-H17, H19
Kobilinsky, Lawrence-FS1
Komar, Debra A.-H5
Konduri, Kameswari-W25
Konjhodzic, Rijad-B29
Kontanis, Elias J.-D17, H46
Koons, Robert D.-B120
Koot, Michael G.-H44
Krenke, Benjamin E.-B66
Kroman, Anne M.-F41
Krompecher, Thomas-G79
Kronstrand, Robert-K35
Kubic, Thomas A.-B47
Kubicz-Loring, Ella-B15
Kurtz, Barry D.-F13

L

Ladd, Carll-B87
Lafleche, Denis-W10
Lang, Joy E.-H25
Langdon, Julie L.-B1
Langman, Loralie J-K5
Lantz, Patrick E.-G87
LaPorte, Gerald M.-J1
Latham, Krista E.-H28, H45
Laughlin, Gary L.-B45
Lavach, Beth-W4
Lecomte, Dominique-G22, G75
Lee, Henry C.-S3
Lee, James Chun-I-B96
Lee, Jumi-B139
Leher, Tamara L.-H4
Leibelt, Craig S.-B58
Lemmon, Julie Wilson-G7
Lemos, Nikolas P .-D31
Lemos, Nikolas P.-K16
Lenox, John B.-C38
Levert, Keith-B113
Lewis, James M.-F48
Li, Ling-G1

Presenting Author Index

Lin, Dong-Liang-K1, K11
Lindblom, Brian S.-J13
Linville, Jason G.-G25
Lipe, TC-W20
Lipton, Barry E.-F44
Listi, Ginesse A.-H58
Llewellyn, Barbara E.-B55
London, Marilyn R.-H71
Lorente, Jose A.-B35, B36
Lorente, Miguel-B89
Loudon, Patricia-W2
Love, Jennifer C.-H36
Lowe, Alexandra L.-W2, W17
Lyons, Bruce-E24
Lyter III, Albert H.-B98

M

MacFabe, Scott-C31
Madrzykowski, Daniel-B77
Maldonado, Erika-I12
Malik, Sobia-G29
Malooly, John E.-B82
Malzbender, Tom-B104
Manhein, Mary H.-H32
Mar, Gregory L.-F46
Marks, Murray K.-H47, H59
Marpet, Mark I.-C24
Marsh, Peter J.-F20
Martin, Paul C.-B138
Martrille, Laurent-G5, H14
Mather Saul, Julie-W3
Max, Brendan P-E23
Maybruck, Julie L.-B62
McCall, Todd A.-S1
McClafferty, Kevin J.-W9
McClary, Carl R.-J3
McClelland, John F.-J7
McCormack, Owen-F32
McDermott, John J.-WS3
McDevitt, John F.-I1
McGivney, James-W3
McGlothlin, D. Ryan-C7
McGowan, Dennis E.-W3
McKenna, James J.-G93
McMillen, Susan D.-F18
McPherson, Susan-B95
Mecklenburg, Sheri H.-W14
Melson, Kenneth E.-S2
Menotti-Raymond, Marilyn A.-W23
Merves, Michele L.-K19
Messner, Paul-W3
Meyers, Jodi E.-B14
Miller Coyle, Heather G.- W2, W23
Miller, Elizabeth A.-D1
Miller, Kevin W.P.-B50
Miller, Marilyn T.-B126
Miller, Michelle L.-H65
Mires, Ann Marie W.-H62
Moenssens, Andre-W11
Moore, Christine M.-K34
Moore, Karla A.-K3
Morehead, Richard A.-K7
Morris, Ronald N.-J9
Morrow, Mike M.-LW2
Morrow, Robert M.-LW2
Morton, Susan E.-B104
Moscato, Gerald-W1
Mozayani, Ashraf-K24
Mueller, James-C31
Muller, Thomas P.-W19
Mundorff, Amy Zelson-H68
Murga, Kimberly B.-B7, B72, B73
Murphy, Gordon K.-G58
Murray, Elizabeth A.-H3
Murray, Rebecca A.-K12
Myers, Alan L.-B41
Myster, Susan M.T.-H48

N

Napper, Robin P.-D25
Nazzaruolo, Bianca L.-B74, B130
Negrusz, Adam-K22
Nelson, Margaret A.-W21
Nelson, Thomas A.-W21
Neufeld, Peter J.-L1
Newman, Jonathan-B52, D42
Newman, Reta-W18
Ng, Khim Hui-D23
Nichols, Ronald G.-B118
Nolton, Sarah E.-B23
Norris, David O.-D34
Norris, James E.-C26
Northrup, Andrew T-E23
Nussbaumer, Christa-B91

O

O'Connell, Linda-H6, H41
Oeberst, Jaime L.-G67
O'Hara, Joseph P.-G63
Oliver, William R.-G80
Olson, Larry A.-J14, W21
Opel, Kerry L.-B70
O'Reilly, Gregory W.-E20
Osterheider, Michael-W19
Ousley, Stephen D.-H13

P

Pagliaro, Elaine M.-B114
Palarea, Russell E.-E2, E6, I8, I9
Palenik, Skip-B42
Palmbach, Timothy M.-B114
Panhorst, Frederick H.-W21
Pappas, Frank J.-F9
Park, Sung-Woo-B11
Parson, Walther-W2
Patton, Susan-W8
Peck, Brian-G31
Perr, Jeannette M.-B6
Perret, Louis S.-D27
Perrier, Michel-F28
Peters, Sonja L.-G34
Peterson, Donn N.-C39
Peterson, Joseph L.-B44, B127
Phillips, Eric W.-K9
Pitkin, Seth-C31
Pitluck, Haskell M.-BS3, E14, W11
Plourd, Christopher J.-W11
Pollitt, Mark-W22
Polski, Joseph-W4
Polverento, Gerry A.-D32
Pomara, Cristoforo-G60
Poorman, James K.-D6
Pope, Elayne J.-B81, H37, H38
Posey, Douglas-G68
Potter, Anthony N.-D28
Pozder, Arijana-B30
Prahlow, Joseph A.-G93, G94
Pretty, Iain A.-F23
Price, Alan-H30
Primorac, Dragan-B93, W2
Prinz, Mechthild K.-W2

Q

Quinton, Reade A.-G37

R

Ragab, Hisham E.-B33
Ramakrishnan, P.N.-C29, J5
Raul, Jean-Sebastien-G53, G83
Raven, Kathy P.-G85
Reffner, John A.-B43
Rehkopf, Jr., Donald G.-E5, E6
Reichs, Kathleen J.-S2
Reid, William H.-W16
Ressler, Robert K.-W19
Reynolds, Jennifer E.-B55
Richards, Gerald B.-J9
Rieders, Fredric-W7
Rieders, Michael F.-W7
Riley, Thomas P.-W21
Rios, Tara R.-F26
Ripple, Mary G.-G20, S1
Rizvic, Adnan-B85
Robertson, James M.-W2
Robertson, John B.-C32
Rodgers, Ryan P.-C6
Rodriguez III, William C.-H72, W13, WS3
Rogev, Meir-WS2
Ronayne-Krause, Amy-W21

Presenting Author Index

Roper, Richard A.-J8
Ropero-Miller, Jeri D.-W12, W16
Rosenbluth, William-C17
Ross, Ann H.-H61
Ross, James P.-S1
Rowe, Walter F.-B106, B137
Ruttman, Danielle D.-E11

S

Saady, Joseph J.-K20
Sabucedo, Alberto J.- B13, G77
Sackman, Bruce-E14, E15
Samples, Marie-S2
Sanger, Margaret A.-W23
Santos Bremme, Adriana Gabriela-H67
Sarajlic, Nermin-H22
Saul, Frank P.-H63, S1, W3
Saul, Julie M.-H64
Sava, Vincent J.-LW4
Savio, Caterina-F49, F50
Schluckebier, Deirdre-G90
Schmitt, Brandi-F21
Schoenly, Kenneth G.-G24
Schorr, David J.-E9
Schreuder, Willem-C27
Schroeder, Scott C.-B61
Schumm, James W.-B65, B68, W2
Sebetan, Ismail M.-B34
Sekiguchi, Kazumasa-B10
Serchuk, Richard B.-F13
Sgan, Stephen L.-G42
Shaler, Robert C-W13
Shamblin, Casey-H24
Shank, Frank-W3
Sharma, Ramesh Kumar-I5
Shea, Brendan F.-B54
Shelly, Joseph-WS2
Shepperd, Denise A.-C11
Shields, Lisa B.E.-G46
Shkrum, Michael J.-W9
Short, Jeffrey W.-C1
Sibert, Robert W.-W3
Siegel, Jay A.-B105
Silva, J. Arturo-I10, I11, I22
Sincox, Allan R.-I4
Sinha, Sudhir K.-B63, B75
Skelly, Joseph-WS2
Sledzik, Paul S.-G17, S1, W3
Smajlovic, Lejla-B9
Smith, James S.-C9, C34
Smith, Jr., James S.-C25
Smith, O' Brian C.-G52, LW5
Snell, Kenneth S.-G40
Soomer, Helena-F15, S2
Souviron, Richard R.-BS8
Sozer, Amanda C.-S1
Speck, Patricia M.-W8
Spence, Michael W.-LW3
Spence-O'Donnell, Barbara-D3
Sperber, Norman D. (Skip)-F40
Spicer, Jr, Oliver S.-B25
Spiehler, Vina R.-K17
Spradley, M. Katherine-H2
Srihari, Sargur N. "Hari"-J10
Srivastava, Varsha-B94
Starrs, James E.-BS3, BS5, W6
Stauffer, Eric-B101
Steadman, Dawnie W.-H23
Steadman, Shelly A.-B5
Stechey, Frank M.-F31
Stefan, Vincent H.-H56
Stern, Gail-I2
Steven, Joy-H6
Stoney, David A.-B49
Stoppacher, Robert-G76
Stout, Kristen K.-C5
Stout, Peter R.-K21
Strong, Scott-D41
Stuart, Jaime-H35
Stubblefield, Phoebe R.-H43
Sullivan, Mary K.-D29
Sur, Anthony K.Y.-F45
Sweeney, Kay M.-B117
Swienton, Anjali R.-FS3
Synstelien, Jennifer A.-H1
Szentmariay, Istvan F.-G12, G54
Szilagyi, George-F5, F42

T

Talbott, John A.-C19
Tamburini, Edmond "Ned"-W8
Tereba, Allan-B53
Tersigni, Mariateresa A.-H27
Tewes, Warren-F35
Thali, Michael-G81, G82
Thatcher,, Jayne E.-K25
Thiam Bon, Lim-B86
Titunik, Ira R.- E12, E13
To, Denise-H60
Torwalt, Carla R.-H55
Tournel, Gilles-G14, G61
Tovar, Robert M.-D22
Trejos, Tatiana-B133
Trestrail III, John H.-W6
Tuller, Hugh H.-H16
Turner, Christopher-FS3

V

Valentine, Jimmie L.-K26, W25
Van Oorschot, Roland-W17
Vanek, Daniel-B83
Vass, Arpad A.-H53
Venkataramana Kiran, Nutulapati-K15
Vesterby, Annie-G10
Viner, Mark D.-D16
von Guenthner, Kanthi-G47

W

Waddell, Melinda J.-W8
Walbridge, Sarah E.-B136
Walls, H. Chip-W16
Walsh, Brian-E21
Walsh, Graham A.-C12
Walsh-Haney, Heather A.-H26
Walter, Richard D.-D9
Ware, Julianne-D10
Warnick, Allan J.-W3
Warren, Michael W.-H69
Watson, William J.-W17
Wecht, Cyril H.-E22, S3, W11
Wells, Robert G.-W5
Welner, Michael-BS4, WS1, WS2
Wesley, George B.-D30
Wetherton, Angela R.-G39
Whitchurch, Christian-C3
Whitcomb, Carrie M.-B22, B124, BS6, D20, W22
White, Welsh-WS1
Wickenheiser, Ray-W17
Wiersema, Jason M.-G15
Willems, Guy-F25
Wilen, Saul B.-BS2
Williams, C. Ken-SS2
Williams, David A.-F38
Williams, John A.-H34
Wilson, Mark R.-B113
Winecker, Ruth E.-W16
Winter, Daniel M.-F47
Winterling, Jill M.-K13
Witkowski, Mark R.-B17
Wojtkiewicz, Patrick W.-W17
Wolf, Barbara C.-G66
Wolf, Dwayne A.-G69, G70
Wood, Robert E.-F33, F34
Woodford, Noel-K28
Woodward, John P.L.-W20
Wu Chen, Nancy B.-K10
Wujcik, Bernard J.-F3

Y

Yadav, Bishwanath-D33, D37, D38, E8
Yang, Nicholas CS-B3
Yunis, Juan J.-B90, D13, D15
Yura, Michael-FS3

Z

Zacharisen, Michael-W25
Zelson Mundorff, Amy-W13
Zemrus, Tasha-G13
Zephro, Lauren Rockhold-H50
Zinnamon, Kristen N.-W23
Zukauskas, Gediminas-I6

Key Word Index

1

12SrRNA-B94

2

2000 Census-G2

3

3-Dimensional Digital Data Analysis-H60
3-Dimensional Imagery-H65

A

AAFS-FS4
ABFDE-J15
ABI 3100-B3
Abu Dhabi-B33
Abu Nidal-G18
Abuse & Neglect-F31
Abuse-G47, K20
Abusive Head Injury-G86, G88
Academics-B32
Accelerants-B11
Accident Reconstruction-E10, L2
Accidental Deaths-G4
Accident-D37
Accreditation-B22, B126, B128, D2, E20, J15
Acetone-G38
Acid Solutions-F49
Acute Water Intoxication-G40
Adduct-B41
Admissibility-B125
Adobe Photoshop-W24
Adsorption-B122
Advocacy-W4
AEME-B41
AFLP-B19
Age Determination-F27, H4, H14
Age Estimation-F28
Age Progression-H59
Age-Dating-C9
Ageing Methods-H5
Aggression-I20
Aging Technique-H21
Agricultural Chemical Facilities-C5
A-Hydroxytriazolam-K1
Air Bag Crash Analysis-C17
Air Bag Premature Deploy-C17
Air Embolism-G43
Aircraft Accident-BS1
Alcohol-D33
Allograft-G42
Al-Qaeda-E2
Alternate DNA Structures-B1
Alternative Mini-Primers-B61
Ambroise Tardieu-LW5
Amerindians-D13
Ammunition Cartridges-D6
Ammunition-D5
AmpFLSTR® Kits-B4
AmpFlSTR® PCR Amplification Kits-B58
Amphetamine-K8
Amphetamines-B97
Analysis-F39
Analyte-Specific-C26
Analytical Chemistry-D43
Analytical Toxicology-K31, W25
Anatomical Charting-G52
Ancestry-H12
Ancient DNA-B61
Animal Cruelty-I20
Animal Identification-W23
Animal-F47
Ankle-G64
Anomalous Data-C33
Antemortem - Postmortem-B38
Antemortem Records-F14
Antemortem-F2
Anthrax-B114, G20
Anthropological Review-G15
Anthropology-H9, H32, H58
Antidepressants-K7
Antipsychotic Drugs-W16
Antisocial Personality Disorder-I20
Aqueous Partitioning-C30
Aqueous Environments-H24
Armed Forces Medical Examiner-G16
Armed Robbery Assault-G57
Armored Vehicle-G57
Army CID-D12
Aromatic Content-B121
Arrhythmogenic Right Ventricular Dysplasia-G73
Arson Analysis-D43
Arson-B123, C13
Art Authentication-B99, B100
Artifacts-H26
Asbestos-B47
ASCLD/LAB-E20
ASCLD-B127
Asphyxia-G13
Assessment-W15
Asthma-W25
ATF Research Lab-B78, C14
ATF-B78
Atherosclerosis-G59
ATR Spectroscopy-J7
Atypical-B24
Autoerotic Death-D12
Automated Chromatogram Matching-B31
Automated Genotyping-B58
Automation-B53
Automobile Accident-G58
Automotive Paint Database-W10
Automotive Paint-B102
Autopsy Interpretation-G84
Autopsy Rates-G49
Autopsy Relevance-G49
Autopsy-E8, G3, G8, G11, G55, G61, K28

B

Bacterial DNA-B83
Ballistic-G82
Barbiturates-K19
Barefoot Morphology-H7
Barotrauma-D11
Basketball-G8
Battered Child Sydrome-G91
Battered Children-G5
Battery-D39
BCLP-F5
Bedsharing/Sleeping Position-G1
Bedsharing-G93
Behavioral Analysis-I9
Benzodiazepines-K16, K23
Beta Testing-B107
Bias Crime-I1, I2
Bias-W14
Bicarbonate-K4
Biological Profile-H43
Biomechanical-G84
Biomechanics of Motor Vehicle Trauma-W9
Biomechanics-C35, C36, C37
Biometrics-D8
Biopsy-G29
Bio-Surveillance-D35
Bioterrorism-B114, G19, G20, G26
Bio-Terrorism-D32
Bipedal Adaptation-H41
Bite Mark Analysis-F43
Bite Mark Overlays-F35
Bite Mark-BS8, F4, F32, F33, F36, F37, F38, F39, F40
Bite Marks-E12, F34
Bite-F45, F47
Blast-B94
Bleed-Through-B110
Blood Identification-B115
Blood Protein-H16
Blood Spatter Interpretation-D21
Blood-K30
Blowfly Larvae-G33
Blunt Abdominal Trauma-G7
Blunt Force Trauma-H36
Body Mass-H35
Body Weight-H43
Bone Histology-H27
Bone Scintigraphy-G5
Bone Trauma-H40
Bones-G32
Brain-G75
Braking-C19
Breaking of Rigor Mortis-G79
Bride Burning-I5
Broadsheet Newspaper-B86
Buccal Swabs-B69
Buccal-B68
Bullet Lead-B120
Bullet Recovery-B119
Bungee Cords-C23

Burials-H57
Buried Body Recovery-D1
Buried Human Remains-H65
Burned Bodies-B81
Burned Bone-B81, H37, H38
Burns-B76

C

Cables-C23
Calcium Oxalate-K29
Calibration-C27
Calligraphy-W1
Canine Detection-B40
Cannabis Sativa-B96
Capillary Electrophoresis-B39
Capnocytophaga-G6
Carbon Monoxide-G51
Cardiac Troponin I-G77
Cardiomyopathy-G72, G73
Career Planning-FS5
Career Preparation-SS2
Case Reviews-H51
Casework Samples-W2
Casework-B129
Cause of Death-G94
Caustics-G60
Cell Separation-B2
Cementum Increments-H4
Census of Publicly Funded Forensic Crime Laborator-B127
Center for International Forensic Assistance-D31
Central America-H61
Certification-H50
Cervical Smear-H55
Cervical Spine-C35
CFS-HumRT-B52
Chain of Custody-F30
Chemical Imagng-B103
Child Abduction-I16
Child Abuse-G85, G87, G88, G89, W5, W8
Child Homicide-I16
Child-G90
Childhood Suicides-G4
Childhood-G96
Chrysomya Rufifaces-G34
Citalopram-K2
Civil Commitment-I13
Civil Law-BS4
Clandestine Laboratory-B15
Clarity-D14
Clarythomicine-D24
Class 1C Arrhythmic Agents-G69, G70
Classification-C4
Clinical Chemistry-W12
Clinical Forensic Medicine-E19, G46, G89
Clinical Forensic Nurse-D29
Cocaine on Currency-B20
Cocaine Residue Recovery/Quantitation-B20
Cocaine: IMS Screening-LC/MS
Confirmation-B20
CODIS-B50
CODISmt-B55, B56
COFSE-FS1
Cold Cases-G31
Collapse-B79
Collecting Ignitables-B11
Collision Isolator Analysis-C17
Collision Reconstruction-W9
Colpscopy-G23
Combat Engineers-F19
Combatants-E3
Combitube®-G76
Commingling-H18, H19
Community Education-F31
Comparative Microscopy-B106
Comparison Microscope-J5
Comparison-B117, F9
Competence-W15
Complications-G76
Computer Aided Image Superimposition-F1
Computer Analysis-F36
Computer Animation-E9
Computer Forensics-B23, BS6, W20, W22
Computer Identification-F20
Computer Imaging-H59
Computer Modeling-B77
Computer Software-F37
Computer-F14
Concordance Study-B4
Concordance-B3
Condom Lubricants-D10
Condom Residues-B92
Conferences-D7
Confession Evidence-WS1
Congenital Cardiomyopathy-G74
Consecutive Matching Striations (CMS)-B118
Consensus-FS3
Constitution-E4
Contaminant Fate and Transport-C32
Contamination-B89
Continuing Education-H47
Conviction Match-G30
Cook County-G95
Copiers-J1
Cornelius Burley-LW3
Coroner Special Operations-D1
Corrosive Substances-H25
Co-Sleeping-G93
Cosmetics-B105
Council-FS1
Counter-Terrorism Investigations- E2, I9
Courtroom Testimony-J14
Craniofacial Growth-H59
Craniometrics-H13, H43
Cranium-H3
Crash of '746-LW2
Crash Test-C18
Cremains-H34
Crete-G55
Crime Scene Analysis-D21
Crime Scene Examination-D12
Crime Scene Investigation-B23, B114
Crime Scene-BS3, D19
Crime-D9, D28
Criminal Convictions-E24
Criminal Investigation-W6
Criminal Justice System-E10
Criminal Justice-E4
Criminal Law-BS4
Criminalistics-B95, B119, B135
Critical Incidents-SS1
Criteria for Identification-B118
Crossbow-G60
Crush Deformation-C18
Custody-G37, I21
Cut Edges-B86
Cyanoacrylate-Fuming-D4
Cybercrime-BS6, W22

D

DanceSafe Test Kit-K12
Data Collection-D32
Data Interpretation-B132
Data Review-B108
Database-B33, B50, D41
Date-Rape Drugs-K22
Daubert-H15, J14
Death Certification-G94
Death In Ambulance Car-G12
Death Investigation Dogs-H63, H64
Death Investigation-W12, W25
Death Scene Investigation-G1
Death-B76, B77, B82, E8, G9, G14, G66
Decay Rates-G24
Decomposition-G35, H31, H35, H46
Defamation-C1
Definitions of Muscular-Skeletal Robusticity-H42
Degradation-B137
Degraded DNA-B70
Delta V (ΔV)-C18
Demarcation Problem-B125
Demographics-H9
Demonstrating Pre-Crash Conditions-E9
Demonstrative Exhibits-E9
Dental Aging Technique-H22
Dental Analysis-F27
Dental Ankylosis-F42
Dental Histology-F41
Dental Identification-F16, F20
Dental Malpractice-F42
Dental Materials-F49, F50
Dental Radiographs-F17
Dental Reconstruction-F34
Dental Records-F2
Dental-F18
Dentistry-F9
Dentition-H25
Dentures-F23
Design Features-J3
Detector Dogs-B28
Development of Rigor Mortis-G79
Developmental Cycle-G34
Deviancy-D9
Device-B68
Diabetes Mellitus-G38
Diazepam-K15, K32
Dichloromethane-B122
Diesel Fuel-C11
Differential Extraction-B2
Difluoroethane-K31
Digestion Time-G33

Digital Analysis-F4
Digital Evidence-B22, B23, BS6, D20, W22
Digital Forensic Photography-F48
Digital Information-E21
Digital Media-D20
Digital Modeling-H62
Digital Photography-D27
Digital Printing-J2
Dihydrocodeine-K28
Dimple-F12
Diphenhydramine-K3, K36
Direct References-B72
Direct Visual Comparison-F21
Disability Evaluation-G50
Disaster Victim Identification-F15, G17
Disaster-F6
Disclosure-E23
Discovery-E21
Discriminant Function Analysis-H2, H13
Discriminant Function-H10
Disinterment-F19
Dislocation of Cervical Spine-C38
Disorders of Sexual Differentiation-H6
Distribution-K13
District Attorney-G21
DMORT-F7, G17
DNA Analysis-B54, W17
DNA Databank-B108, G30, G31
DNA Database-B19
DNA Exoneration-I3, I4
DNA Extraction-B8, B67, B130
DNA IQ™-B8
DNA Outsourcing-B55
DNA Profiling-H29
DNA Purification-B53
DNA Quantitation-B52
DNA Testing-B56, E24, L1
DNA Typing-B66, G15
DNA-B9, B12, B29, B30, B34, B38, B39, B57, B59, B68, B74, B85, B89, B90, B106, BS8, D25, D26, D41, F8, G28, H20, H23, H55
DNA-Typing-B91
Document Analysis-J10
Document Casework Notes-W21
Document Examination-J2, J8, J13
Documents-J5, J7
Dog Bites-F43, F46
Dog-F45
Domestic Violence-I8, W8
Dopamine D2 Receptore-I7
Dowry Death-I5
Dr. McCrone-B44, B45, B46, B47, B48, B49
Drinking-D33
Drive-F45
Drowning-G40, G43, G61
Drug Analysis-B21, B88
Drug Database-B88
Drug Excretion-K1
Drug Facilitated Sexual Assault (DFSA)-B13
Drug Interaction-K25
Drug Levels-G66
Drug Toxicity-W16
Drug-D33
DSC-B97
Due Process-E5
DUI-K23
Dumped Bodies-H32
Duplicating Film-F12
Duragesic®-G67
Dyes & Pigments-B99
Dyes-B140
Dysgraphia-J13

E

Ear Prints-B116, B117
Ecstasy-K12
Ecuador-B35
Education-B32, D7, D34, FS2, FS3, H48, H49
Elasticity-C23
Elder Abuse-G46
Elder Neglect-G46
Elderly-G11, G45, G47
Electric Injury-G81
Electrical Accidents-C21
Elemental Analysis-B120, B133
ELISA-K17
Emergency Planning-D16
Emerging Forensic Scientists-SS3
EMS Transportation-G12
Enemy Detainees-E3
Enemy-combatant-E5
Environmental Forensics-B84
Environmental Gasoline-C34
Environmental Transport-C33
Environment-C2, C10
Ephedrine-B15, K21
Epilepsy-G10
Equilibrium Constant-B14
Error-C27
Escalated Homicide-G91
ESDA-J1
Esophageal Rupture-G76
Ethanol-K6, K32
Ethics-E23
Ethylene Glycol-K29
Evidence-D3
Evil-BS4
Examination of Documents-J9
Excessive Force-D39
Executive Orders-E11
Exhumations-E16, H17
Expert Testimony-W11
Expert Witness-E23, W11
Expert Witness Testimony-SS2
Expert-C13
Explosion-G56
Explosions-C16
Explosives Analysis-B6
Explosives-B40, B46
Extraction-B21
Exxon Valdez-C1

F

Fabrics-H33
Facial Reconstruction-H62
Fall-G84
Falling From Height-G54
Falls From Heights-H39
False Confession-I3, I4
Famprofazone-K8
Fast Gas Chromatography-K19
Fast GC-C3
Fatal Fires-B78
Fatality-G65, K5, K27
Father Damien-LW4
Fatty Acid Ethyl Esters-K34
Feature Extraction-J10
Female Internal Genitalia-G39
Fentanyl-G67, K33
FEPAC-FS4
Fetal Exposure to Alcohol-K34
Fetal Metabolic Acidosis-K4
Fiber-B138, B139
Fibers-B135, B136, B137, B140
Fiber-Transfer Studies-B136
Field GC-MS Analysis-C3
Field Recovery-H58
File-G27
Filicide- I12, I17
Fingernail-B5
Fingerprinting-C8
Fingerprints-B103, D4, D8, F38
Finite Elements-H40
Fire Debris Analysis-B6, B31, B121, B122, W18
Fire Debris-B11, D43
Fire Dynamics Simulator-C15
Fire Investigation-B78, B81, C14, C29, G52, H37, H38
Fire Investigations-C15
Fire Modeling-B80, C15
Fire Protection-B79
Fire Suppression-H30
Fire Testing-C14
Firearms and Tool Mark Identification-B118
Firearms-B119, D5
Fire-B76, B77, B82, BS1, C20
Flashback-C13
Flecainide-G70
Flexion Injury-C35
Flour Dust Exposure-D38
Fluorescence-B115
Footprint/Impression Evidence-H7
Foreign Body Asphyxiation-G11
Forensic Accounting-WS2
Forensic Anthroplogy-H49
Forensic Anthropology Facility (ARF)-G24
Forensic Anthropology-H8, H17, H19, H20, H21, H22, H24, H30, H33, H34, H35, H36, H39, H47, H48, H50, H51, H66, H68, H69, H71, H72
Forensic Archaeology-H52, H70
Forensic Botany-D34, G36
Forensic Courses-H53
Forensic Dentistry-F8, F24
Forensic Entomology-F24, G24, G25, G35
Forensic Expert Medical Opinion-G50
Forensic Experts-SS1
Forensic Identification Procedures-W3
Forensic Identification-F1
Forensic Medecine-LW5
Forensic Mental Health Assessment-I15

Forensic Mortuary Site Archaeology-H47
Forensic Nursing-D3, D40
Forensic Odontological Assessment-F5
Forensic Odontologist-E13
Forensic Odontology-F1, F2, F10, F11, F13, F21, F28, F29, F37, F48, F49, F50, H14
Forensic Pathology-G64
Forensic Podiatry-H7
Forensic Processes-BS2
Forensic Psychiatry & Psychology-WS1
Forensic Psychiatry-I10, I12, I17, I22, WS2
Forensic Radiology-D16
Forensic Science Education-FS1, FS4, FS5
Forensic Science-B32, B48, B49, B80, B116, B117, C4, F17, F26, FS2, G51, G63, G71, G81, G82, H39
Forensic Sciences-C24, D7, F24, F28, G22, G45, H15
Forensic Scientific Investigation-SS3
Forensic Skill Applications-E7
Forensic Soil-B27
Forensic Toxicology-E17, K16, K36, W12, W16
Forensic-B26, BS3
Forensics-C12, E10
Forensic Psychiatry-I12
Forgeries-J8
Fourth Amendment Rights-D39
Fracture Mechanics-H40
Fracture-G92
Fragmentation-F3
Frame by Frame-D22
Fraud-W14
Free Product-C30
Freezing Process-H27
FT-ICR MS-C6
FTIR-B105
Fuel System Run-On-C20
Fuel System-C20
Fujita-Pearson Scale-D11
Funding-W4

G

Gabapentin-K30
Gamma-Hydroxybutyric Acid-B14, B16
Gander-F16
Gas Chromatography-C7, K10
Gasoline Precautions-C16
Gasoline Release-C34
Gasoline Storage-C16
Gasoline-C9
GBL-B17, B18
GC/MS-B92, B101, K9
GC/ToF-MS-B31
GC-FID-C11
Gel Inks-B98
GeneMapper™ ID Software-B58
Genetic Admixture-D15
Genetic Analysis-H28
Geneva Convention-E3
Genotype-B4
Genotyper-B54
Genotyping-B113
Geographic Analysis-H32
Georgia Bureau of Investigation-G89
Gesticular Probing-D22
GHB Free Acid-B16, B17, B18
GHB-G65, K14
Glass Analysis-B132, B134
Glass Cut-F40
Glass-B133, C4
Glitter-B24
Gloves-B89
Glutathione-B41
GPS-H58
Graves-H67
Ground Penetrating Radar-H65
Groundwater Plume-C31
Groundwater-C32
Guide-D18
Gunshot and Blunt Force Trauma-H57

H

Hair DNA-B10
Hair-B106, K14, K35
Halcion®-K1
Halotype Reference Database-B51
Hand Radiographs-H44
Handedness-B95, H1
Handwriting Evidence-E18
Handwriting Individuality-J10
Handwriting-J11, J12
Hanging-G37, LW3
Haplotype-B64
Harris County Medical Examiner Office-G68, K24
Hate Crimes-I1, I2
Head Injury-W5
Head Model-G83
Headspace Analysis-K6
Healthcare Professional-E14
Healthcare Professionals-E15, E16, G68
Heart-G72, G75
Hemangioma-G75
Hemifacial Atrophy-F42
Hepatitis-G42
Herbicides-B84
Heteroplasmy-B10
High Resolution-C6
Hispanic Populations-F26
Historic DNA-H29
Historical Aerial Photography-C5
Historical Manuscripts-W1
History-LW5
Hit-and-Run Vehicle Identifications-W10
Homicide-D21, G21, G45, G60, G61, G71, G90, I12, I16
Honor Death-G18
Hospital Homicidal Poisoning-W7
Hospital-D28
HPLC-B13, K7
HPLC-MS-MS-K16
HS 101; TMX HS110-K6
Human Identification-B12, B57, B85, F21, G64, H8, H12, H15, H18, H19, H20, H21, H22, H44, H69
Human Mitochondrial DNA-G33
Human Remains-H31
Human Rights-H66
Human Skeletal Remains-H55
Humanitarian Missions-D31
HVI/HVII Linear Array-B107
HVI/HVII-B109
Hydraulics-C32
Hydrophilic Interaction Chromatography-K18
Hyoid Bone-G48, H10
Hyperextension-G59
Hypertrophic Cardiomegaly-G41
Hypertrophy-G72
Hyponatremia-G40

I

ICMP-B9, B29, B30, B57, B83, B85
Icon-G27
ICP-MS-B132
Identification-B38, B93, D18, F3, F18, F22, F23, F29, F36, H68, LW3, WS3
Identifications-D26
Identifier-B3
Ignitable Liquids-W18
Image Analysis-G80
Image Resolution-F48
Imaging-B104
Immunoassay-K21
Impact Impressions-D6
Impaired Writer-J13
Impulsive Homicide-G91
Impurity-D23
Imputability-D24
In Vivo-F33
Inaccurate Charting-F17
Incapacitation-G83
Incidence-G44
Incident Reconstruction-C22
Indentification-H72
Independent Analysis-BS8
Indirect References-B72
Individualization-J11
Infancy-G41
Infant-G92
Infants-K37
Inferential Relationships-BS2
Infusion Pump-K33
Injury Severity Score-G54
Injury Surveillance-D32
Injury-C36, C37, G56
Ink Analysis-B98, J6
Ink-J7
Inkjet-J2
Inks & Pigments-B100
Innocence Project-L1
INS-F27
Insurance-D37
Interaction-K32
Interagency Cooperation-LW1
Interlaboratory Study-B60
Intermediate Target-G82
Internal Standard-K11
International Collaboration-F15
International Database-D31
International Law-H66
Interpersonal Violence-W8

Interpol's Standards-F15
Interpretation-B110
Intoxication-K29
Intrathecal-G14
Intravenous-K5
Ion Mobility Spectrometry-K15
IR Spectroscopy-B17
ISO Standards-E20
Isolated Noncompation of The Left Ventricle-G74

J

Judicial Due Process-E1
Judicial-I21
Jurisdictions-SS1
Jurisprudence-E19, WS1

K

Ketamine and Norketamine-K22
Ketoacidosis-G38
Kidnapping-WS3
Kinetic Energy-H34

L

Laboratory Accreditation-B129
Laboratory Management-D42
Lady Diana-L2
LA-ICP-MS-B102
Lambda DNA-H45
Laryngeal Trauma-G48
Laser Ablation-B133
Laser Desorption-C7
Laser Ionization Mass Spectrometry-C7
Latent Fingerprints-D27
Law Enforcement Training-H50
LC/MS-B84
LC-MS-B140
LC-MS-MS-K35
Lead-C9
Leprosy-LW4
Lethal Drug Identification-E17
Liability Separation-C31
LIB-B102
Lidocaine-G71
Limitations-D14
LIM's-B71
Linear Arrays-B37, B109
Liquid-Codeine-K24
Litigation-C10
Load Stress-C39
Lobbying-W4
Locard-B24
Locked Facets-C38
Log Trailer-C19
London Nail Bomber-E19
Lorazepam-K27
Low Copy Number DNA Analysis-W17
LSD-K9
Lucis Imaging Technology-E12
Lyell's Syndrome-D24

M

Maceration-H23, H28
Maggot Crop-G25
Maggot Mass-G34
Magnetic Resonance Microscopy-G81, G92
Majority-F25
Mapping-D19
Marijuana-B19
Marine Environment-G62
Marine Taphonomy-H31
Mark-F47
Masking Identity-H25
Mass Disaster Training-F13
Mass Disaster-B72, B73, BS1, F11, F14, G15, G32, H8
Mass Disasters-B74, B130, D16, H72
Mass Fatality Incident-D17
Mass Fatality Incidents-W3
Mass Fatality Recovery-H70
Mass Fatality-D18, H68, W13
Mass Grave-B93
Mass Graves-H17, H54
Mass Spectrometry-B99, B100, B113, C6, J6
Massacre-SS3
Mass-Disasters-F16
Matrix-Specific-C26
McCrone-B42
MDA-K11
MDMA-B28, K11, K12
Measurement Accuracy-B60
Measurements-H18
Meconium-K34
Media Relations-G16
Medical Examiner-G21
Medical Examiner's Office-G95
Medical Examiners-G19
Medical Expert Testimony-E22
Medical Investigation-D30
Medical Malpractice-E22, G50
Meningeal Hemosiderin-G85
Metallography-C12
Metaxalone-K2
Metformin-K18
Methadone-G66, K20
Methamphetamine-B15, D23, K8, K37
Methanol-C28
Method Detection Limit-C26
Methodologies in Forensic Anthropology-H42
Meuse Argonne-F19
Michael Swango-E15
Microanalysis-C2
Microchemistry-B42
Microchip Technology-B2
Microchip-B39
Microsatellites-B62
Microscopic-B92
Microscopy-B42, B43, B44, B45, B46, B47, B115, H27
Microspectroscopy-B138, B139
Military War Deaths-SS3
Military-I6
Miniplex-B70
Missing Persons Repository-F29
Missing Persons-G36
Mitochondria-B94, W2
Mitochondrial DNA Analysis-B75
Mitochondrial DNA-B50, G25
Modus Operandi-D36
Molokai-LW4
Mongoloids-H13
Monozygotic Twins-F20
Morgue Operations-D17, W13
Morphine-K27
Morphological Variation-G48
Mortality-G95
Motor Vehicle Accident-G7
Movies-BS3
MtDNA-B10, B37, B107, B109
Multidisciplinary Teams-W3
Multidisciplinary Victim Identification-F11
Multifactorial-G58
Multiple Pattern Injuries-F44
Multiple Suspects-F44
Multiplex-B64
Murder-F44, W6
Muscle Paralyzing Drugs-W7
Myocardial Fibrosis-G10

N

National Center for Forensic Science-B124
National Forensic Academy-H53
National Forensic Laboratory Information System-B88
National Security-E5
Necrotizing Lymphadenitis-G20
Neglect-G47
Nerve Gases-K26
Neuroimaging-I19
New Euro-J3
New Forensic Science Discipline-D20
Newberry Library-W1
Ninhydrin-D4
NMR Spectrometry-B18
Non-Human DNA Evidence-W23
Nonmetric Traits-H12
North Carolina-G2
No-Suspect and Suspect Casework-B55
No-Suspect Casework-B56
Note Taking-W21
Notes-W21
Nuclear DNA From Hair Shafts-B130
Nuclear DNA Preservation-H46
Nuclear DNA-G32

O

Objectivity-E18
Occupant Injuries-G57
Odontology Tools-E12
Odontology-F3, F6, F22, F23, F25, F32, F41
Offender Hit-G30
Offender Motivation-I1, I2
Oils-B101
Olympic Peninsula-LW2
Operational Methodology-E2
Opiates-K24
Opioids-K28

Oral Injuries to a Biter-F40
Orientation-F12
OSHA-C21
Osteology-H5
Outcomes-B126
Out-of-Hospital Cardiac Arrest-G12
Outsourcing-B71
Overdose-K2, K33
Overlay-F4
Oxycodone-K5, K13, K17, K20

P

PAHs-C10
Paint Data Query (PDQ)-W10
Pakistani-B26
Palette-G27
Panama-B75
Pancreatic Cancer-G63
Paraffin Blocks-B7
Paraguay-B36
Participant Demographics-H49
Paternity Testing-B90
Patient Safety-D30
Pattern Injuries-BS7
Patterns of Inhumation-H67
PCBs-C33
PCR DNA Analysis-B5
PCR Inhibitors-H29, H45
PCR-B1, B87
Pediatric-G96
Pediatrics-K36
Pedophile Killers-I18
Pedunculated Esophageal Lipoma-G13
Peeling-D22
Pellet-D5
Pelvic Dimensions-H41
Pelvic Shape-H41
Penetrating Trauma-H56
Pentagon 9-11 Identifications-G16
Pepper Spray-B25
Perimacular Retinal Folds-G87
Personal Identification of Human Remains-H42
Petechial Hemorrhages-G44
Petroleum Hydrocarbons-C30
Petroleum Products-B121, C11
Philately-BS5
Philosophy of Science-B125
Photocopied Documents-J9
Photogrammetry-C22
Physical Anthropology-H5, H14, H60, H61
Physical Constants-C29
Physician Attitudes-G49
Pick-Up-C19
Pink Teeth-G62
Pipe Bombs-C12, G28
Pit Bull Terrier-F43
Plant DNA Typing-W23
Poisoning Patients-E17
Poisoning-K18
Poison-W6
Polarization-B139
Police Interrogation-I3, I4
Police-BS7, I6
Politics-D26
Polymorphism-B61, I7
Polynomial Texture Mapping-B104
Population Database-B37
Population Genetics-B34
Porcine-F33
Portable GC-C3
Postmortem Changes-F41
Postmortem Distribution-G67
Postmortem Examination-G3
Postmortem Findings-G56
Postmortem Genital Exams-G23
Postmortem Interval-G35, G77, G78, H33, LW1
Postmortem Profiles-F22
Postmortem Staining-G62
Postmortem Toxicology-K25, K30
Postmortem-E8, K3, K13, K31, K37
Powerplex®-B90
Powerplex-16™-B35, B36
PowerPlex™ 1.1-B5
Precious Doe-F18
Preliminary-F39
Presa Canario-F46
Primer Extension-B111
Printers-J1
Printing Devices-J5
PRISM-H60
Probability of Paternity-B7
Processed Fingerprints-B67
Product of Conception-B7
Professional Disciplinary Actions-E22
Profiling-B123, D23, D36, I9
Propafenone-G69
Propofol-K4
Prosecution-E14
Protocols-E13
Pseudoephedrine-K21
Pseudoscientific Interpretation-B129
Psuedo 3-D Computer Overlays-F35
Psychological Profiles-E1
Psychotherapy-I21
PTM-B104
Public Health-D35
Public Transportation-E11
Pulmonary Function-D38
Pyrolysis-B97
Pyrosequencing-B112

Q

Qatar-B34
QIAamp-B8
Qiagen BioRobot-B69
Quadriplegia-C38
Qualitative Analysis-C8
Quality Assurance-B128, C8, D2, D30, W18
Quality Management-D29
Quality Manual-D2
Quantitation-B53
Questioned Document Examination-J4
Questioned Documents-B98, J9, J14

R

Race-H3
Radiographic Digitalization-W24
Raman-D10
Rape-G22, K14
Rave-G65
rDNA IGS-B96
Real-Time PCR-B52
Recognition & Reporting-F31
Recovery Operations-W13
Recovery-WS3
References-B73
Reflectance-B105
Regression-C27
Report Writing-D14
Research-B124, J11
Resource-D42
Response Ratio-K17
Restraint Systems-G58
Retinal Hemorrhages-G86
Retinal Hemorrhage-W5
Retinal Periphery-G86
Rib Fractures-H36
Rigor Mortis-G79
Risk Assessment-I8
RNA Degradation-G78
Road Traffic-D37
Rollover-C37
Root Cause Analysis (RCA)-D29
Rottweiler-F46
RT-PCR-G78

S

Sadism-D9, I18
Sado-Masochism-G22
Sample Preparation-B21
Santeria-H26
SB-17-LW2
Scanning Electron Micrscope-C2
Scene Investigation-G36
Science-W14
Scientific Fraud-C1
Scientific Method-J12
Scientific Working Group Digital Evidence (SWGDE)-B22
Screening-D25
SCUBA Diving-G43
Season of Death-H4
Security Features-J3
Self-Cleaning Window Glass-B134
Self-Made Rifle-G53
SEM-EDS-B27
Semen-G39
Sepsis-G6
Serial Crime-I11
Serial Killer-E14
Serial Killers-I10, I11
Serial Killings-I18
Serial Sexual Offenders-W19
Service-D42
Sex Determination-H6, H10
Sex Estimation-H2, H11
Sex Offender Registration-I15
Sexual Abuse-E24
Sexual Assault-G31
Sexual Dangerousness-I14
Sexual Dimorphism-H2, H11

Sexual Homicide-G23, I11
Sexual Offender-I13, I14
Sexual Offenders-I19
Sexual Predator-I13
Sexually Dangerous Person-I14
Sexually Violent Offenders-I15
Shaken Baby Syndrome-G87
Sharp Force Trauma-H56
Sharp Trauma-H23
Shedding-B136
Shoelaces-B95
Shoeprints-B115
Shooting Scene Reconstruction-D6
Short Tandem Repeat (STR)-B66, W2
Short Wave Ultraviolet Light-D27
Short-Courses-H48
SIDS-G3
Silica-B59
SIM-K9
Single Nucleotide Polymorphism-B111
Single X-Ray Identification-F10
Skeletal Analysis-H6
Skeletal DNA-H28, H45
Skeletal Identification-H63, H64
Skeletal Remains-F9, G63, H26
Skeletal Survey-G5
Skeletal Trauma-G52, H37, H38
Small Amplicons-B65
Smallpox-G19, LW1
Smoke Inhalation-G51
Smoking-D38
SNP Analysis-B113
Snuff Film-G80
Soil Analysis-H16
Soil-C28
Solid Phase Microextraction-B14
Solid-Phase Extraction-K19
SPE-B25
Special Decedent Recovery-D1
Species Identification-B96
Spectroscopic Analysis (FTIR, NMR)-B16
Sperm After Washing-B91
Spermatozoa-G39
Sperm-B91
Sphenoid Sinus-G44
Spinous Process-H1
Splenic Laceration-G7
SPME-B6, B13, B25, B28
SPME-GCMS-B40
Spongy Myocardium-G74
Sports Track Medical Liabilities-D40
Srebrenica-B12
SR-XRF-B131
Stable Isotopes-B123
Staging-D36
Stalking-I8
Stamps-BS5
Standards-C25, W15
Staten Island Landfill-F7
Stationary Phases-K7
Statisics-D28
Statistical Analysis-B51
Statistics-B120
Statutes of Limitations-E11
Stereo Microscope-B27
Stereoscopic Analysis-C5
STR Analysis-B108, B110
STR Multiplex-B60
STR Testing-B74
STR/DNA-E21
Strategies of Murder-H67
STR-B9, B29, B30, B33, B35, B36, B59, B65, B69, B70, B83, B93, D13, D15, D41, G28, G29
Stress Index-C39
STRs-B1, B54, B73, B87
STR's-B67
Structures-B79
Sub-Adult Skeletons-H57
Subadults-H3
Subarachnoid Hemorrhage-G59
Succinylcholine-W7
Sudden Death-G8, G13, G41, G73
Sudden Infant Death Syndrome-G2, G93, G94
Sudden Infant Death-G1
Sufentanil-G68
Suffocation-G90
Suicide by Incineration-H30
Suicide-G37, G53, G55, G69, G70, G83, G96, I6, I7
Survey-H54
Survival Time-G54
Suspicious Deaths-E16
Suspiciousness Factor-D3
SWAT-BS7
SWGDAM Validation-B63
Switzerland-K23
Syndromic Surveillance-D35

T

Tabloid Newspaper-B86
Tampering-D8
Taphonomy of Clandestine Graves-H63, H64
Taphonomy-B137, H24, H46, H61
Tattoos-G9
Teaching-B45, H52
Technical Court Testimony-F38
Techniques-D34
Technology-D19, W20
Tenability-B80
Terrorism Prevention-BS2
Terrorism-B82, BS5, E1, E4, E7, G18, H69, W20, WS2
Test Validation-J15
Test-Foot Acclimation-C24
Testimony-E18
Tests-C25
The State Institute of Forensic Medicine-J4
Therapeutic-K3
Thermodynamics-C29
Third Molars-F25, F26
Three-Banded Pattern-G29
Time Since Death Marker-G77
Tissue-G42
Tools-E13
Topographic Tooth Mapping-F35
Toxic Mold-C25
Toxicology-K10
Trace DNA Analysis-W17
Trace Element-B131
Trace Evidence-B103, B131, B134, B135, D10
Tracking-B71
Traffic Accident-L2, G10
Training Opportunities-H52
Training Programs-H51, H53
Training-B124, B128, FS2, FS3, G26, K10
Tramadol-K25, K35
Trampoline-C36
Tranquilizer-K15
Transient Evidence-F30
Traumatic Brain Injury-G85
Traumatic Diffuse Axonal Injury-G88
Triage Station-D17
Trial Preparation-W11
Tribute-B43, B44, B48, B49
Turkey-G9, I17, J4
Twenty Year Complex Therapy-F5
Tympanic Membrane-D11

U

UIC-B127
Ulna-H11
Undergraduate Programs-B126
Uniqueness-F34
United Airlines Flight 93-G17, H71
United Flight 93-H70
Unnatural Childhood Deaths-G4
Unnatural Death-I5
Unusual Patterned Trauma-H56
Urine Analysis-K26
Urine-K22
UV-B138

V

Validation Study-H44
Validation-J12
Vampirism-I22
Vehicle Dynamics and Kinematics-W9
Vehicle Fluids-B101
Vendor's Considerations for First-aid Care-D40
Vertebral Column-H1
Vesicant-K26
Veterans Administration-E15
Victim Identification-F10, H71
Victims-B75
Video Analysis-G80
Vindesine-G14
Violations-C21
Violence-I10, I19, I22
Violent Sexual Fantasy-W19
Violent Sexual Offenses-W19
Virtual Clay-H62
Virtual Staff Extension-G26
Visual Imagery-H54
Volatile Fatty Acids-H16
Volatile Organics-C28
Voluntary-D25
Volunteer Opportunities-E7
Voter Fraud-J8

W

Walkthrough-F30
Walkway-Safety Tribometry-C24
Walter McCrone-B43
Water Supply-C34
Waterloo Profiler-C31
Web Database-J6
Whiplash-C39
William M. Bass Donated Collection-H9
WinID3 Training Program-F13
WinID- F8, W24
Wire Frame Rendition-C22
World Trade Center-B65, F6
Wound Healing-F32
Wrongful Convictions-L1
WTC-F7

X

X-Ray-F50

Y

Y-Chromosome Haplotype-B112
Y-Chromosome-B62, B66, B111, D13, D15
Young Forensic Scientists Forum-FS5
Y-PLEX 6-B87
Y-PLEX™6 and Y-PLEX™5-B63
Y-SNP-B112
Y-STR Database-B51
Y-STR-B26, B63, B64
Y-STRs-B62

Z

Zip Gun-G53
Zoonotic-G6