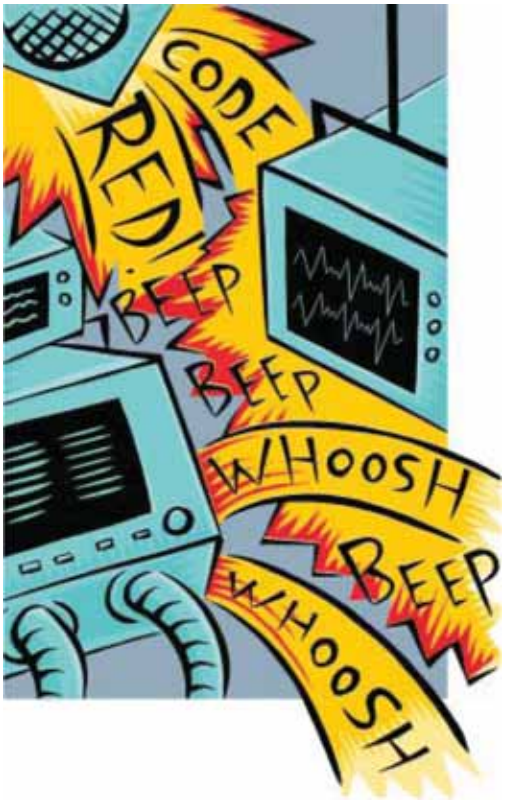
# Sound Practices: Noise Control in the Healthcare Environment.

"Unnecessary noise is the most cruel abuse of care which can be inflicted on either the sick or the well," Florence Nightingale wrote in her 1859 book, *Notes on Nursing*.[1] Understanding the basics of sound transmission and measurement is essential to a realistic assessment of a facility's sound environment.




Despite—or, to some extent, because of—incredible advances in medical technology over the past century and a half, noise remains a large and largely unsolved problem in healthcare environments. In fact, a new study by acoustical engineers at Johns Hopkins University found that hospital noise levels have increased steadily over the past 50 years. Since 1960, average daytime hospital sound levels have risen from 57 decibels to 72 dB, while average nighttime levels have jumped from 42 to 60 dB—all far exceeding the World Health Organization's recommendation of 35 dB as a top measure for sound levels in patient rooms.[2]

The Johns Hopkins researchers reported that medical and communications technologies were major culprits behind increasing noise levels. Communications devices like overhead pagers and cell phones fill the air with that most distracting of sounds—human speech—and patients and healthcare workers find themselves raising their voices ever louder in an effort to be heard over the din. Within patient rooms, monitoring and life-sustaining equipment continually beeps and whooshes around patients' beds, occasionally erupting into alarming warning signals.[3] "These noises are concentrated around the patient's head," notes Linda Greenberg, clinical consultant for Herman Miller for Healthcare, "because that's where caregivers naturally tend to position equipment so it's easier to use with the patient."[4]

## Effects on patient outcomes

Modern research suggests that Florence Nightingale wasn't exaggerating when she referred to hospital noise as "abuse." Studies show that high levels of sound have negative physical and psychological effects on patients, disrupting sleep, increasing stress, and decreasing patients' confidence in the competence of their clinical caregivers.[5]

A considerable body of research has documented the effects of noise on patient outcomes. For example, exposure to sudden, unexpected noise raises patient heart rates and has been proven to have a negative influence on patient recovery times.[6] Chronically high levels of sound, on the other hand, tend to increase blood pressure levels; a new study by University of Michigan researchers found a direct correlation between overall decibel levels and blood pressure levels.[7]

Higher blood pressure leads to a higher risk of cardiac problems, and a team of European researchers, in a study of 4,115 patients in 32 Berlin hospitals, found that chronic noise increased the risk of heart attacks by 50 percent for men and 75 percent for women.[8] In a hospital environment, where people are already ill and psychologically stressed, unnecessary noise can be very harmful.

## Impact on staff effectiveness

Although the effects of noise on those working to care for patients in hospital environments are less well documented, hospital staff is clearly affected in many of the same ways. "People who work in noisy environments for long shifts, day in and day out, also have similar stress-induced experiences," says Susan Mazer, president of Healing Healthcare

Systems. “They report everything from exhaustion to burnout, depression, and irritability expressed at home.”[9]

Recent findings in the field of cognitive science show that mental activities requiring a lot of working memory, such as paying attention to a variety of different cues or performing a complex analysis, are especially noise-sensitive.[10] The frequent interruptions and distractions noise causes often result in medication errors, one of today’s most challenging issues in delivering care, according to clinical consultant Greenberg. “Since noise breaks concentration, it can contribute to the number of medication errors that is becoming a costly and dangerous situation in many healthcare facilities.”[11] When a sudden loud noise causes an involuntary reflex reaction in a surgeon or when a nurse fails to hear a warning signal over the general sound level in a chronically noisy ICU, performance suffers and accidents can result.

Swedish researchers studying a coronary critical care unit found that healthcare workers exposed to different levels of noise over the workday reported higher levels of stress and tension during periods defined as acoustically “bad “ (as measured by sound pressure levels, reverberation time, sound propagation, and speech intelligibility). During acoustically “good” periods, staff perceived the work environment more favorably, and patients correspondingly judged staff attitudes and care to be better than during the “bad” acoustical periods.[12]

## Considerations of privacy

Interfering and distracting sounds can contribute to medical and nursing errors, and the Joint Commission on Accreditation of Health Care Organizations (JCAHO) standards state that “ambient sound environments should not exceed the level that would prohibit clinicians from clearly understanding each other.”[13] On the other side of this acoustical coin, however, is the issue of patient privacy, brought to the forefront in recent years by the Health Insurance Portability and Accountability Act (HIPAA).

Speech privacy is important in any healthcare setting. Patients know that if they can overhear conversations in nearby rooms or nursing stations, others can overhear their conversations as well. A lack of auditory privacy can make people uncomfortable and less likely to discuss private matters with their caregivers.

## Why it’s so noisy

Former patients often note the supreme irony in the fact that the hospital environment, the place where quiet is most essential, is the one place it’s least likely to be found. There are reasons for this, of course, most of which have to do with concern for patient health and safety.

In addition to the sound emanating from all the machines and human beings working to monitor and promote patient health, a major cause of noisy hospital environments is the built environment itself. Hospital interiors and furnishings are typically made of

hard, reflective materials that won't harbor infectious organisms and are easily cleaned. All these sound-reflecting surfaces propagate noise down hallways and into patient rooms, causing sounds to echo, overlap, and linger.[14] Rolling equipment such as procedure carts and housekeeping dollies moving across uncarpeted floors add to the din, as do pneumatic tube systems, metal chart holders, and elevator doors and alarms.

The sheer number of people required to care for hospitalized patients—nurses, physicians, technicians, and maintenance and housekeeping staff—contributes to the sound level, and the ratio of staff to patients rises with acuity levels. "Inpatient centralized nurse stations have the highest concentration of people in the smallest footprint," notes clinical consultant Greenberg.[15] "While smaller, decentralized stations where two to three caregivers work are becoming common, the problem of noise can still persist. Even with staff dispersed in decentralized substations, small groups of people frequently congregate in the areas just outside patient rooms."[16] During shift changes and physician rounds, these gatherings create peak times of occupancy and noise.

## Basics of sound and noise

Sound is the effect of vibration on air. Vibration—of vocal cords, of a ringing alarm bell, of a cart wheel that hasn't been oiled—creates sound waves that transmit the energy of the vibration away from its source. The human ear is sensitive to both the rate of vibration (the frequency of the sound waves) and its intensity. The intensity, the physical pressure of vibrating air particles on the ear drum, is experienced as loudness and measured in decibels. To give an idea of the magnitude of sounds that can be found in hospital environments, the decibel level of a portable X-ray machine is roughly equivalent to that of motorcycle; a bedside monitor alarm approaches the intensity of sound created by heavy truck traffic.[17]

While sound can be measured objectively, noise is a subjective phenomenon and not an acoustic property. The Environmental Protection Agency defines noise as "any sound that may produce an undesired physiological or psychological effect in an individual or group." The Occupational Safety and Health Administration's definition is simply "unwanted sound." Since there's no way to measure noise empirically, it must be assessed in relation to other factors—decibels in context, in other words. At the wrong time or place the sound of laughter may be more disturbing than the louder but more appropriate sound of an infusion pump or heart monitor.[18]

It's also important to understand, acoustics experts say, that when it comes to sound management silence is not golden—or the goal. If the level of continuous sound or noise floor of a space is too low, conversations can be easily overheard and sharp sounds like a cabinet door slamming or a glass breaking can startle people unnecessarily. Noticeable changes in sound levels over time and in different areas of the hospital facility make it harder for patients and caregivers to block out unwanted sound. A continuous and consistent noise floor ranging between 42 and 48 dBA can help preserve speech privacy and protect concentration.[19]

All noise is sound, but all sounds are not necessarily noise. The sound of caregivers moving quietly through the corridors can be reassuring to patients in their rooms. The sound of a harp playing in the background can be soothing, even healing.

## Assessing and managing the sound environment

Hospitals need auditory environments that promote clear and timely communication while also protecting proprietary information from being overheard and possibly misused or misunderstood. Closed doors and other visual barriers can hamper staff accessibility without assuring that patients and their families won't hear proprietary information or preventing nurses and physicians from exchanging critical information at the right time but in the wrong place.

Designing sound environments for hospital facilities, then, must include considerations of intelligibility levels as well as decibel levels.

The first step in reducing noise in hospital environments is identifying its sources. A digital decibel meter is an effective tool for measuring the sound levels of specific areas of the hospital at different times of day. The "Sound Quality Committee" at an Atlanta area hospital measured the decibel levels of 238 pieces of equipment, from rolling carts to monitors to communication devices, finding that different mixes of sound sources contributed to the noise levels at different times of day.[20]

In addition to quantitative measurements, of course, it is important to assess the perception of noise by patients and their families. This can be accomplished by reviewing patient satisfaction survey results on issues related to disturbances caused by noise.

Once noise sources have been identified, a variety of noiseabatement strategies, from sophisticated sound-masking systems to "Quiet, Please!" signs, may be employed. In general, studies of the effectiveness of different measures suggest that design interventions are more successful than organizational or behavioral interventions.[21] However, policy changes regarding use of communications devices can be effective. Switching from loudspeaker paging to vibrating beepers and setting standards governing the use of cell phones, nurse call systems, and the discussion of confidential information in public spaces can go a long way toward reducing unwanted sound and protecting patient privacy.

Environmental design strategies for noise reduction include the maintenance and replacement of hospital equipment, the layout and acoustical treatment of patient rooms, nurses' stations, and corridors, and the implementation of emerging technologies to mask sound, reduce speech intelligibility, and introduce healing sound into the environment.

## Equipment repair and replacement

With all the rolling carts and machines in hospitals today, considerable noise reduction

can be achieved by simply fixing or replacing squeaky wheels and scheduling regular maintenance to keep mobile equipment in quiet working order. The noise level of heavy rolling equipment can be reduced by as much as 30 decibels just by lubricating the moving parts.[22]

Other effective strategies include padding chart holders and pneumatic tube systems, and lowering volume levels on clinical and communication equipment. Making purchasing choices that are based on auditory performance—selecting folded towel dispensers over rolltype dispensers, for example, or choosing cleaning and maintenance equipment not only for its price and function but also for its decibel output—can contribute to quieter environments.

As hospitals adopt Electronic Medical Records (EMRs), they significantly reduce paper charts. However, during the transition to electronic records, charts, with the noises that result from handling them, will persist. Another problem—noise from overhead paging systems—won't recede until more facilities adopt nurse call systems that use wireless technology.

## Design of patient rooms and adjacent areas

Walls are still the first line of defense in acoustic design. Physical barriers between patients and noise sources will block sound movement fairly effectively if they are of the proper height and constructed of sound-absorbing materials. However, the floor and ceiling can do more to collar noise. Together they typically account for 70 to 80 percent of the acoustical properties of a patient room.

Noise levels are obviously much lower in single-bed rooms than in shared rooms or bays. Studies consistently show that most of the noise in a shared room is associated with the presence of another patient. One survey of more than two million patients receiving care in 2003 found that patient satisfaction with hospital noise levels was over 11 percent higher in single rooms than doubles.[23] In new hospital construction, there is already a trend toward standardizing on single-bed private rooms.

In areas like ICUs and nurses' stations, where visual access is essential, clear plexiglass or nonbreakable glass is a workable alternative to architectural walls or freestanding partitions. While naturally more sound-reflective than acoustically treated opaque sound baffles, transparent barriers between patient rooms and corridors or nurses' stations can provide a level of noise control and speech privacy while maintaining an open line of sight.[24]

Of course, it's impossible to erect barriers of any kind between patients and the sound sources within their rooms. Here, the replacement or treatment of hard, reflective surfaces with soundabsorbing materials can dramatically reduce noise levels. Experts recommend materials with a Noise Reduction Coefficient (which measures ability to absorb sound) above .85 and a Ceiling Attenuation Class (measuring ability to block sound) of at least

35. Hospitals that have replaced “hard-lid” ceilings with high-performance acoustical tiles and tiled floors with sound-absorbing carpet report that they have been able to reduce decibel levels and improve patient sleep without sacrificing cleanliness or infection control.[25]

Distance is another separation strategy that can be employed. Sound intensity decreases by 6 decibels every time the distance between the sound source and the listener doubles.[26] Locating noisy equipment like ice machines or printers as far as possible from patient rooms (and acoustically treating those locations and connecting corridors to prevent their racket from reverberating its way back to patient rooms) is an obvious but often overlooked plan of action.

The location of nurses’ stations is also an important design consideration. Especially during shift changes, the activity level in a central nurses’ station can create decibel levels that approach or even exceed those of a motorcycle or a jack hammer.[27] Decentralizing nurses’ stations, if space allows, disperses people and reduces the concentration of sound emanating from their activities.

However, central workstations are likely to remain for several functions on the nursing unit, even with the use of decentralized nurses’ stations. To keep noise in check, careful planning of work zones and locating equipment according to who uses it must be considered. “As part of studying the workflow in these areas,” says clinical consultant Greenberg, “we have the staff look at different ways of organizing functions. The unit secretary has specific needs that are very different than the nurses’. Dispersing the noise created by crowded stations helps everyone concentrate. Because working with medical records and entering and checking physician orders happens in these areas, they are critical places for creating an environment for accurate documentation.”[28]

## Adding sound to reduce noise


Another method for controlling noise involves actually adding sound to the environment. Sound-masking systems work to reduce the distance over which speech and other distracting sounds can be heard by raising the decibel level of the “noise floor” in a controlled fashion.[29] A series of speakers installed in the ceiling distributes electronically generated background sound that serves to cover or reduce the impact of noise spikes. This specially engineered sound creates an ambient environment that is perceived to be quieter and that enhances speech privacy in healthcare facilities.

Emerging technologies that use computing technology to shape sound offer the possibility of localized sound-masking that can be customized for specific situations. Perhaps eventually individual patients and caregivers will be able to control them. These technologies are particularly effective in masking conversations. If a voice is understandable, it catches one’s attention, and that’s when confidentiality can be broken. Voice-scrambling technology, which uses a sound processor and speakers to multiply and disorder voices that come within its range, addresses this issue. The strategic placement of such devices—in nurses’ or admitting stations, for instance—could go a long way toward protecting patient confidentiality.[30]

Adding soft music or nature sounds like falling water to the environment can also help to mask less pleasant sounds and may even offer a healing effect. In hospital settings, music combined with images of nature has been shown to reduce patient requests for pain medication.[31]

## Keeping it quiet

Acoustics experts caution that noise is not a problem that can be fixed once and for all, but an ongoing issue that requires continual attention in healthcare facilities. Regular sound assessments and acoustical maintenance of equipment are essential to sustaining an auditory environment that promotes the effectiveness of caregivers and patient rest and healing.

## Notes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