INTERNATIONAL SOCIETY FOR INFECTIOUS DISEASES

GUIDE TO INFECTION CONTROL IN THE HEALTHCARE SETTING

Tuberculosis

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Topic Outline

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KEY ISSUES

Tuberculosis (TB) remains one of the leading causes of preventable death in adults worldwide. The vast majority of TB cases and deaths occur in middle- and low-income populations. However, nosocomial transmission of TB to healthcare workers and patients occurs in high-, middle- and low-income countries. Effective infection control practices can reduce the risk of TB transmission in healthcare settings.

KNOWN FACTS

• Transmission of TB primarily occurs via inhalation of infectious airborne droplet nuclei.
• Transmission of TB to healthcare workers and nosocomial outbreaks of TB among patients, including multidrug-resistant TB (MDR-TB), have been well documented in industrialized and low resource countries.
• Healthcare workers are at increased risk for both latent TB infection (LTBI) and active TB disease compared to the general population.
• Human immunodeficiency virus (HIV) infected healthcare workers with latent TB infection have a high risk of progressing to active TB disease.
• Patient factors associated with TB transmission include coughing, smear-positivity, disease of the larynx or lungs, cavitary disease on chest radiography, and inappropriate anti-TB therapy.
• Procedures that result in the aerosolization of *Mycobacterium tuberculosis* such as bronchoscopy, sputum induction, endotracheal intubation, respiratory suction, and autopsies have resulted in TB transmission to healthcare workers.
• Many TB patients, including those with MDR-TB, may be effectively treated in community-based settings avoiding hospitalization and reducing the risk of nosocomial transmission.

• Treatment of LTBI reduces the risk of active TB disease.
• Effective infection control practices lower the risk of new TB infections in healthcare workers and patients.

SUGGESTED PRACTICE

Preventing TB transmission in healthcare facilities requires early identification, isolation, and treatment of patients with active TB disease. Recommended infection control strategies to reduce TB transmission depend on the prevalence of active TB in the patient population and the resources available to implement control programs. Unfortunately, the areas with the greatest need for TB infection control policies often have the fewest resources for creating and maintaining effective control programs. Many inexpensive interventions can significantly reduce the risk of TB transmission in healthcare settings.

Administrative Controls

Administrative controls are the first and most-important level of TB control in healthcare settings. The following measures should be taken:
• Assign responsibility to an infection control officer for implementation, enforcement, and evaluation of TB infection control policies.
• Conduct a TB risk assessment at the facility to include identifying the number of TB patients seen at the facility, the amount of time TB patients spend in different areas (such as emergency rooms, waiting rooms or wards), the prevalence of HIV among healthcare workers and patients, the specific roles of the healthcare workers and their potential exposures to infectious droplets.
• Develop and implement a TB infection control policy to ensure prompt detection, isolation, and treatment of persons with suspected or confirmed TB disease. Once policies have been established and put into place, maintain ongoing enforcement and education for healthcare workers as adherence to TB control measures falls over time without continuous education and monitoring.
• Evaluate the use of current facilities and the need for renovation or development of new spaces to provide adequate implementation of controls.

• Ensure timely availability of laboratory testing, specimen processing, and reporting with an emphasis on using World Health Organization (WHO) recommended rapid diagnostic tests.
• Ensure proper cleaning and disinfection of potentially contaminated equipment (e.g. endoscopes).
• Perform active surveillance of healthcare workers for active TB disease. Consider screening healthcare workers for LTBI and treating them if present.
• Develop an educational program for all healthcare workers. This should provide information on TB transmission, recognizing the signs and symptoms of active TB, understanding the interaction between TB and HIV, and the control policies in place to prevent TB transmission to healthcare workers and patients.
• Provide HIV screening to healthcare workers. HIV-positive healthcare workers should limit time spent in high-risk TB transmission areas (e.g. emergency rooms, TB wards, sputum collection areas, and bronchoscopy suites), undergo routine screening for active TB, and have access to both antiretroviral therapy and isoniazid preventive therapy.
• Promptly identify patients with TB symptoms and separate them from other patients, including those with active TB, until they can undergo sputum testing, preferably with a WHO recommended rapid diagnostic test. Specific symptom criteria for triage will depend on the setting and patient population, but should include cough greater than 2 weeks, hemoptysis, fever, weight loss, and night sweats.
• Isolate patients diagnosed with active TB from other patients, especially from those patients with known or suspected HIV. Specific criteria for isolation (e.g. smear positivity, culture status) will depend on local settings and patient population. MDR-TB and extensively drug-resistant TB (XDR-TB) patients should also be separated from other patients, including those with drug sensitive TB, as transmission may occur between groups. If individual isolation rooms are not available, a cohort system may be used.
• Continue airborne isolation of patients with active TB until they are no longer infectious.
• Educate patients with suspected or confirmed TB about respiratory hygiene and cough etiquette at the time of triage. They should be provided with surgical masks, tissues, or cloths and instructed to turn their heads and cover their mouths when coughing or sneezing.
• Promptly initiate anti-TB therapy in patients diagnosed with active TB according to treatment guidelines developed by the WHO, United States Centers for Disease Control (CDC), or similar expert group.

• Use appropriate signage to indicate isolation areas and to promote cough etiquette.

Environmental Controls

Environmental controls consist of those measures that prevent the spread and reduce the concentration of infectious droplet nuclei in ambient air.

• Adequate ventilation in healthcare settings is essential for preventing the transmission of TB and other airborne infections. Particular attention should be paid to high-risk transmission areas such as emergency rooms, waiting rooms, sputum collection areas, TB wards, procedure areas, and TB isolation rooms.

• Natural, mixed-mode, and mechanical ventilation systems may be used. The choice of ventilation system depends on an assessment of the facility and should be informed by local programmatic, climatic, and socioeconomic conditions. Any ventilation system requires ongoing monitoring and maintenance on a regular schedule.

• Regardless of the type of ventilation system used, design should seek to achieve airflow from the source of potential contamination to air exhaust points or to areas away from other patients that allow for sufficient air dilution.

• In high-income countries and other settings were feasible, TB patients and those undergoing evaluation for TB should be isolated in airborne infection isolation (AII) rooms. These rooms are designed with negative pressure so that air flows from the corridor into the room and not from the room into the corridor. Such rooms should be mechanically ventilated to a minimum of 12 air changes per hour (ACH).

• Conduct periodic air exchange measurements and airflow evaluation.

• For closed mechanical ventilation systems where resources allow, air from TB isolation rooms should be exhausted outside away from intake fans or waiting areas or passed through high-efficiency particulate (HEPA) filters before being re-circulated. Though the effectiveness of HEPA filters in preventing nosocomial transmission of TB is not well established, they remove 99.7% of particles ≥ 0.3 μm in size. *M. tuberculosis* droplet nuclei are between 1 μm and 5 μm in size and should be removed by filtration.

• Consider the use of ultraviolet germicidal irradiation (UVGI) where resources and expertise allow. The goal of UVGI is to inactivate airborne droplet nuclei. The two most common forms of UVGI are upper room irradiation and duct irradiation. In upper room air irradiation, UV lights are shielded and directed towards the ceiling away from patients to reduce the risk of skin and eye toxicity while providing germicidal benefit. Well-

designed UVGI upper room systems can disinfect *Mycobacteria* or surrogate organisms in a test room equivalent to 10-20 ACH. Duct irradiation is used to disinfect air exhausted from TB isolation rooms. UVGI should not be used in place of optimized ventilation systems or HEPA filters. These systems are potentially hazardous if not installed correctly, so need to be designed and installed by well-qualified engineers and technicians.

Personal Protection

• All healthcare workers should wear N95 particulate respirators when caring for patients with infectious or suspected active TB, especially during high-risk procedures such as sputum induction, intubation, or bronchoscopy. N95 respirators should be fitted correctly before using. N95 masks filter ≥ 95% of particles 1 μm in size when used properly with a tight facial seal. Surgical masks are useful for TB patients to reduce the number of infectious particles in the air, but have only 50% filter efficiency and lack a tight facial seal, and so should not be used by healthcare workers in place of N95 masks.

SUGGESTED PRACTICE IN UNDER-RESOURCED SETTINGS

• Develop and implement a TB infection control policy to ensure prompt detection, isolation, and treatment of persons with suspected or confirmed TB disease, for example using a FAST protocol (Find cases Actively using screening and rapid molecular diagnostics, Separate and promptly Treat effectively). Once policies have been established and put into place, ongoing enforcement and education for healthcare workers are crucial as adherence to TB control measures falls over time without continuous education and monitoring.
• Minimize time spent by TB patients in healthcare settings. Routine hospitalization to commence TB treatment is not necessary and should be reserved for those patients who otherwise require inpatient care. Pursue outpatient evaluation and treatment where appropriate.
• Natural ventilation systems may be used where resources preclude the construction or maintenance of AII rooms. Studies have shown that natural ventilation may provide better ventilation than rooms with mechanical ventilation with up to 28-40 ACH. Factors associated with improved ventilation include opening windows and doors, larger window and door openings, cross-ventilation, and wind speed. As noted above, careful attention should be paid to direction of airflow to avoid contamination of surrounding areas. Consider placing high-risk isolation areas on upper floors of buildings, higher elevations, or downwind of non-TB and HIV wards.
• Well-designed, maintained and operated fans can improve ventilation and air mixing. Such mixed-mode ventilation systems may be used if natural ventilation alone does not provide adequate ventilation. However, the efficacy of window fans exhausting air outside in preventing nosocomial TB transmission is unknown.
• Other low-cost strategies to reduce transmission in TB-endemic, low-resource settings include separate open-air shelters or waiting rooms for

patients with suspected TB awaiting or undergoing evaluation, installation of large windows, skylights, high-level windows or vents installed just under the ceiling, or opening vents or windows on doors to help improve cross-ventilation. Consider designing buildings with up-sloping ceilings or roofs with open gaps or windows at the high points to allow for stack ventilation. This also creates natural airflow as hot air rises. Simple wind-driven turbines placed on the roof may also help extract air from the building and improve ventilation.

SUMMARY

TB remains one of the leading causes of preventable morbidity and mortality worldwide with approximately 10.4 million new cases and 1.4 million deaths in 2015. 98% of cases and deaths occur in middle- and low-income countries. About one-third of the world's population is estimated to be infected with *M. tuberculosis* and therefore at risk for developing active TB. Individuals co-infected with HIV and TB, including healthcare workers, have a very high risk of developing active TB and should be treated for LTBI if they have no contraindications once active disease is excluded. Institutional transmission of TB has occurred throughout the world and healthcare workers are at high risk for acquiring TB infection and active disease. Many administrative steps for TB control, such as improving the evaluation and separation of suspected TB cases, cough etiquette, prompt initiation of anti-TB treatment and avoiding unnecessary hospitalization may be possible without a large financial investment. Some environmental controls such as AII rooms, HEPA filters, and UVGI may be cost-prohibitive in many settings in TB endemic countries, but opening windows and doors, adding fans to improve airflow or installing skylights will improve ventilation and may reduce the risk of TB transmission for relatively low cost. Personal protection of healthcare workers and visitors with N95 particulate respirators is also recommended whenever caring for infectious or

suspected TB patients. Even in low-resource settings, healthcare workers should be provided with fit-tested N95 particulate respirators, especially in high-risk transmission settings such as aerosolization procedures or when in contact with MDR-TB or XDR-TB infected patients. Ongoing assessment, proper implementation, and continuous reinforcement of TB infection control practices should reduce or eliminate the spread of TB in healthcare settings.

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