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Health care workers, tuberculosis, and the human immunodeficiency virus epidemic

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Tuberculosis (TB) transmission is a recognized risk in health care settings (1—4). Nosocomial transmission has been associated with close contact with intubation and suctioning with mechanical ventilation (2), open abscess irrigation (3), and autopsy (4). Sputum induction and aerosol treatments that induce cough may also increase the potential for TB transmission (5).

During 1990 and 1991, nosocomial outbreaks of multidrug-resistant tuberculosis (MDR-TB) in four hospitals [one in Miami (5, 6) and three in New York City (6)] were investigated by the Centers for Disease Control (CDC). The majority of these cases involved patients and health care workers seropositive for the human immunodeficiency virus (HIV).

In the Florida outbreak, 65 patients diagnosed with MDR-TB had *Mycobacterium tuberculosis* isolates resistant to at least isoniazid and rifampin. Of the 65 patients, 62 (95%) were known to be infected with human immunodeficiency virus (HIV).

In hospital A in New York City 35 patients with the acquired immunodeficiency syndrome (AIDS) were diagnosed with MDR-TB resistant to at least isoniazid and streptomycin. In hospital B (New York City) 38 patients were diagnosed with MDR-TB resistant to at least isoniazid, rifampin, and streptomycin. Thirty-six (94%) of these patients were known to be HIV seropositive. In hospital C (New York City) 31 patients were diagnosed with MDR-TB resistant to at least isoniazid and rifampin; four of these patients were resistant to isoniazid, rifampin, streptomycin, and other drugs tested. Of these cases, 28 (91%) were HIV seropositive. Eight cases of active MDR-TB have been reported among health care workers in these hospitals. Each of the eight has epidemiologic or laboratory links to the hospital outbreaks. Four of these workers were infected with HIV and have died from MDR-TB.

Methods

To address the implications of this epidemic of nosocomial MDR-TB transmission, a working group of representatives from the CDC was convened. A draft document was produced and revised extensively on the basis of review by CDC centers, institutes, and offices. The resultant document, "Guidelines for Preventing the Transmission of Tuberculosis in Health-Care Settings, with Special Focus on HIV-Related Issues" (7), was published in the *Morbidity and Mortality Weekly Report* published by the CDC.

Results

The prevention of TB transmission in health care settings requires that all of the following basic approaches be used: (i) prevention of the generation of infectious airborne particles by early identification and treatment of persons with tuberculous infection and active TB, (ii) prevention of the spread of infectious droplet nuclei into general air circulation by the application of source-control methods, (iii) reduction of the number of infectious droplet nuclei in air contaminated with them, and (iv) surveillance of personnel in health care facilities for TB and tuberculous infection.

TB transmission is the most likely to occur from patients with unrecognized pulmonary or laryngeal TB who are not on effective antituberculosis therapy and have not been placed in TB isolation. Thus a high level of suspicion must be maintained for the diagnosis of TB in persons at high risk of TB. TB may be more difficult to diagnose among persons with HIV infection, however. The diagnosis may be overlooked because of an atypical clinical or radiographic presentation or the simultaneous occurrence of other pulmonary infections (eg, *Pneumocystis carinii* pneumonia). Among persons with HIV infection, the difficulty in making a diagnosis may be further compounded by impaired responses to tuberculin skin tests (8), low sensitivity of sputum smears for detecting AFB (9), or overgrowth of cultures with *Mycobacterium avium* complex among patients with both this complex and TB infections (10).

A diagnosis of TB should be considered for any patient with persistent cough or other symptoms compatible with TB, such as weight loss, anorexia, or fever. Diagnostic measures should include history, physical examination, tuberculin skin test, chest radiograph, and microscopic examination and culture of sputum (11, 12). Other diagnostic methods, such as bronchoscopy or biopsy may be indicated in some cases (13). In health care settings, certain techniques can be

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applied to prevent or reduce the spread of infectious droplet nuclei. They include source-control methods, such as the use of booths for sputum induction or the administration of aerosolized medications and the patient's use of a tissue to cover all coughs and sneezes. Once droplet nuclei have been released into room air, they should be eliminated or reduced in number by general ventilation, which may be supplemented by additional measures (eg, trapping organisms by high-efficiency filtration, killing organisms with germicidal ultraviolet irradiation, or persons exposed to TB patients using disposable particulate respirators). From a theoretical viewpoint, none of the four methods (ventilation, high-efficiency filtration, ultraviolet irradiation, or particulate respirators) appears to be ideal. None of the methods used alone or in combination can completely eliminate the risk of TB transmission.

Ventilation for health care facilities should be developed and maintained in consultation with experts in ventilation engineering. The direction of air flow should be set up and maintained so that air flows from clean areas to less clean areas. Ventilation standards for indoor air quality in health care facilities have been published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers and by the Federal Health Resources and Services Administration (14).

If air from potentially contaminated general use areas (eg, emergency rooms or clinic waiting areas) cannot be exhausted directly to the outside, high-efficiency particulate air filters with test efficiencies of $\leq 99.97\%$ may be useful for removing infectious organisms from air before recirculation in a room or before return to common supply ducts.

The use of ultraviolet germicidal irradiation (254 nm wavelength) to prevent TB transmission is controversial. Its efficacy in clinical settings has not been demonstrated under controlled conditions, but there is a theoretical and experiential basis for believing it is effective (15). The main concern about ultraviolet germicidal irradiation is safety. Short-term overexposure to ultraviolet irradiation can cause keratoconjunctivitis and erythema of the skin (16). Bulbs should be periodically checked for dust, cleaned as needed, and replaced at the end of the rated life of the bulb. Maintenance personnel should be cautioned that fixtures should be turned off before inspection or servicing.

Appropriate masks may provide additional protection against TB transmission. Standard surgical masks may not be effective because of poor face fit and inadequate filtration characteristics. A better choice is the particulate respirator, originally developed for industrial use. Although the appearance may be similar to that of cup-shaped surgical masks, the respirator provides a better facial fit, and it filters out particulates in the droplet nucleus size range (1—5 μg). However, the efficacy of particulate respirators in protecting susceptible persons from infection with TB has not been demonstrated. Wearers should be adequately trained in the use and disposal of the respirators and should carefully follow manufacturer's instructions. Ideally, a respirator program consistent with guidelines of the National Institute for Occupational Safety and Health (17) and the requirements of the Occupational Safety and Health Administration — General Industry Occupational Safety and Health Standards (29 Code of Federal Regulations Part 1910.134) — should be implemented. Such a program includes training, fit testing, care and maintenance, and medical monitoring.

A TB screening and prevention program for the personnel of health care facilities should be established for protecting both the personnel and the patients. At the time of employment and periodically thereafter, purified protein derivative (PPD)-negative health care workers should be skin tested for skin test conversions. Health care workers who may be frequently exposed to patients with TB or who are involved with potentially high-risk procedures (eg, bronchoscopy, sputum induction, or aerosol treatments given to patients who may have TB) should be retested at least every six months. Health care workers in other areas should be retested annually.

Discussion

Since publication of the guidelines, additional outbreaks of nosocomial MDR-TB have taken place, one in upstate New York and one in the New York State Correctional Facility System (CDC, unpublished data). At a hospital in upstate New York, 52 health care workers had skin test conversions following exposure to prison A inmates with MDR-TB. One correctional officer developed MDR-TB after hospital duty guarding inmates with MDR-TB; he subsequently died from MDR-TB. In addition, five noninmate patients were reported with positive MDR-TB cultures. In prison A, from 1 January to 1 December 1991, seven inmates were diagnosed with MDR-TB. All were immunocompromised; all are deceased. The outbreak in prison A has been linked by restriction fragment length polymorphism to the outbreak in New York hospital B.

The unfortunate nexus of HIV infection and TB, especially MDR-TB, has appropriately heightened concern among health care workers over the nosocomial transmission of TB. Not only are individuals with HIV infection more likely to become infected with *M tuberculosis,* but they are also far more likely to progress to active disease (18). This situation poses a continuing practical dilemma for the health care worker working with HIV-infected patients: how to continue to deliver ethical, professional health care and at the same time protect oneself from the dangers of TB transmission. All hospital personnel, including volunteers, who may be exposed to patients with known or suspected TB should be educated about the medical consequences of becoming infected with MDR-TB and should follow appropriate precautions for minimizing such exposures (7).

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