Transmission of *Mycobacterium tuberculosis* from Health Care Workers

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The Centers for Disease Control and Prevention (CDC) recently reported the transmission of *Mycobacterium tuberculosis* from a health care worker to patients in New York City.[1] Several aspects of the episode were notable: the health care worker was foreign-born; latent tuberculosis infection had previously been diagnosed by tuberculin skin testing, but the health care worker had declined treatment; and after active disease developed in the health care worker, 1500 persons were exposed, which necessitated a large-scale contact investigation to determine the extent of transmission and prevent further spread.

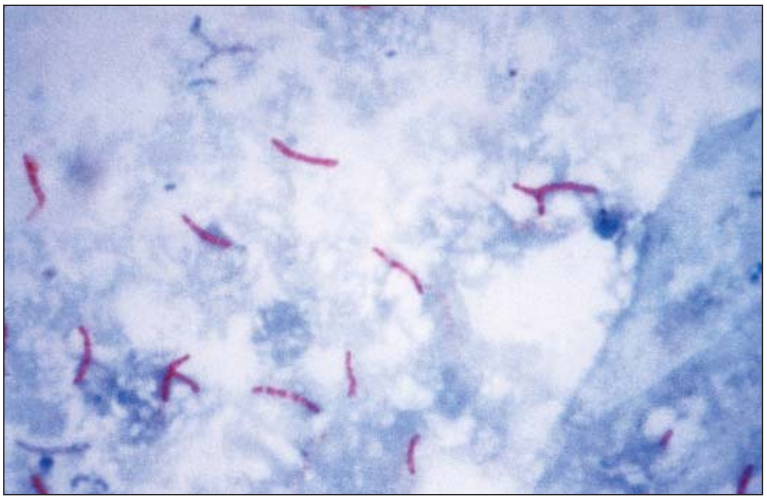
Today, the incidence of tuberculosis in the United States is the lowest ever recorded. This downward trend has been driven largely by steady decreases in incidence among persons born in this country. However, case rates have not decreased among foreign-born persons living in the United States, and tuberculosis in the foreign-born now accounts for most of the reported domestic cases. Latent tuberculosis infection is also more common among foreign-born persons: one third of the world's population, but less than 10 percent of the U.S. population, has latent infection.

In recent decades, the proportion of foreign-born health care workers in this country has increased. One fourth of all practicing physicians in the United States graduated from foreign medical schools, and the number of foreign-born nurses employed here has increased in response to a shortage of registered nurses. Although these health care workers play a crucial role in health care delivery, one consequence is that an increasing proportion of U.S. health care providers are infected with *M. tuberculosis*.

Recommended approaches to the diagnosis and treatment of *M. tuberculosis* infection in foreign-born health care workers are the same as those for health care workers who were born here. However, applying such recommendations to foreign-born persons can be complicated. Bacille Calmette–Guérin (BCG), the most commonly administered vaccine in the world, may confound the interpretation of the tuberculin skin test. In addition, in countries where tuberculosis is endemic, the prevalence of positive tuberculin skin tests is very high. Many immigrants to the United States assume that they have been infected for several years and are therefore not at risk for active tuberculosis. Furthermore, in many countries outside the United States, treatment of latent tuberculosis infection is not routinely offered.

The New York City case highlights these challenges. In 2003, a nurse from the Philippines who worked in a newborn nursery and maternity ward had pulmonary tuberculosis that went undiagnosed for two months. An opportunity to avert this situation had been missed 11 years earlier, when a routine preemployment tuberculin skin test was positive, but she declined treatment for latent tuberculosis infection. She reasoned that most adults from the Philippines who had positive tuberculin skin tests were not treated and that BCG vaccination at birth could explain the positive result.

Approximately 1500 persons had had contact with the nurse while she was considered infectious, but only one third of them



CDC/George Kubica

Candidates for Treatment of Latent Tuberculosis Infection.*

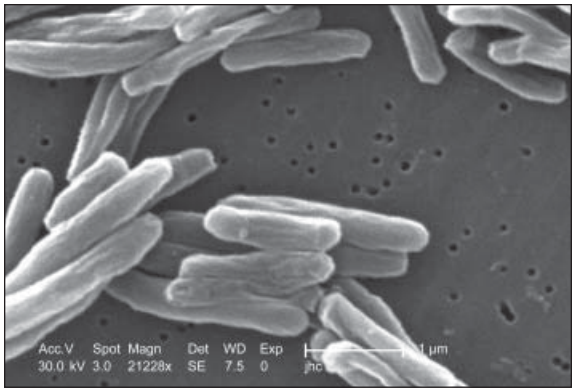
Test Result	Persons for Whom Treatment Should Be Considered
Induration ≥5 mm on tuberculin skin test, regardless of age	Persons infected with HIV
	Recent contacts of a person with active tuberculosis
	Persons with fibrotic changes on chest radiography consistent with previous tuberculosis
	Organ-transplant recipients
	Other immunosuppressed persons (e.g., persons receiving ≥15 mg of prednisone per day for ≥1 mo)
Induration ≥10 mm on tuberculin skin test or positive result on QFT-G test	Persons born or who have lived in a developing country or a country with a high incidence of tuberculosis
	Residents and employees in group settings where the risk is high (i.e., correctional facilities; hospices; skilled nursing facilities; hospitals and other health care facilities; residential settings for persons with HIV, AIDS, or other immunocompromising conditions; and homeless shelters)
	Persons who inject illicit drugs
	Persons with a conversion of a tuberculin skin test or QFT-G test
	Personnel in mycobacteriology laboratories
	Persons with clinical or immunocompromising conditions that place them at high risk for tuberculosis (silicosis; diabetes mellitus; chronic renal failure; certain hematologic disorders such as leukemias and lymphomas; other specific cancers such as carcinoma of the head, neck, or lung; unexplained weight loss of ≥10 percent of ideal body weight; gastrectomy; or jejunoileal bypass)
	Persons living in an area with a high incidence of tuberculosis
	Children <4 yr of age
	Infants, children, and adolescents who are exposed to adults who are at high risk for tuberculosis
Induration ≥15 mm on tuberculin skin test	Persons with no known risk factors for tuberculosis infection

* Adapted from Jensen et al.[3] Candidates include persons who are at increased risk for *M. tuberculosis* infection and those at increased risk for active disease once infected. Active tuberculosis must be ruled out before treatment of latent infection is initiated. Relative contraindications to treatment of latent infection include clinically significant liver injury, active hepatitis, or excessive alcohol consumption. HIV denotes human immunodeficiency virus, and QFT-G QuantiFeron-TB Gold test.

could be located for follow-up. Among those located, at least four infants were found to be infected. A similar episode occurred recently in Boston, where the epidemiologic investigation involved more than 5000 potential contacts of a health care worker with pulmonary tuberculosis.

Driver et al. recently reported that in 2002, the incidence of tuberculosis among foreign-born health care workers in New York State was nearly 10 times that among U.S.-born health care workers in that state.[2] In their study, most health care workers with tuberculosis had previously been known to have a positive tuberculin skin test, and one half had previously met the criteria for treatment with isoniazid, yet few had been treated. Clearly, treatment of latent tuberculosis infection should be provided to all health care workers who meet the established criteria (see table), though public health laws do not mandate such treatment in persons who decline it. After BCG vaccination at birth, tuberculin reactivity wanes within 6 to 12 months. Among persons who are vaccinated after 1 year of age, tuberculin reactivity may persist longer, but it rarely lasts more than 10 years if there is no subsequent infection with *M. tuberculosis*. Thus, previous BCG vaccination should

generally not influence the interpretation of a tuberculin skin test in persons who were vaccinated more than 10 years earlier. However, foreign-born health care workers frequently attribute positive skin tests to BCG vaccination and are less likely to recommend isoniazid for themselves or for members of their family than for others.[4]



The tuberculin skin test has low specificity, but there are newer tests that are more specific for *M. tuberculosis*. These tests include whole-blood assays that detect the release of interferon gamma by cells incubated ex vivo with *M. tuberculosis* peptides or proteins. In May 2005, one such assay, the QuantiFeron-TB Gold (QFT-G) test, was approved by the Food and Drug Administration for the diagnosis of latent *M. tuberculosis* infection. This assay uses, as the stimulating antigens, synthetic peptides based on two proteins that are secreted by all strains of *M. tuberculosis* and pathogenic strains of *M. bovis* (early secretory antigenic target 6 and culture filtrate protein 10) but that are absent from BCG vaccine strains and most nontuberculous mycobacteria.

The CDC recently established guidelines for use of the new assay.[5] Previous BCG vaccination is less likely to lead to a false positive result on this test than it is on the tuberculin skin test. The new test may have lower sensitivity than the older test, but it is difficult to make comparisons because there is no gold standard for the detection of latent infection. There are limited data regarding the use of the QFT-G test in persons who have recently been exposed to tuberculosis, immunocompromised persons (including those infected with the human immunodeficiency virus), children younger than 17 years of age, populations with a high likelihood of harboring latent tuberculosis infection, and persons undergoing periodic screening. Nonetheless, the CDC indicates that the QFT-G test can be used in place of the tuberculin skin test in any circumstances, including contact investigations, evaluation of recent immigrants who previously received BCG vaccination, and screening of health care workers.[5] Additional studies of the new assay are needed to assess its value for predicting the development of active tuberculosis.

The CDC recently published updated guidelines for the prevention of transmission of *M. tuberculosis* in health care settings.[3] These guidelines include a list of all categories of health care workers who should be included in tuberculosis-surveillance programs. Treatment of latent tuberculosis infection should be targeted to the groups listed in the table, since they are at increased risk for progression to active disease.

The recent contact investigations in New York City and Boston revealed that relatively few persons had become infected through exposure to the index patient, and to date, no secondary cases of active tuberculosis have occurred. A low frequency of adverse health outcomes often results in a perceived lack of urgency about treatment and makes it difficult to persuade people with latent tuberculosis infection to complete a course of treatment. However, both episodes demonstrate the tremendous potential for a bad outcome when infection is left untreated.

It is important that patients be able to trust their health care providers to "do no harm." All health care workers in the United States, regardless of their country of birth, must earn that trust by doing everything possible to minimize risk to patients. In this regard, assiduous adherence to the available guidelines for the prevention of transmission of *M. tuberculosis* in health care settings, including aggressive management of latent tuberculosis infection, is a crucial step in the right direction.

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System Failure versus Personal Accountability — The Case for Clean Hands

Donald Goldmann, M.D.

A new mother sits by her tiny, premature baby in a neonatal intensive care unit. She watches as a physician touches the baby without first washing his hands or using the waterless, alcohol-based hand antiseptic just a couple of feet away. A few minutes later, a nurse and then another doctor also fail to perform these basic procedures. When her baby was admitted to the unit, the mother was told to remind caregivers to wash their hands, but only after witnessing repeated failures does she muster the courage to speak up about the practice she thought would be routine. By then, her baby has acquired methicillin-resistant *Staphylococcus aureus* (MRSA) — probably transported on the hands of a caregiver who had been examining other babies who are colonized with MRSA. A few days later, MRSA invades the baby's bloodstream; it eventually proves fatal. Such preventable infections, caused by the failure to practice hand hygiene, are far from rare, and they occur in many of the finest neonatal intensive care units in the United States.

MRSA and other health care–associated infections have been prime targets of hospital infection-control and patient-safety programs for years, yet the prevalence of antibiotic-resistant bacteria continues to increase, and the rate of infections caused by these pathogens remains unacceptable. What can be done about these seemingly intractable problems?

Patient-safety experts stress that complex, error-prone systems are at the root of most mistakes in health care. Archaic, poorly designed systems often undermine the best efforts of well-intentioned, highly motivated clinicians and health care personnel to provide safe care. A major goal of contemporary patient-safety programs is to encourage a culture of safety and create a blame-free environment in which errors are seen as a by-product of bad systems, not as caused by bad or incompetent people. This orientation toward improving systems rather than blaming people who make mistakes is critical, since it encourages caregivers to report adverse events and near misses that might be preventable in the future. Improvement is impossible without such reports, which permit hospitals to gain an understanding of the factors that lead to mistakes and create systems that support safer practices. Although reports tend to focus on major, dangerous errors that occur relatively infrequently, lower-profile mistakes that many caregivers make virtually every day, such as not washing their hands, also need to be documented and understood if the systems are to be improved.

But if we really are serious about making care safer, I would argue that we need to find the right balance between blaming mistakes on systems and holding individual providers accountable for their everyday practices. Curbing the alarming increase in the rate of antibiotic-resistant infections surely requires both systemic improvements and increased personal accountability.

Infections with antibiotic-resistant bacteria such as MRSA, which are difficult to treat, are transmitted primarily by the contaminated hands of health care providers who have touched a colonized patient or something in the patient's environment. Patients who are colonized or infected with resistant pathogens often have billions of colony-forming units of bacteria per milliliter of sputum or per gram of stool. Their skin and immediate environment may also be heavily contaminat-