Editorial

Where Are We in Tuberculosis Infection Control?

Michael L. Tapper, MD

This month's issue of *Infection Control and Hospital Epidemiology* is devoted to the subject of tuberculosis (TB) and its control in healthcare settings. Few other recent problems in hospital epidemiology have had the impact upon infection control practices and have caused the degree of concern and consternation evoked by the initial reports of nosocomial outbreaks of TB in institutions in Puerto Rico, Miami, and, most dramatically, in New York City and the New York State prison system.[1-6] Most of these outbreaks have been characterized by a high attack rate involving human immunodeficiency virus (HIV)-positive patients, with alarming morbidity and mortality.

In many of the institutions, the isolates of *Mycobacterium tuberculosis* were resistant to both isoniazid and rifampin, the two leading agents used for the treatment of TB; hence, the name multidrug-resistant (MDR)-TB. While reports of TB outbreaks in healthcare facilities have paralleled the resurgence of TB in the community, principally in urban areas where public health and community TB control efforts had been neglected, the use of molecular typing techniques has made clear that transmission within a healthcare facility of a single unique strain of TB can occur with remarkable ease. While the intrainstitutional transmission of TB is hardly new, and the risk to healthcare workers from institutional spread of TB was recognized long ago, the magnitude of these recent outbreaks and the degree to which such outbreaks could proceed unchecked, involving both patients and healthcare workers, have caused understandable alarm among patients and workers about the safety of receiving or providing health care in such institutions. Furthermore, the fact that such outbreaks could extend to healthcare workers (with reported tuberculin skin-test conversion rates in some institutions ranging from 33% to 50%) has led to charges of indifference on the part of the infection control community and hospital administrators to the risks of healthcare workers in caring for patients with active TB. These concerns prompted several labor unions to petition the Occupational Safety and Health Administration (OSHA) to issue a temporary emergency standard to protect healthcare workers. To date, the activities of OSHA in the field of TB have been limited to the issuance of a compliance directive and memorandum to its regional offices and state programs regarding the essentials of a TB control program, operating under its general duty clause to ensure a safe work place. A more comprehensive TB and respiratory pathogen control standard (similar to that developed for bloodborne pathogens) is expected to be issued by OSHA later in 1995.

To assess the status of existing TB control measures in US hospitals, Fridkin et a1[7,8] provide a two-part report of responses to a questionnaire developed in collaboration with SHEA, examining the status and efficacy of TB control programs between 1989 and 1992. Not surprisingly, there was a wide disparity in the degree to which institutions were in compliance with the guidelines for the control of nosocomial transmission of TB promulgated by the Centers for Disease Control and Prevention (CDC) in 1990.[9] Interestingly, despite the controversy and confusion over recommended means of respiratory protection, the survey indicated that by 1992 an increasing

From Lenox Hill Hospital, New York, New York.
Address reprint requests to Michael L. Tapper, MD, Hospital Epidemiologist, Lenox Hill Hospital, 100 East 77th St., New York, NY 10021.
94-ED-193. Tapper ML. Where are we in tuberculosis infection control? Infect Control Hosp Epidemiol *1995;16:125-128.*

proportion of hospitals were in compliance with the CDC's 1990 recommendation for use of particulate respirators. However, environmental controls, such as negative pressure rooms and dilutional ventilation, appeared to have received little additional attention. Most facilities had some sort of tuberculin skin-testing program for employees. Although the frequency of a positive tuberculin skin test at the time of initial hiring appeared to increase during the time of the study, the rate of skin-test conversion for existing employees did not seem to change.

The second part of the report by Fridkin and colleagues[8] is an attempt to assess the efficacy of TB infection control programs. In this analysis, among institutions reporting more than six TB patients per year, those that had failed to comply with the 1990 CDC guidelines for acid-fast isolation rooms seemed to have higher rates of tuberculin skin-test conversions among their employees. The authors found that, although three times as many skin tests were performed as part of routine tuberculin skin-testing programs at hospitals compliant with the CDC isolation criteria, the conversion rate for healthcare workers was almost always lower in compliant hospitals as compared to noncompliant hospitals. Similarly, the authors report that among hospitals with at least 10 TB patients per year, those hospitals that reported functioning respiratory isolation rooms with negative pressure had significantly lower healthcare worker skin-test conversion rates than those without negative pressure rooms. This difference was found to be true, however, only for larger hospitals or for those taking care of large numbers of patients with active TB. No such difference was found for smaller facilities, regardless of their compliance or noncompliance with environmental controls to prevent the dissemination of TB.

While these findings seem to validate the importance of adherence to the environmental control strategies recommended by the Centers for Disease Control in the 1990 guidelines, they must be interpreted with caution. As the authors note, the study was limited by its voluntary nature and the potential biases inherent in a passive survey. While the results of this survey would appear to indicate that those institutions that did maintain negative pressure rooms were less likely to have high rates of healthcare worker tuberculin skin-test conversions, this study does not clarify which portion(s) of a TB infection control program are most important. In short, what works? Diligent attention to maintaining negative pressure rooms may be merely a marker for a comprehensive infection control program or for a hospital administration committed to devoting resources to the control of nosocomial TB. Such institutions are equally likely to have effective administrative protocols for the early identification, isolation, and treatment of patients with active TB. Hence, although the two reports by Fridkin et al suggest that the December 1990 CDC guidelines may be an effective means to control nosocomial TB transmission, as suggested in their previous studies of outbreaks, they still do not answer the fundamental question of which methods of control are most important in limiting the nosocomial spread of TB to patients and healthcare workers.

The manuscript by Stroud et al[10] attempts to evaluate the same issues following a well-described outbreak of MDR-TB at Roosevelt Hospital in New York City. In this study, control mechanisms were introduced over three successive periods (defined arbitrarily as period 1, period 2, and period 3). In period 1, infection control measures were notable mainly for their absence or nonadherence. During period 2, administrative and source controls were stressed, including earlier case recognition, institution of isolation and therapy for patients suspected of having active TB, and monitoring for compliance with isolation. In period 3, engineering controls were introduced, including negative-pressure rooms, increased air exchanges, isolation facilities for aerosol pentamidine therapy and sputum induction, and the use of dust-mist particulate respirators. Significantly, patient-to-patient transmission of TB was greatly diminished during period 2, even in advance of engineering modifications and the introduction of more stringent personal respiratory protection. Patient-to-patient transmission was not eliminated entirely during period 2, and ongoing transmission appeared to relate to one particularly infectious patient. Despite these encouraging data, however, tuberculin skin-test conversions reflecting patient-to-worker transmission persisted during periods 2 and 3. Inadequate baseline skin-test data and inadequate follow-up did not permit a precise determination of the efficacy of the control measures in preventing transmission to healthcare workers. The authors note with some caution that full implementation of the 1990 CDC guidelines, including higher levels of respiratory protection and/or supplemental air-sterilizing mechanisms such as ultraviolet germicidal irradiation or high-efficiency particulate air (HEPA) filtration, might be necessary to protect workers fully.

The fourth related article, "Tuberculosis Surveillance in Long-term Institutions" by Naglie et al,[11] reports a survey of tuberculin skin-testing practices in long-term care institutions in Ontario, Canada. Perhaps the most interesting point is that Canadian regulatory authorities differentiate between homes for the aged (in which tuberculin skin-testing pro-

grams apparently are mandated in Ontario) and nursing homes (in which they apparently are not). Not surprisingly, tuberculin skin-testing programs were carried out more adequately in the former than the latter. Stead and others in the United States have presented convincing evidence of the risk of transmission of TB in the elderly.[12] Our current obsession with the risk to HIV-positive patients and the resurgence of urban TB in impoverished communities should not blind us to this traditional at-risk population, in which TB remains a significant problem. Indeed, untoward exposures or unrecognized TB may be at least as likely to occur in association with care for the elderly, particularly those with atypical forms of pneumonia, as with care for HIV-positive patients.

The fifth article, "Nosocomial Tuberculosis: An Outbreak of a Strain Resistant to Seven Drugs,"[13] is a detailed report of an outbreak involving an upstate New York hospital. This hospital is located in an area of low TB prevalence, but it provides care for inmates from the New York State prison system. Although this facility was relatively new and had all the optimal engineering and environmental elements to prevent the dissemination of TB, this careful analysis revealed the inherent limitations and frailties of even the best-designed engineering systems. Negative-pressure rooms reverted to positive pressure, particularly when airflow patterns were disrupted by closing doors or by ventilation changes such as air conditioner use. Similar to the outbreak reported at Roosevelt Hospital, this outbreak was traced to a single highly infectious patient with a frequent cough and strongly positive sputum smears. As often is typical in these outbreaks, the individual was not suspected of having MDRTB at the time of his hospitalization and thus was treated with medications to which his organism was insensitive; he remained highly infectious throughout his hospital stay. The ability to assess and monitor infectivity, currently limited to evaluating smears for acid-fast bacilli, may become a critical means of assigning priority when infection control facilities are limited. The alarming postscript to this article reports that following the completion of the investigation an additional 28 healthcare workers developed skin-test conversions as a result of exposures to other patients hospitalized with drug-resistant TB, and two workers required treatment for active disease. A much more extensive list of corrective actions was put into place, including enhanced administrative controls; the institution of a standard four-drug regimen; improved laboratory services; monitoring and reporting of chest radiographs suspicious for TB; an emergency room triage protocol for admission; and supplemental environmental controls, such as ultraviolet germicidal irradiation and HEPA filtration, along with the use of disposable particulate respirators. These more extensive measures were successful in reducing the rate of tuberculin skin-test conversions below that observed prior to the initial outbreak in 1992.

The final article in this series, by Ussery et al,[14] reminds us that the transmission of drug-resistant TB is not limited to hospitals or to clinics. In this report, a significant number of workers appeared to have acquired TB infection while working in a medical examiner's office. In common with other reports in this issue, environmental controls often were present but either were ineffective, malfunctioning, or inoperative. This outbreak makes it clear that an individual who does not have direct contact with infected patients or body tissues, such as a secretary, might be at risk if air contaminated by droplet nuclei from a TB patient is allowed to disseminate throughout a healthcare facility.

How should the healthcare community respond to the challenges raised in these articles? One can look at the glass as being half full or half empty. The reports by Fridkin et al suggest that American healthcare institutions still had a long way to go in 1992 to meet the criteria outlined in the 1990 CDC guidelines for the prevention of nosocomial transmission of TB, much less the more detailed 1994 revised guidelines,[15] recently published by the CDC. The alternative viewpoint is to regard the glass as half full: most institutions, in fact, are moving toward fuller compliance with existing recommendations to prevent the nosocomial dissemination of TB, despite severely limited resources and overlapping or conflicting guidelines from the CDC, the National Institute for Occupational Safety and Health, OSHA, and a variety of state regulatory agencies. The Fridkin report of the CDC/SHEA survey makes clear that for smaller institutions or for those with few TB patients there was little difference between institutions that had or had not instituted CDC guidelines for environmental control. This observation was recognized in the final revision of the 1994 CDC guidelines, which provided additional risk assessment categories of minimal and very low risk. Unfortunately, those institutions with the greatest burden of TB patients also are likely to be the institutions with the fewest resources to provide the kind of corrective actions that the articles by Stroud and Ikeda itemize. A resurrection of dedicated institutions for the treatment of TB does not appear to be the solution, since triage, initial diagnosis, admission, and treatment often will need to occur in general hospital facilities.

The explosive controversy in the last several years over engineering controls, and even more so over personal respiratory devices, has been based largely on the lack of efficacy data and the seemingly

prohibitive costs associated with many of these corrective approaches. However, at least two of the articles in this issue indicate that lesser programs, despite incorporation of stringent administrative controls, may be inadequate to prevent fully the transmission of TB between patients and to workers. Hence, we are left to face these troubling issues: What level of risk to airborne pathogens are healthcare workers and society in general willing to tolerate? What is an acceptable rate of tuberculin skin-test conversions in a healthcare facility? Is the acceptable rate different if the prevalent isolate is drug resistant, so that chemoprophylaxis with an agent such as isoniazid is an unavailable strategy? What is an acceptable level of risk for transmission of nosocomial TB to a patient? We have no easy answers to these questions, nor do we have adequate data to determine the range of transmission and risk in our nation's healthcare facilities. Paucity of data and an inexact science, however, do not obviate the need to issue recommendations based on the best data available at the present time.

The studies contained in this issue of *Infection Control and Hospital Epidemiology* point out that administrative controls can substantially reduce transmission of TB in facilities but that elimination of transmission, particularly among HIV-infected patients or to healthcare workers, is likely to require the fuller complement of administrative, engineering, and personal respiratory control mechanisms. If we wish policy to be well-grounded in science, there is an urgent need to examine, both in the laboratory and in healthcare settings, the efficacy of a variety of control mechanisms. The recent issuance of the final revised CDC guidelines and the proposed development of an OSHA respiratory standard provide a framework against which critical assessment of our current concepts of TB infection control can and should take place. The public's and the political world's perceptions and memories are short-lived; with the decrease last year in reported incident TB cases in the United States, the battle for funds to control TB in the community and in healthcare settings will become more difficult. We must make certain that the mechanisms that we recommend for control are scientifically valid and economically feasible. The challenge to the infection control community and to our colleagues in industrial hygiene and occupational medicine is to validate our concepts quickly, to discard those that are out of date or incorrect, and to be open-minded about modifying our existing precepts as new and better data come along.

REFERENCES

1. Beck-Sague C, Dooley SW, Hutton MD, et al. Hospital outbreak of multidrug-resistant *Mycobacterium tuberculosis* infections; factors in transmission to staff and HIV-infected patients. *JAMA* 1992;268:1280-1286.
2. Pearson ML, Jereb JA, Frieden TR, et al. Nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis;* a risk to patients and health care workers. *Ann Intern Med* 1992;117:191-196.
3. Edlin BR, Tokars JI, Grieco MH, et al. An outbreak of multidrug-resistant tuberculosis among hospitalized patients with acquired immunodeficiency syndrome. *N Engl J Med* 1992;326:1514-1521.
4. Jarvis WR. Nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis. Res Microbiol* 1993;144:117-22.
5. Centers for Disease Control. Nosocomial transmission of multidrug-resistant tuberculosis among HIV-infected persons—Florida and New York, 1988-1991. *MMWR* 1991;40:585-591.
6. Coronado VG, Beck-Sague CM, Hutton MD, et al. Transmission of multidrug-resistant *Mycobacterium tuberculosis* among persons with human immunodeficiency virus infection in an urban hospital: epidemiologic and restriction fragment length polymorphism analysis. *J Infect Dis* 1993;168:1052-1055.
7. Fridkin SK, Manangan L, Bolyard E, Society for Healthcare Epidemiology of America, Jarvis WR. SHEA-CDC TB survey, part I: status of TB infection control programs at member hospitals, 1989-1992. *Infect Control Hosp Epidemiol* 1995;16:129-134.
8. Fridkin SK, Manangan L, Bolyard E, Society for Healthcare Epidemiology of America, Jarvis WR. SHEA-CDC TB survey, part II: efficacy of TB infection control programs at member hospitals, 1992. *Infect Control Hosp Epidemiol* 1995;16:135-140.
9. Centers for Disease Control. Guidelines for preventing the transmission of tuberculosis in health-care settings, with special focus on HIV-related issues. *MMWR* 1990;39 (no. RR-17).
10. Stroud L, Tokars J, Grieco M, et al. Interruption of nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis* among AIDS patients in a New York City hospital. *Infect Control Hosp Epidemiol* 1995;16:141-147.
11. Naglie G, McArthur M, Simor A, Naus M, Cheung A, McGeer A. Tuberculosis surveillance practices in long-term care institutions. *Infect Control Hosp Epidemiol* 1995;16:148-151.
12. Stead WW, Lofgren JP, Warren E, Thomas C. Tuberculosis as an endemic and nosocomial infection among the elderly in nursing homes. *Ann Intern Med* 1985;312:1483-1487.
13. Ikeda RM, Birkhead GS, DiFerdinando GT Jr, et al. Nosocomial tuberculosis: an outbreak of a strain resistant to seven drugs. *Infect Control Hosp Epidemiol* 1995;16:152-159.
14. Ussery XT Bierman JA, Valway SE, Seitz TA, DiFerdinando GT, Ostroff SM. Transmission of multi-drug resistance *Mycobacterium tuberculosis* among persons exposed in a medical examiner's office in New York. *Infect Control Hosp Epidemiol* 1995;16:160-165.
15. Centers for Disease Control. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 1994. *MMWR* 1994;43 (no. RR-13).