Editorial

Tuberculosis: What You Don't Know Can Hurt You

Keith F. Woeltje, MD, PhD

First, the good news. The 1997 statistics from the Centers for Disease Control and Prevention (CDC) show that the incidence of active tuberculosis (TB) has continued to decline, as it has since 1992.[1] This decline can be credited to increased public-health resources for appropriate treatment of patients with active TB, contact management, and preventive therapy. The decline is also due to an increased awareness by physicians and other healthcare workers that (here comes the bad news) TB is still a problem in this country. Despite gains in TB control, the federal government estimates that in 1994 approximately 6.5% of the population was infected with *Mycobacterium tuberculosis*.[2] Although the vast majority of those infected never will become ill, active TB will occur in over 30,000 patients before the end of the millennium. Although only a minority will be hospitalized, these patients may be seen in emergency rooms and clinics, requiring healthcare workers to maintain awareness of TB as an important problem.

This issue of *Infection Control and Hospital Epidemiology* brings us two articles that highlight different aspects of this problem for hospital workers. In one, Kellerman and colleagues at the CDC report on the actual costs to implement respiratory protection programs for hospital employees at five hospitals.[3] Four of these hospitals (three in New York City and one in Miami) had nosocomial outbreaks of multidrug-resistant TB. The fifth hospital was a rural hospital in Nebraska that had no documented cases of nosocomial TB. Starting in 1991, the study hospitals began to change from the use of surgical masks to dust-mist (DM) and dust-mist-fume (DMF) respirators. In 1994, in response to Occupational Safety and Health Administration (OSHA) guidelines, many began to use high-efficiency particulate air (HEPA) filter respirators. Their actual costs ranged from $1,600 to $223,000 for these respirators. The highest cost was in a hospital using only DM respirators; their cost would have been over a million dollars had they used HEPA masks that year.

Given that N95 respirators are now the mandated minimum standard for personal respiratory protection, Kellerman also estimated the total number of DM, DMF, and HEPA respirators used at each hospital in 1994, then calculated what the respirator costs would have been had they been using N95 respirators. This figure ranged from $62,024 to $422,526 among the outbreak hospitals, but was only $270 for the rural hospital. These estimates assume that there would be equal degrees of reuse of masks. To provide an independent estimate of mask use, the authors did an observational study in 1995 at one of the New York hospitals. They estimated 31 patient-room visits requiring mask use per isolation day. There were 24 patients at that hospital that year with active TB out of 314 patients placed in isolation to rule out TB, for a total of 2,427 isolation days. This led to the calculation of 75,237 masks needed if there were no reuse, for a projected cost of $81,256. By comparison, the same hospital had 36 patients with active TB during 1994, but used only 57,429 respirators. Assuming the same degree of over-isolation of patients and same number of patient visits per day, one would have estimated that 112,855 masks would have been used (1.5 times as many as in 1995, since there were 1.5 times as many patients with active TB). This suggests that there was likely a substantial amount of reuse of the DM and HEPA masks (presumably more of the latter, because they look expensive and not as disposable). Alternatively, there may have been substantial use of surgical masks by healthcare workers; these were not included in the 1994 calculations.

Kellerman also looked at the actual cost of initial fit-testing programs, using reasonable assumptions about the

From the Washington University School of Medicine, St Louis, Missouri.
Address reprint requests to Keith F. Woeltje, MD, PhD, Medical College of Georgia, Section of Infectious Diseases, 1120 15th St, Augusta, GA 30912-3130; e-mail, kwoeltje@mail.mcg.edu.
98-ED-088. Woeltje KF. Tuberculosis: what you don't know can hurt you. Infect Control Hosp Epidemiol *1998;19:626-628.*

amount of staff and administrative time required, and actual instructor salaries. These costs ranged from $16,993 to $26,175 among the three New York hospitals. The rural hospital spent $8,736, which was the least amount spent but by far represents the largest proportion of the overall respiratory protection program. The Miami hospital did not have a fit-testing program because it is a public institution and not bound by OSHA regulations.

The authors at the CDC compared the amounts for actual costs and for estimated costs if N95 respirators were used with figures published previously by Adal[4] and Nettleman.[5] Adal estimated that it would take 41 years, at a cost of $1.3 million to $18.5 million, to prevent one case of occupationally acquired active TB. Nettleman had similar estimates: $7 million to prevent a case of TB and $100 million per life saved. Kellerman states that the amounts in the current article represent reasonable expenditures, as opposed to the very high sums previously reported. Even reducing the amounts calculated by Adal and Nettleman by 80% to account for the lower cost of N95 versus HEPA respirators, the costs determined by Kellerman and coworkers are much lower. However, these articles use very different measures. Kellerman is looking at actual expenditures, without including any measure of efficacy. The articles by Adal and Nettleman tried to estimate the cost to prevent a case of occupationally acquired TB by changing to HEPA respirators. Both articles considered the fact that many employee skin-test conversions are the result either of exposure outside the hospital or of exposure to patients not yet in isolation. Kellerman criticizes the articles because they come from areas of low prevalence, but the Nettleman article is based on a survey of 159 Veterans' Administrations hospitals with widely variable numbers of TB patients. Adal and Nettleman also made generous assumptions on the effectiveness of HEPA respirators versus standard masks, assumptions that would have provided for conservative cost estimates. Both use higher estimates of the number of patient-room visits (50-60/isolation day) than Kellerman, but Adal specifically assumed reuse of respirators in his cost estimates. Thus, I think that the authors of all the articles probably would arrive at similar estimates of the number of masks expected to be used per isolation day and thus would arrive at similar estimates of actual respirator costs. The cost per case of TB prevented remains in question.

Many nosocomial outbreaks of TB occurred in the late 1980s and early 1990s.[6-9] Most of these outbreaks were controlled by the institution of basic infection control measures. Although in many cases changes were made to "better" respiratory protection than a surgical mask, because of concomitant changes in administrative and engineering controls, the effect of the change in respiratory protection could not be determined. Certainly, there is good evidence that HEPA masks are not necessary to control an outbreak.[7-9] It is clear that the most important factor in controlling outbreaks of TB and increases in skin-test conversion rates has been the implementation of appropriate administrative controls, ie, the timely identification and isolation of patients with TB. Without this, engineering controls and personal respiratory protection have no opportunity to work.

The importance of patient isolation is highlighted by the other TB article in this issue. Haas and colleagues report a patient with acquired immunodeficiency syndrome (AIDS) who was admitted with respiratory complaints and found to have TB after his condition worsened on standard antimicrobial therapy.[10] During the 4 days in which he was not isolated, he exposed 172 healthcare workers with previously negative tuberculin skin tests, 35 (20%) of whom had tuberculin skin-test conversions. The authors defined conversion as a skin test >10 mm. They do not list the number of exposed employees with tuberculin skin tests of >5 mm. A unit receptionist and another patient with AIDS who had been on the same floor as the index case later developed active TB. The index case, the second AIDS patient, and the receptionist all had the same strain by molecular typing. Interestingly, restriction fragment-length polymorphism analysis showed this strain to be similar to an multidrug-resistant TB strain found in New York City (the W strain). The Tennessee isolate was, fortunately, drug-sensitive.

What don't we know about TB, and how will that hurt us? We don't know the optimal way to identify patients with TB quickly while minimizing over-isolation. The hospitals cited by Kellerman had mask utilization rates ranging from 62.5 respirators per patient with active TB (in the rural hospital) to 4,805 respirators per patient with active TB (at the Cabrini hospital in New York). Clearly, the degree of over-isolation for patients with suspected TB must vary tremendously among these hospitals, because most mask use will be for patients who end up not having TB.

We don't know if N95 masks are better than surgical masks or other less expensive respirators at preventing employee skin-test conversion. Although the CDC suggests the costs for these masks is reasonable, compared with the overall budget for a hospital infection control program, the cost may be substantial and may lead to cutbacks in other areas of infection control. This would be disastrous, especially if administrative controls were cut back. It is possible that, in order to limit respirator use, there could be subtle (or not so subtle) pressure not to isolate patients, which may worsen the problem the respirators were supposed to solve, employee TB exposure. Granted, other regulations are aimed at preventing this. The article from the CDC suggests that we are unlikely to find out in this country the relative utility of different kinds of respirators because the studies never will be done. It is possible that investigators in other countries will attempt a more rigorous approach to determining the most appropriate personal respiratory protection.

We don't know if fit testing provides any added benefit. Again, although the dollar amounts reported by the CDC are not exorbitant, with today's shrinking healthcare budgets, any inappropriate spending should be eliminated (or more optimistically, that money could be spent elsewhere to improve infection control). Although fit testing is mandated by OSHA, and apparently will continue to be mandated,[2] perhaps allowances could be made to determine its utility in appropriate study settings. Perhaps public hospitals not required to follow the OSHA guidelines could serve this purpose. Hospitals already are trying a variety of approaches to minimize expenses while meeting the requirements.[11,12]

Finally, we don't know as much as we need to about TB infectivity. The article from Vanderbilt describes a strain that was very effective in causing infection. How it is related to multidrug-resistant strains in New York and how strains are spread across the country are issues that bear further study. Better understanding of local variations in TB epidemiology will be especially important given the increasing proportion of cases of active TB diagnosed in recent immigrants.[1] We need to know how to modify our control strategies to account for these local variations.

What we don't know about TB can hurt us. We can be hurt medically by under-appreciation of the disease. We can be hurt financially by using expensive interventions that provide no additional benefit over less expensive alternatives. Fortunately, what we do know is being used effectively to reduce rates of TB in this country; but, this should not prevent us from determining where our knowledge is lacking and correcting those deficits.

REFERENCES

1. Centers for Disease Control and Prevention. Tuberculosis morbidity—United States, 1997. *MMWR* 1997;47:253-257.
2. Occupational Safety and Health Administration. Occupational exposure to tuberculosis; proposed rule (29 CFR 1910). *Federal Register* October 17, 1997.
3. Kellerman SE, Tokars JI, Jarvis WR. The costs of healthcare worker respiratory protection and fit-testing programs. *Infect Control Hosp Epidemiol* 1998;19:629-634.
4. Adal KA, Anglim AM, Palumbo CL, Titus MG, Coyner BJ, Farr BM. The use of high-efficiency particulate air-filter respirators to protect hospital workers from tuberculosis. *N Engl J Med* 1994;331:169-173.
5. Nettleman MD, Fredrickson M, Good NL, Hunter SA. Tuberculosis control strategies: the cost of particulate respirators. *Ann Intern Med* 1994;121:37-40.
6. Jarvis WR. Nosocomial transmission of multidrug-resistant *Mycobacterium tuberculosis*. *Am J Infect Control* 1995;23:146-151.
7. Maloney SA, Pearson ML, Gordon MT, Del Castillo R, Boyle JF, Jarvis WR. Efficacy of control measures in preventing nosocomial transmission of multidrug-resistant tuberculosis to patients and healthcare workers. *Ann Intern Med* 1995;122:90-95.
8. Fella P, Rivera P, Hale M, Squires K, Sepkowitz K. Dramatic decrease in tuberculin skin test conversion rates among employees at a hospital in New York City. *Am J Infect Control* 1995;23:353-356.
9. Blumberg HM, Watkins DL, Berschling JD, Antle A, Moore P, White N, et al. Preventing the nosocomial transmission of tuberculosis. *Ann Intern Med* 1995;122:658-663.
10. Haas DW, Milton S, Kreisworth BN, Brinsko VL, Bifani PJ, Shaffner W. Nosocomial transmission of a drug-sensitive W-variant *Mycobacterium tuberculosis* strain among patients with acquired immunodeficiency syndrome in Tennessee. *Infect Control Hosp Epidemiol* 1998;19:635-639.
11. Lieb VA, Kozinn WP, Baxter P. Self-paced learning stations for tuberculosis respirator training: report of a pilot program. *Am J Infect Control* 1996;24:299-303.
12. Hannum D, Cycan K, Jones L, Stewart M, Morris S, Markowitz SM, et al. The effect of respirator training on the ability of healthcare workers to pass a qualitative fit test. *Infect Control Hosp Epidemiol* 1996;17:636-640.