Are US Hospitals Making Progress in Implementing Guidelines for Prevention of Mycobacterium tuberculosis Transmission?

Lilia P. Manangan, RN, MPH; Dawn N. Simonds, BS; Gina Pugliese, RN, MS; Karen Kroc, BS; Shailen N. Banerjee, PhD; Judith R. Rudnick, MD; Kristin Steingraber, BS; William R. Jarvis, MD

**Background:** Outbreaks of tuberculosis (TB) in hospitals have occurred when the Centers for Disease Control and Prevention (CDC) guideline recommendations for preventing the transmission of Mycobacterium tuberculosis were not fully implemented.

**Objective:** To determine whether US hospitals are making progress in implementing the CDC guidelines for preventing TB.

**Methods:** In 1992, we surveyed all public (city, county, Veterans Affairs, and primary medical school-affiliated) US hospitals (n = 632) and 444 (20%) random samples of all private hospitals with 100 beds or more. In 1996, we resurveyed 136 random samples (50%) of all 1992 respondent hospitals with 6 or more TB admissions in 1991.

**Results:** Of the 1076 hospitals surveyed in 1992, 763 (71%) respondents returned a completed questionnaire. Among these, 536 (71%) of 755 reported having rooms that met CDC criteria for acid-fast bacilli isolation, ie, negative air pressure, 6 or more air exchanges per hour, and air directly vented to the outside. The predominant respiratory protective device for health care workers was nonfitted surgical mask and attending physicians were infrequently (50%) included in tuberculin skin-testing programs. In the 1996 resurvey, 103 (76%) of 136 respondents returned a completed questionnaire. Of these, 99 (96%) reported having rooms that met CDC criteria for acid-fast bacilli isolation. The N95 respiratory protective devices were predominantly used by health care workers, and attending physicians were increasingly (69%) included in the hospitals' tuberculin skin-testing programs.

**Conclusions:** Most US hospitals are making progress in the implementation of CDC guidelines for preventing the transmission of M tuberculosis.

*Arch Intern Med. 1998;158:1440-1444*

Despite the recent decline in the number of individuals with tuberculosis (TB) during 1993-1995, transmission of *Mycobacterium tuberculosis* to patients and health care workers (HCWs) in health care settings remains a recognized risk. Serious morbidity and mortality can occur among patients and HCWs when recommendations in the Centers for Disease Control and Prevention (CDC) TB guidelines are not fully implemented, as documented by hospital outbreaks of both drug-susceptible and multidrug-resistant (MDR) strains of *M tuberculosis*.2-5

To emphasize the importance of the CDC TB guidelines in preventing *M tuberculosis* transmission in health care settings, CDC updated the 1990 TB guidelines in 1994.6-7 The 1994 CDC TB guidelines recommend 3 major areas of TB infection control: (1) identification, isolation, and early treatment of individuals known or suspected to have TB, (2) engineering controls to facilitate dilution of infectious droplet nuclei and to prevent their spread, and (3) personnel health, ie, respiratory protection and tuberculin skin-testing (TST) programs for HCWs and other hospital employees.

To determine TB infection control practices and the degree of implementation of the CDC TB guidelines at US hospitals, the American Hospital Association, in collaboration with CDC, surveyed a sample of US hospitals in 1992. To assess subsequent progress in implementing the 1994 CDC TB guidelines, we resurveyed in 1996 a sample of hospitals with 6 or more admissions of patients with TB in 1991 that responded to the initial survey. The questionnaire was divided into 3 parts to correspond to the 3 major areas of infection control as recommended in the CDC TB guidelines. This article focuses on the findings of 2 parts of the questionnaire, ie, engineering controls and per-
**METHODS**

Using a 1990 American Hospital Association data tape of all US (including Puerto Rico) hospitals, in 1992 we surveyed all 632 city, county, Veterans Affairs, and primary medical school–affiliated hospitals, which we classified as public hospitals. In addition, we randomly sampled 444 (20%) of all privately owned hospitals with 100 beds or more, which we classified as private hospitals. In April 1992, we mailed questionnaires to the department of infection control at the selected hospitals (N = 1076). In July 1992, we mailed a second survey to the chief executive officer of all nonresponding hospitals.

In October 1996, we resurveyed 136 random samples (30%) of all 1992 respondent hospitals with 6 or more TB admissions in 1991. We conducted the survey via telephone, fax, and/or mail.

We collected data on the number of annual admissions of patients with TB and MDR-TB, engineering controls, and personnel health program characteristics. For updating and comparison purposes, we merged the data from a sample (n = 103) of hospitals that participated in both the 1992 and 1996 surveys. We used SAS statistical software or Epi Info to analyze the data. We compared the categorical variables with the Fisher exact test or likelihood ratio test as appropriate and the continuous variables with a Wilcoxon rank sum test. In calculating rates, we used the number of hospitals that provided a response to a specific question as the denominator (not all responded to every question).

The findings of the third part of the questionnaire, ie, identification of M tuberculosis in the laboratory, were published in early 1996.8

**RESULTS**

**1992 QUESTIONNAIRE**

Of 1076 surveyed hospitals, 763 (71%) respondents returned a completed questionnaire; this included at least 1 hospital from all 50 states, District of Columbia, and Puerto Rico. Public and private hospitals had similar response rates (450 [71%] of 632 and 313 [70%] of 444, respectively). Of the 763 responding hospitals, 227 (30%) reported having 100 to 199 adult acute care beds; 274 (36%), 200 to 399 beds; and 262 (34%), 400 beds or more.

**TB Admissions**

During 1989-1991, the proportion of hospitals to which patients with TB were admitted increased as did the mean number of patients admitted; 179 (25%) of 726 respondents in 38 states and the District of Columbia admitted patients with MDR-TB. Public hospitals admitted more patients with TB or MDR-TB and were more likely than were private hospitals to report nosocomial transmission of M tuberculosis to HCWs and to patients.

Hospitals with a ward for patients with acquired immunodeficiency syndrome had increased risk of nosocomial M tuberculosis transmission to patients (4 [10%] of 41 vs 10 [1%] of 698; odds ratio [OR], 7.4; P = .005), but not to HCWs (7 [18%] of 39 vs 89 [13%] of 675; OR, 1.4; P = .39).

**Engineering Controls**

In 1992, 536 (71%) of 755 respondents reported having rooms that met CDC criteria for acid-fast bacilli (AFB) isolation (ie, negative air pressure, ≥6 air exchanges per hour, and air directly vented to the outside). Overall, respondents reported 0 to more than 60 (median, 7) AFB isolation rooms per hospital. However, 648 (89%) of 727 hospitals had no facilities that met CDC criteria in their emergency departments. There was no significant difference in the number of AFB isolation rooms at public or private hospitals.

At 545 (83%) of 657 hospitals, at least 1 room met one of the CDC criteria for AFB isolation rooms (ie, negative air pressure). However, in 334 (61%) of 545 hospitals, the air flow in these rooms was not routinely checked. Of the 211 hospitals where the air flow was checked routinely, 81 (38%) had it checked annually and 28 (13%) had it checked at least monthly.

At 679 (90%) of 753 hospitals, there was a written policy stating that doors should be kept closed in rooms occupied by patients admitted to AFB isolation rooms to ensure negative air pressure. However, in practice, at 339 (44%) of 775 hospitals, staff left the doors to AFB isolation rooms open some or most of the time. In addition, 451 (61%) of 734 hospitals by policy and 517 (70%) of 734 hospitals by practice allowed patients out of AFB isolation rooms for medical procedures that could have been performed in the room (eg, endoscopy). Furthermore, 73 (10%) of 755 by policy and 148 (20%) of 755 by practice allowed patients out of isolation rooms for reasons other than medical indications (eg, to visit patients’ lounge).

**Personnel Health**

Health care workers generally (99%) wore surgical masks when entering AFB isolation rooms. Similarly, patients admitted to AFB isolation rooms generally (99%) wore surgical masks when outside of their rooms. Patients at 446 (61%) of 730 hospitals and HCWs at 447 (61%) of 730 hospitals used nonfitted surgical masks, while patients at 50 (7%) of 761 hospitals and HCWs at 77 (10%) of 761 hospitals used particulate respirators.

At 747 (99%) of 758 hospitals, there was some form of TST program for hospital personnel. Nurses were included in all TST programs but other personnel, such as administrative staff, were included more often (622 [87%] of 716) than house staff (345 [60%] of 575), students (372 [56%] of 665), or attending physicians (294 [45%] of 654). At 618 (89%) of 745 hospitals, nurses received TST at least annually with 288 (50%) of 573 hospitals for house staff and 216 (33%) for attending physicians. Although 738 (99%) of 744 hospitals performed TST at time of hire, only 24 (3%) of 745 performed TST at the termination of employment.
At 672 (91%) of 735 hospitals, staff attempted to determine if an HCW TST conversion was due to an occupational exposure. However, only 234 (35%) of 672 hospitals responded to the question on TST conversion; of these, 194 (83%) reported TST conversions in their HCWs. We were not able to calculate the overall or specific HCW TST conversion rates because of insufficient data.

### 1996 QUESTIONNAIRE

Of the 136 resurveyed hospitals, 103 respondents (76%) returned a completed questionnaire; this included at least 1 hospital from 32 states. The response rate was 66 (64%) of 103 for public and 37 (88%) of 42 for private hospitals.

### TB Admissions

During 1992-1996, the proportion of hospitals with admissions of patients with TB decreased compared with the increase during 1989-1991. The median number of patients with MDR-TB admitted during 1993-1996 was fewer than 0.5; patients with MDR-TB were admitted to hospitals in 21 (66%) of 32 states surveyed. Public hospitals were significantly more likely than were private hospitals to admit 6 or more patients with TB per year or patients with MDR-TB during 1992, 1993, and 1996 than were private hospitals.

Only 1 of 74 respondents reported patient-to-patient nosocomial M tuberculosis transmission in 1993; none of the 74 reported such transmission during 1994-1996. Only 7 (7%) of 103 reported nosocomial M tuberculosis transmission to HCWs during 1992-1996.

### Engineering Controls

The number of hospitals having rooms that met the CDC criteria for AFB isolation increased from 59 (64%) of 92 in 1992 to 99 (96%) of 103 in 1996; the median number of AFB isolation rooms increased from a median of 4 to 12. The number of hospitals using a portable high-efficiency particulate air filter in AFB rooms also increased, from 23 (27%) of 84 in 1992 to 44 (43%) of 103 in 1996. In 1992, only 42 (49%) of 85 hospitals routinely checked the AFB rooms for negative air pressure compared with 96 (97%) of 99 hospitals in 1996. Furthermore, by 1996, most (76 [84%] of 90) hospitals reported monitoring the negative air pressure flow at least every month (Table 1).

### Personnel Health

In 1996, HCWs in 85 (83%) of 103 hospitals were using an N95 respirator when entering a room of a patient with suspected or infectious TB, compared with HCWs in 8 (8%) of 101 hospitals using a particular respirator in 1992 (Table 2). Health care workers in 93 (91%) of 102 hospitals participated in a respirator fit-testing program.

All the respondent hospitals had some form of TST screening program for personnel; 103 (100%) of 103 included nurses, 103 (100%) of 103 included respiratory therapists, and 89 (89%) of 101 included administrative staff. The number of hospitals that included house staff and attending physicians in their TST screening program increased from 56 (69%) of 81 and 43 (50%) of 86, respectively, in 1992, to 65 (89%) of 73 and 65 (69%) of 94, respectively, in 1996 (Table 3). Almost all (102 [99%] of 103) of the TST programs attempted to determine occupational exposure. However, only 6 (6%) of 101 included a TST at the termination of employment.

Only 30 (29%) of 103 hospitals provided data for personnel TST conversion rates during 1992-1996. However, at these facilities, the HCW TST conversion rate decreased from 35 in 1992 to 30 in 1995 and 20 TST conversions per 10 000 HCWs from January to June 1996.

### Table 1. Comparison of Hospitals According to Use of Specific Engineering Controls, 1992 and 1996 Surveys

<table>
<thead>
<tr>
<th>Engineering Controls</th>
<th>1992</th>
<th>1996</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid-fast bacillus isolation rooms †</td>
<td>59/92 (64)</td>
<td>99/103 (96)</td>
</tr>
<tr>
<td>Mean</td>
<td>6.9</td>
<td>15.0</td>
</tr>
<tr>
<td>Median</td>
<td>4.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Range</td>
<td>0-45</td>
<td>0-74</td>
</tr>
<tr>
<td>UV germicidal irradiation</td>
<td>12/91 (13)</td>
<td>18/101 (18)</td>
</tr>
<tr>
<td>Portable high-efficiency particulate air filter</td>
<td>23/84 (27)</td>
<td>44/103 (43)</td>
</tr>
<tr>
<td>Routine check of negative air pressure</td>
<td>42/85 (49)</td>
<td>96/99 (97)</td>
</tr>
<tr>
<td>Frequency of negative air pressure check Monthly or less</td>
<td>5/35 (14)</td>
<td>76/90 (84)</td>
</tr>
<tr>
<td>Quarterly</td>
<td>1/25 (4)</td>
<td>1/60 (2)</td>
</tr>
<tr>
<td>Semiannually</td>
<td>1/25 (4)</td>
<td>1/60 (2)</td>
</tr>
<tr>
<td>Annually</td>
<td>1/25 (4)</td>
<td>1/60 (2)</td>
</tr>
</tbody>
</table>

### Table 2. Comparison of Hospitals According to Type of Respiratory Protective Device Used by Health Care Workers, 1992 and 1996 Surveys

<table>
<thead>
<tr>
<th>Type of Respiratory Protective Device</th>
<th>1992</th>
<th>1996</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical, nonfitting</td>
<td>69/101 (68)</td>
<td>1/103 (1)</td>
</tr>
<tr>
<td>Soft, molded or fitted</td>
<td>34/101 (34)</td>
<td>NA</td>
</tr>
<tr>
<td>Particulate respirator</td>
<td>8/101 (8)</td>
<td>40/103 (39)</td>
</tr>
<tr>
<td>Dust mist or fume</td>
<td>NA</td>
<td>4/103 (4)</td>
</tr>
<tr>
<td>High-efficiency particulate air filter ‡</td>
<td>NA</td>
<td>36/103 (35)</td>
</tr>
<tr>
<td>N95</td>
<td>NA</td>
<td>85/103 (83)</td>
</tr>
</tbody>
</table>

* NA indicates not applicable.
† Includes only hospitals that were resurveyed in 1996.
‡ The N95 respiratory protective device meets minimum requirement of the Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health.
The 1992 survey showed the following: (1) the number of hospitals to which patients with TB were admitted increased during 1989-1991, (2) nearly one third of all hospitals did not have adequate facilities to isolate a patient with TB, (3) many hospitals had inadequate numbers of AFB isolation rooms, (4) almost half of those with AFB isolation rooms did not routinely test the air flow in these rooms, (5) nosocomial M tuberculosis transmission to patients and HCWs occurred, with a higher likelihood of transmission in public hospitals, and (6) public hospitals had more admissions of patients with TB and MDR-TB than did private hospitals and yet had fewer adequate AFB isolation rooms.

These results caused great concern among public and private health officers, including those in academia, public or private health care organizations, and local or state and federal government organizations. The 1992 survey, along with data from other surveys and outbreak investigations, played a key role in the development of the 1994 CDC TB guidelines and in convincing public health officials and hospital administrators to implement these guidelines.

Two years after the 1994 CDC TB guidelines were published, our 1996 resurvey provides further data suggesting a need for more complete implementation of these guidelines. These data supplement previous nationwide TB surveys: (1) the mycobacteriology laboratory component of the 1992-1995 American Hospital Association survey, (2) the 1992 Association for Professionals in Infection Control and Epidemiology and CDC survey, and (3) the 1995 Association for Professionals in Infection Control and Epidemiology and CDC survey of TB infection control practices in children's hospitals, all of which documented a gradual increase in the nationwide implementation of the 1994 CDC TB guidelines at US health care facilities.

The 1996 resurvey shows that hospitals have added and/or retrofitted rooms to meet the CDC criteria for AFB isolation. Interestingly, almost half of the resurveyed hospitals had portable high-efficiency particulate air filter units in their AFB isolation rooms, although the efficacy of high-efficiency particulate air filters in reducing the risk of M tuberculosis transmission is not documented. The survey also shows that hospital personnel are more aware of how to properly maintain the AFB rooms, with the majority routinely checking the pressure differentials in these rooms.

When we compared the hospitals that participated in both 1992 and 1996 surveys, we found a significant improvement in the number of AFB isolation rooms meeting CDC criteria. In addition, the predominant type of HCW respiratory protection device used at these hospitals changed from a surgical, nonfitted mask in 1992 to an N95 respirator in conjunction with an HCW fit-testing program in 1996. The increase in the number of adequate AFB isolation rooms and the use of appropriate respiratory protection by HCWs may have contributed to the concomitant reduction of HCW TST conversion rates as found in earlier studies.

Our study also showed an improvement in the number of hospitals that included house staff and attending physicians in TST programs from 1992 to 1996 (69% vs 89% and 50% vs 69%, respectively). Yet, the study identified a need for continued improvement in including house staff and attending physicians in the hospitals' TST programs and in the surveillance of TST conversions among HCWs, an essential component of a TB infection control program.

Similar to the 1992 Society for Healthcare Epidemiology of America and CDC survey, most hospitals in our survey had written policies requiring TST screening of personnel, but few had data to document how such policies are practiced. The total number or rate of TST conversions among HCWs could not be provided by most hospitals. Without such data, it is difficult to assess the efficacy of the TB infection control programs at these hospitals. Our data suggest a need for proper collection and management of HCW TST data so that periodic analysis of these data is possible and hospital areas where M tuberculosis transmission occurs can be readily identified.

Our survey has a number of limitations. All data were historical and reported by hospital personnel. The results should be considered as best estimates; most likely the number of AFB isolation rooms meeting CDC criteria would be less if evaluated further and the number of TST conversions would be greater if surveillance programs were active and complete. Care should be taken in generalizing to all US hospitals because the sample in the 1992 survey was selected to include hospitals in all states in which patients with TB were most likely to be hospitalized and the 1996 survey included only those hospitals that responded to the 1992 survey.

Despite these limitations, the results of our study show that in 1992 few US hospitals had fully implemented the 1990 CDC guidelines; however, by 1996, most US hospitals had made progress in implementing recommendations in the 1994 CDC TB guidelines. With this improvement in TB infection control practices, our study...
also documents a decrease in reported nosocomial M tuberculosis transmission at US hospitals. In 1992, 96 (13%) of 716 hospitals reported nosocomial M tuberculosis transmission to HCWs and 14 (2%) of 728 to patients; by 1996, the percentage of these hospitals decreased by half (7 [7%] of 103 to HCWs and 1 [1%] of 74 to patients). This finding further supports the results of previous follow-up investigations at hospitals that had outbreaks of MDR-TB that documented that complete implementation of the CDC TB guidelines successfully terminated or significantly decreased patient-to-patient and patient-to-HCW transmission of MDR-TB.15-17

Our surveys document an improvement in the implementation of TB infection control measures at US hospitals. Continued implementation of these guidelines and improvement in the management of HCW TST data are necessary if we are to continue to reduce the risk of occupational acquisition of M tuberculosis among HCWs in US hospitals.

Accepted for publication December 12, 1997.

Reprints: Lilia P. Manangan, RN, MPH, Hospital Infections Program, Mailstop E-69, 1600 Clifton Rd, Atlanta, GA 30333 (e-mail: lpm2@cdc.gov).

REFERENCES