

Value of Examining Three Acid-Fast Bacillus Sputum Smears for Removal of Patients Suspected of Having Tuberculosis from the “Airborne Precautions” Category

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We examined the potential risk of tuberculosis transmission if we modified our policy for release of patients from the “airborne precautions” category from three negative acid-fast bacillus (AFB) smears to two, or even one. Over a 4-year period, respiratory cultures from 42 patients grew *Mycobacterium tuberculosis*. Of these, 36 patients (81%) had a positive AFB smear result on the first submitted specimen. One additional patient (2%) had a first smear-positive finding on the second submitted specimen, and no patients had a first smear-positive result on the third submitted specimen. Respiratory cultures from five patients (12%) grew *M. tuberculosis* without ever having a positive AFB smear result. These data indicate that in our institution, reducing the number of negative smears required before removal of patients from the airborne precautions category would pose little, if any, increase in the risk of spreading tuberculosis.

Health care facilities are required to adhere to Occupational Safety and Health Administration guidelines and Centers for Disease Control and Prevention recommendations for preventing the transmission of tuberculosis to employees or patients (1). Under these guidelines, patients suspected of having pulmonary tuberculosis are placed in and remain in the “airborne precautions” category until discharge, until another diagnosis is made, or until a determination has been made that the patient is noninfectious. A number of community-based studies have demonstrated that a single variable, the acid-fast bacillus (AFB) smear status of the source case, strongly predicts which patients are the most contagious (8, 9). Current hospital infection control policy requires three negative AFB sputum smears, obtained on three separate days, before a patient may be removed from the airborne precautions category. At our institution, nontuberculosis isolates account for nearly 90% of positive smears. We examined the potential risk of tuberculosis transmission if we modified our policy for release from airborne precautions from three negative smears to two, or even one. We then compared the costs associated with the current policy to those of the two modifications by determining procedures billable to the patient for potentially unnecessary days spent under airborne precautions.

We reviewed the last 4 years of mycobacteriology laboratory data from all patients with expectorated or induced sputum specimens yielding growth of *Mycobacterium tuberculosis*. Specimens were processed, concentrated, examined microscopically, and inoculated by standard methods (4). First smear-positive specimens were amplified with the Eisenach IS1660 primers, which are specific for *M. tuberculosis* (2). When appropriate, cultures were probed by AccuProbe (GenProbe, San Diego, Calif.) for the presence of the *M. tuberculosis* complex, the *Mycobacterium avium*-*M. intracellulare* com-

plex, *Mycobacterium kansasii*, or *Mycobacterium gordonae*. Identification of other mycobacteria was accomplished by conventional biochemical testing.

Of 42 patients with sputum cultures that grew *M. tuberculosis*, 36 (81%) had a positive AFB smear result from the first specimen submitted. One additional patient (2%) had the first smear-positive finding on the second submitted specimen. There were no tuberculosis patients that were smear positive on the third smear only. Five (12%) patient sputum cultures grew *M. tuberculosis* without ever having had a positive AFB smear result (three or more negative smears).

Table 1 demonstrates the potential transmission of *M. tuberculosis* based on the policy adopted. Under current policy, five tuberculosis patients that never had a smear-positive result were considered potential transmission risks. If the policy had been modified (modification 1) to two negative smears before release from the airborne precautions category, there would have been no change in the number of potential transmission risk patients. If the policy had been modified further (modification 2), to only one negative smear before release, one smear-positive patient (total of 6) would have been released, posing a potential increase in the risk of transmission to others.

Based on data collected the first 4 months of 1999 (data not shown), our institution would be expected to place around 360 patients into the airborne precautions category each year. Of these, 270 will have ≥ 3 negative AFB smears, the vast majority remaining culture negative for AFB. Approximately 40 of these smear-negative patients will become AFB culture positive, with 1 or at most 2 yielding *M. tuberculosis*. The remaining 90 patients will be AFB smear positive on the first or second smear. If modification 1 were implemented in our institution, we could expect about 270 fewer patient days under airborne precautions, resulting in a \$32,000 decrease in patient charges (based on \$120/day). Similarly, using modification 2, the decrease in patient charges for 540 fewer patient days under airborne precautions would be \$65,000. This potential savings would have to be weighed against the increased costs associated with an additional postexposure workup.

Airborne transmission of tuberculosis is a public health con-

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TABLE 1. Policy impact on release from the "airborne precautions" category for 42 patients with culture-positive pulmonary tuberculosis^a

Policy	No. (%) of patients under AP	No. (%) of patients not under AP ^b	Increased risk (%) due to policy
Current (≥ 3 negative smears)	37 (88)	5 (12)	NA
Modification 1 (2 negative smears)	37 (88)	5 (12)	No change (0)
Modification 2 (1 negative smear)	36 (85)	6 (15)	1 additional patient (3) ^c

^a AP, airborne precautions; NA, not applicable.

^b Number of nontreated tuberculosis patients not under airborne precautions who could potentially transmit *M. tuberculosis*.

^c The smear-positive finding from this one patient was read as 1+, i.e., 3 to 9 AFB per slide.

cern. It has been estimated that 10 secondary infections arise annually from 1 untreated smear-positive case of tuberculosis (11). In the United States, only 50 to 60% of patients with pulmonary tuberculosis will have a positive sputum smear (1). Even with the combined sensitivity of three smears, approximately 4 of 10 patients with pulmonary tuberculosis will go undetected until cultures become positive for growth. However, the AFB smear-based approach to isolation has proven successful in interrupting nosocomial outbreaks of tuberculosis (3, 5, 7, 8). The AFB smear is a cheap and rapid test compared to culture for identifying highly infectious persons.

At a minimum, the examination of at least one sputum specimen is necessary to predict the infectivity of patients suspected of tuberculosis. Nelson et al. showed that the diagnostic value of a second specimen is considerable, improving the overall sensitivity of culture by nearly 30% regardless of smear result (6). Yet the same study showed that only 5% of tuberculosis patients were smear positive on the third or subsequent specimen, leading the authors to conclude that rarely is a third specimen of diagnostic value. Similarly, Cascina et al. found the sensitivity of culture increased by 16% with the second specimen and by another 8% with the third specimen (A. Cascina, A. Fietta, and L. Casali, Letter, *J. Clin. Microbiol.* 38:466, 2000).

Our study differs from these earlier reports in that we were interested in determining the value of first, second, and third AFB smear results in deciding whether to remove a patient from the airborne precautions category. Interestingly, in our institution, the sensitivity of the first smear was higher (82%) than in the earlier reports (73 and 72%, respectively). In addition, *M. tuberculosis* was grown from the first specimen for all smear-positive samples and from the first specimen from 5 of the 6 patients with a smear-negative finding in our institution. Our data indicate that in our institution 12% of patients with pulmonary tuberculosis will have three or more negative smears. The percentage remains the same if the criterion for release is decreased from three negative smears to two. Exposure risks would presumably be low since smear-negative, culture-positive specimens result from decreased numbers of viable organisms in respiratory secretions. In our study we had five culture-positive patients with three or more negative AFB smears, indicating that multiple cultures are needed to detect *M. tuberculosis* in smear-negative (paucibacillary) patients. One patient had a positive smear finding on the second sputum specimen submitted, which was read as 1+, indicating low numbers in the final specimen. There was never a negative smear followed by a 2+ or 3+ result. Therefore, patients with tuberculosis that produce smear-negative sputa tend to remain low shedders unless some significant clinical change occurs. Clinical judgment is a more important criterion for submitting additional AFB specimens than the fact that the patient has already had one or even three previous negative smears. Similar strategies have been indicated for removing culture-positive tuberculosis patients from the airborne precautions cate-

gory during antimycobacterial therapy. Telzak et al. suggested that treated patients could be removed from isolation after only two consecutive negative smears without significantly increasing the risk of person-to-person transmission (12).

It is important to reduce hospital expenses such as those generated by unnecessary placement of patients under airborne precautions, while at the same time insuring that the risk of transmission to other patients or health care workers is not increased. Our calculations are based on savings to the patient due to earlier removal from the airborne precautions category. Other cost variables not analyzed include early removal due to another diagnosis, delayed removal because sputum specimens are not submitted on a daily basis, and increased costs associated with a tuberculosis exposure workup. Lastly, our cost analysis does not take into account the increased difficulty of providing health care to an individual under airborne precautions. Regardless of the exact amount of savings that might be generated, our data suggest that a change in policy from three to two negative smears before release (modification 1) would not cause an identifiable risk of spreading tuberculosis in our institution. In fact, modification 1 would have no impact on detection of the five smear-negative (≥ 3 negative smears), culture-positive tuberculosis patients identified during the course of the study.

The current University of North Carolina hospital infection control policy requires three negative AFB smears, with each specimen obtained at least 24 h apart, before a patient is released from the application of airborne precautions. Our study suggests that modifying the smear policy from three to two negative smears would result in no increased risk of spreading tuberculosis and would decrease the number of days patients are unnecessarily placed under airborne precautions. In addition, patients would realize a decrease in billable charges related to days spent under airborne precautions. Clinical judgment as to whether a patient has pulmonary tuberculosis, not the number of negative AFB smears, should determine whether a patient could be removed from the airborne precautions category.

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