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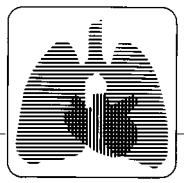

bronchoscopy

An Outbreak of Bronchoscopy-Related *Mycobacterium tuberculosis* Infections Due to Lack of Bronchoscope Leak Testing*

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Background: **Bronchoscopy-related transmission of *Mycobacterium tuberculosis* is rarely reported. In August 1999, five *M tuberculosis*-positive bronchial washing culture findings were noted in patients who underwent bronchoscopy in July in a hospital that reported only eight *M tuberculosis*-positive culture findings from 1995 to 1998, prompting further investigation.**

Methods: **A case was defined as a *M tuberculosis*-positive culture finding from specimens obtained from patients who underwent bronchoscopy during January to August of 1999. Bronchoscopy and laboratory records, procedures, and practices were reviewed. *M tuberculosis* isolates were compared using restriction fragment length polymorphism (RFLP) analysis.**

Results: **During July 1999, 19 bronchoscopic procedures were performed in 19 patients. Bronchial washing specimens for mycobacterial culture were obtained from 18 patients. Ten cases were identified. Two case patients, including the index patient, had signs and symptoms of active tuberculosis prior to bronchoscopy. *M tuberculosis* infections developed in two more case patients despite starting a standard four-drug antituberculous regimen within 3 weeks after bronchoscopy. Six case patients had positive culture findings but no evidence of infection. All *M tuberculosis* isolates were antituberculosis-drug susceptible, and all but one were indistinguishable by RFLP analysis. Three bronchoscopes were used during the outbreak period; one bronchoscope was used in 9 of the 10 case patients (relative risk, 8.1; 95% confidence interval, 1.3 to 52). A hole was discovered in the sheath of this bronchoscope. Leak testing, a critical step in bronchoscope reprocessing, was not routinely performed at this institution.**

Conclusions: M tuberculosis **contamination of the bronchoscope occurred during the index patient's procedure. The hole in the sheath provided access to a space that was difficult to mechanically clean and chemically disinfect. The reprocessing recommendations of bronchoscope manufacturers, including leak testing after each use, should be closely followed.** ***(CHEST 2002; 121:976–981)***

Key words: bronchoscopy; disease outbreaks; equipment contamination; *Mycobacterium tuberculosis*; tuberculosis

Abbreviations: RFLP = restriction fragment length polymorphism; TB = tuberculosis

Bronchoscopy allows direct access to and visualization of the airways to aid in the diagnosis and treatment of various respiratory conditions. The number of bronchoscopic procedures performed annually has increased substantially since flexible fiberoptic bronchoscopes became commercially available in 1967, and at least 500,000 bronchoscopic procedures are performed each year in the United States.[1] Most are performed to evaluate suspected infections or abnormal chest radiographic findings.[2] Because they come into contact with mucous membranes, bronchoscopes are considered "semi-critical" under the Spaulding Classification System of patient-care devices, and therefore require at least a

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high-level disinfection between uses.[3] A high-level disinfectant should destroy all microorganisms, with the exception of high numbers of bacterial spores.[3]

Reported infections associated with bronchoscopy are rare; most studies[4–8] report incidence rates of < 1%. However, infectious complications of bronchoscopy are often difficult to recognize and may be underreported.[6,9–11] Sequestered organic material poses the greatest contamination risk; thus, bronchoscopy-related infections are often associated with improper reprocessing procedures. The most common reported agents include Pseudomonas species and mycobacteria.[6] While nontuberculous mycobacteria usually originate from the aqueous environment, contamination with *Mycobacterium tuberculosis* generally comes from an infected patient.[6] Most reports of bronchoscopy-related tuberculosis (TB) outbreaks actually describe pseudoinfections, and eight true infections have been documented.[11–17] This report describes an outbreak in which *M tuberculosis* was transmitted from a patient with active TB to at least two more patients via a contaminated bronchoscope.

Materials and Methods

Background

On August 3, 1999, an infection-control practitioner from a 225-bed community hospital notified the Wisconsin Division of Public Health of *M tuberculosis*-positive bronchial washing culture findings from five patients undergoing bronchoscopy between July 6, 1999, and July 16, 1999. Bronchoscopy was performed on all five patients with the same flexible fiberoptic bronchoscope. We conducted a retrospective cohort study to identify the source and apply infection-control measures.

Case Definition and Case Finding

We defined a case as a *M tuberculosis*-positive culture finding in specimens obtained from patients undergoing bronchoscopy from January 1, 1999, through August 31, 1999. We reviewed the mycobacteriology records of the hospital laboratory from January 1, 1995, through August 31, 1999, to identify patients with positive culture findings for *M tuberculosis*. We reviewed bronchoscopy records, including procedure logs, and patient records. Tuberculin skin tests were performed on bronchoscopy patients and staff soon after suspected exposure and again 90 days later using the Mantoux method with five tuberculin units of tuberculin purified protein derivative. Persons with a history of TB or a previous positive skin test result were not retested.

Procedures Review

We observed specimen-handling practices to assess the potential for cross-contamination in the laboratory. We observed bronchoscopy procedures and instrument reprocessing practices and reviewed written bronchoscope reprocessing protocols.

Laboratory Investigation

Environmental specimens were obtained from the bronchoscopy suite for mycobacterial culture, including specimens from bronchoscopes, biopsy forceps, and cytology brushes. Clinical specimens, including BAL, sputum, or tissue specimens, were digested with *N*-acetyl-L-cysteine and decontaminated with sodium hydroxide. Environmental and clinical specimens were concentrated by centrifugation and inoculated into a liquid medium, incubated at 37°C, and processed using a radiometric culture detection system (BACTEC model 460; Becton Dickenson; Franklin Lakes, NJ). Mycobacterial isolates were sent to a reference laboratory for speciation. The DNA fingerprints of all *M tuberculosis* isolates were compared by restriction fragment length polymorphism (RFLP) analysis using the PvuII/IS6110 method.[18]

Results

Case Finding

The hospital laboratory averaged just two positive *M tuberculosis* culture findings per year during 1995 to 1998 (range, one to four positive findings per year). Ten cases were identified, all of which were in patients undergoing procedures during July (Fig 1). Eight of the 10 case patients were male, and the median age was 60 years (range, 33 to 85 years). Bronchoscopy was performed in the case patients to evaluate a lung mass or masses in six patients, chronic cough in two patients, a cavitary lesion in one patient, and a cavitary lesion and infiltrates in one patient. The index patient had signs and symptoms of TB prior to bronchoscopy, and *M tuberculosis* was cultured from a bronchial washing obtained during bronchoscopy on July 6. The nine subsequent case patients had *M tuberculosis* cultured from bronchial washings obtained between July 7 and July 23 (Table 1). All nine isolates had an 11-band RFLP pattern that was identical to the index case patient's pattern, designated M251–99.11. In addition to the positive bronchial washing finding, the index patient had "mycobacterial caseating granulomatous pneumonitis" based on examination of a right upper lobe biopsy obtained during his procedure. Despite treatment attempts, including directly observed therapy, he died approximately 1 month later. After bronchoscopy, case patients 2, 5, and 6 had persistent evidence of *M tuberculosis* infection. Patient 2 produced *M tuberculosis*-positive sputum specimens at 3, 4, and 5 days after bronchoscopy; the RFLP pattern of the day-3 isolate was also M251–99.11. Patient 5 had a partial lung resection 6 weeks after bronchoscopy to remove a malignancy from his right lower lobe; coincidentally, there were "small miliary nodules ranging in size from 3 to 6 mm" found in the resected specimen, as described in the pathology report. *M tuberculosis* pattern M251–99.11 was cultured from one of the nodules. Patient 6, a Southeast Asian immigrant with a history of TB and signs and symptoms of active TB prior to bronchoscopy, had *M tuberculosis* pattern M251–99.11 isolated from

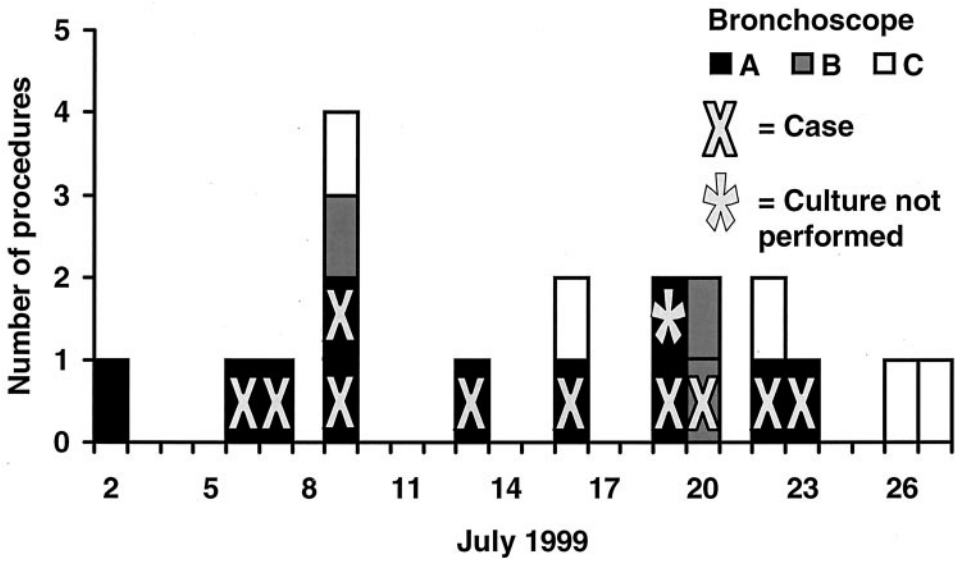

FIGURE 1. Bronchoscopic procedures performed at the study hospital during July 1999 by instrument used and case status of patient.

her bronchial washing. She also produced a *M tuberculosis*-positive sputum specimen 1 month after bronchoscopy; however, this isolate had a one-band RFLP pattern, designated M270–94.1. She was the only case patient known with risk factors for HIV; however, she declined testing. All patients with a positive *M tuberculosis* culture finding received a standard four-drug antituberculous regimen consisting of isoniazid, rifampin, pyrazinamide, and ethambutol.

One tuberculin skin test conversion was documented in a bronchoscopy nurse following the outbreak. She had a negative skin test result (0-mm induration) in August 1999 and a positive skin test result (20-mm induration) 3 months later. This nurse assisted with bronchoscopic procedures for patients 1 and 6, the two patients with evidence of active TB prior to bronchoscopy, and she received isoniazid for treatment of latent TB infection.

Table 1—*Bronchoscopy-Related* M tuberculosis *Infections at the Study Hospital, 1999**

Case No.	Age, yr	Sex	Date of Procedure in 1999	Indication for Bronchoscopy	RFLP Pattern	Bronchoscope Used	Tuberculin Skin Test Dates, Results	TB†	Postbronchoscopy Diagnosis
1	85	M	July 6	Cavitary lesion	M251-99.11	A	June 1999, 0 mm‡	Yes	TB
2	67	M	July 7	Lung mass	M251-99.11	A	July 1999, 0 mm‡	Yes	Bronchitis
3	46	M	July 9	Lung mass	M251-99.11	A	March 1999, 0 mm; October 1999, 0 mm	No	Sarcoidosis
4	38	M	July 9	Pulmonary nodules	M251-99.11	A	October 1999, 0 mm	No	Caplan syndrome
5	70	M	July 13	Lung mass	M251-99.11	A	July 1999, 0 mm	Yes	Lung cancer
6	33	F	July 16	Infiltrate Cavitary lesion	M251-99.11 M270-94.1	A	August 1993, 10 mm; July 1999, 17 mm	Yes	TB
7	62	M	July 19	Lung mass	M251-99.11	A	August 1999, 0 mm; October 1999, 0 mm	No	Lung cancer
8	69	M	July 20	Cough	M251-99.11	B	August 1999, 0 mm; December 1999, 0 mm	No	Bronchitis
9	59	F	July 22	Cough	M251-99.11	A	August 1999, 0 mm; October 1999, 0 mm	No	Bronchitis
10	69	M	July 23	Hilar mass	M251-99.11	A	August 1999, 0 mm	No	Lung cancer

*M = male; F = female.
†Evidence of *M tuberculosis* infection.
‡Anergic.

Procedures Review

Laboratory Processing: Specimens were processed for mycobacterial culture as they were received, and a radiometric culture detection system (BACTEC model 460) was used. We found no evidence of cross-contamination in this instrument. The index case patient's bronchial wash specimen was not processed in the BACTEC model 460 with the other specimens, there was no evidence of instrument malfunction, and the laboratory staff adhered to the proper operating protocol. Common dispensers of reagents with wide mouths were used during specimen processing, increasing the risk of cross-contamination.[19–21] However, because there were seven specimens with negative findings processed following the positive finding in the index patient, and because five of these specimens were processed on the same day as the positive specimen finding, the likelihood of cross-contamination in the laboratory was low.

Bronchoscope Reprocessing and Inspection

Nineteen bronchoscopic procedures were performed by four bronchoscopists in July using three different bronchoscopes. One instrument, bronchoscope A (model BF Type 1T40; Olympus; Tokyo, Japan), was used in 9 of the 10 case patients (relative risk, 8.1; 95% confidence interval, 1.3 to 52). Patient 8 had the only case involving bronchoscopy with a different instrument, bronchoscope B (model BF Type P20; Olympus).

The steps in bronchoscope reprocessing include mechanical cleaning of the lumen and instrument port with an enzymatic detergent, leak testing, and a 20- to 30-min soak in a disinfectant solution followed by rinsing and drying steps.[22] There are several chemical sterilants approved for high-level disinfection of endoscopes[23]; this hospital used a 7.5% hydrogen peroxide and 0.85% phosphoric acid solution (Sporox; Sultan Chemists; Englewood, NJ). A review of the bronchoscope reprocessing procedures of the hospital revealed that leak testing was not routinely performed. Furthermore, the written reprocessing protocol was outdated, no timer was available for the disinfectant soak, and personal respirators were not readily available for bronchoscopy suite staff. Staff did, however, use gloves and eye protection.

The three bronchoscopes used during the outbreak period were sent to the manufacturer for inspection. A routine leak test was performed on each instrument by submerging the insertion tube in water and forcing air at low pressure through the insertion tube interstitium, looking for air bubbles to identify leaks. A small leak was discovered in bronchoscope A. It was located in the external sheath of the maneuverable tip, very close to the end.

Laboratory Results

Environmental culture findings from the three bronchoscopes, the biopsy forceps, and the cytology brushes were negative for mycobacteria; however, in response to the outbreak, the infection-control department of the hospital processed the bronchoscopes in an ethylene oxide gas sterilizer before specimens were collected.

Discussion

We conclude that *M tuberculosis* contamination of bronchoscope A occurred during the index patient's procedure. The hole in the bronchoscope sheath provided access to a space that was difficult to mechanically clean and chemically disinfect. Because the hole was located very close to the distal end of the insertion tube, *M tuberculosis* from the index case was potentially delivered directly to the distal airways of subsequent patients. The hole was not detected because bronchoscope leak testing was not routinely performed at this institution. We found no common exposures other than bronchoscopy in the case patients.

Most prior reports of bronchoscopy-related TB outbreaks actually describe pseudoinfections; there appear to have been eight previously reported true infections.[11–17] In this outbreak, *M tuberculosis* was transmitted from the index patient to two subsequent patients via the contaminated bronchoscope with resulting infection, as evidenced by the culture-positive sputum specimens from patient 2 and the tubercle-laden lung specimen from patient 5. The culture-positive sputum specimens from patient 2 were collected 3 to 5 days after bronchoscopy. While we believe that *M tuberculosis* was transmitted from the bronchoscope to patient 2, it is not clear whether 3 to 5 days is sufficient time to develop infection.[24]

While patient 6 had evidence of persistent *M tuberculosis* infection, we believe that *M tuberculosis* was not transmitted from the index patient to patient 6 because she had signs and symptoms of active TB prior to bronchoscopy and because the RFLP pattern of her follow-up sputum culture did not match that of the index patient's pattern.

Six patients were exposed to the contaminated bronchoscope but apparently did not develop infection with the outbreak strain, while the case status of another patient is undetermined because specimens were not obtained for culture. Rather than considering the initial bronchial washing culture findings as false-positives, which is appropriate during pseudo-

outbreaks,[21,25–27] we believe that true infection in these patients may have been masked or prevented by prompt initiation of four-drug antituberculous therapy, particularly when active infection developed in two individuals despite four-drug therapy.

Why patient 8 was affected despite undergoing bronchoscopy with a different bronchoscope is not clear. One possible explanation is laboratory cross-contamination resulting in carryover of mycobacteria from one sample to another. During our laboratory review, we identified the use of common reagent dispensers with wide mouths as a possible source of cross-contamination.[19–21] Furthermore, the BACTEC model 460 uses a common needle to sample multiple specimens and has been associated with specimen cross-contamination previously.[28,29] However, if there were cross-contamination in the laboratory, we would expect more cases among patients in whom bronchoscopes B and C were used. Another explanation is that the instrument identifier was incorrectly entered in the bronchoscopy log. While the study hospital followed guidelines from the Association for Professionals in Infection Control and Epidemiology, Inc., which recommend that facilities performing endoscopy should maintain a log indicating for each procedure the patient's name and medical record number, the endoscopist, and the serial number or other identifier of the endoscope used,[22] it is possible that bronchoscope A was used in patient 8 and erroneously recorded as bronchoscope B.

One nurse was also infected, presumably via aerosol transmission. While engineering controls in the bronchoscopy suite were adequate, the nonavailability of personal respirators may have contributed to her infection.

Our study shows how important it is to adhere to the reprocessing procedures specified by bronchoscope manufacturers. This includes conducting leak testing after each procedure.[22] If a leak is detected, the bronchoscope should be sent to the manufacturer for repair or replacement. Furthermore, bronchoscopy is a cough-inducing and aerosol-generating procedure and should not be performed in patients with active TB unless absolutely necessary.[30] Finally, if TB is known or suspected, bronchoscopy-suite personnel should wear personal respirators.[30]

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