

# The Q-Net™ Monthly

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## What's News

Welcome to Q-Net's 11th year of publication. Q-Net welcomes this month's newest subscribers from: *Belarus, England, Hungary, Indonesia, New Zealand, Peru, Romania, and Russia*. Back issues to this newsletter are available at: <http://www.myendosite.com>

## Editor-in-Chief

All of the articles published in this newsletter are written by: **Lawrence F Muscarella, PhD, Chief, Infection Control at Custom Ultrasonics, Inc. Ivyland, PA**

## What is 'Q-Net'?

Q-Net is a technology-assessment network of questions and answers. Its newsletter is *The Q-Net™ Monthly*.

The mail goal of Q-Net is to encourage the infection control, endoscopy, and OR communities to not only ask good questions but to also demand well referenced responses.

Q-Net addresses the needs of both the health care provider whose goal is to provide the best care possible and the patient who deserves affordable quality health care.

**FOCAL POINTS:** • Contaminated respiratory specimens do not necessarily indicate a nosocomial infection. • Whereas respiratory specimens contaminated with *M. tuberculosis* typically indicate an outbreak, their contamination with atypical mycobacteria usually indicates a pseudo outbreak.

## "Positive" respiratory specimens: A true or pseudo infection?

### Question

***"Our hospital recently noticed a significant increase in the number of respiratory specimens contaminated with Mycobacterium avium-intracellulare (MAI). These specimens were collected during BAL using bronchoscopes, which are reprocessed using an automated machine. Could you discuss the significance of the contamination of respiratory specimens with MAI and other types of mycobacteria including M. tuberculosis, the causative agent of tuberculosis?"***



**Background and answer:** The identification of respiratory specimens contaminated with *Mycobacterium avium-intracellulare* (MAI) and other types of mycobacteria and microorganisms can be cause for concern, having

potentially significant epidemiological, infection control, economic, and ethical implications. To evaluate the significance of contaminated respiratory specimens and reply to this question, the medical literature was reviewed. Focus during this review was placed on the following topics: (1) bronchoscopy and BAL; (2) the two groups of mycobacteria; (3) differences between a true (or "real") infection and a pseudo (or "false") infection; (4) a description of the potential sources and modes of nosocomial transmission of MAI and other types of mycobacteria including *M. tuberculosis*; and (5) factors that might contribute to or be responsible for contamination of respiratory specimens.

The medical literature was also reviewed to identify practices that minimize the risk of: (a) environmental contamination of respiratory specimens, and (b) the nosocomial transmission of MAI via contaminated bronchoscopes, gastrointestinal (GI) endoscopes, and other types of flexible endoscopes.

**Bronchoscopy, BAL, and respiratory specimens:** Bronchoscopy is a procedure that uses a flexible (or rigid) bronchoscope to visualize and examine the lungs and respiratory tract. If a patient displays clinical symptoms of pulmonary tuberculosis, pneumonia, lung cancer, or another respiratory disease, a pulmonologist may

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use a bronchoscope to perform bronchoalveolar lavage, or "BAL," to diagnose the disease. During BAL, the respiratory tract is washed, or lavaged, by flushing sterile saline (or sterile water) through the working (or suction) channel of the bronchoscope. Because of its contact with and irrigation of the patient's lower respiratory tract, this lavage solution, known as bronchoalveolar lavage fluid, or "BALF," becomes contaminated with not only the patient's lung cells, mucous, and other fluids and infiltrates, but also any types of microorganisms that may have colonized or infected the respiratory tract. The bronchoscope's working channel is also used to suction or collect a sample of the BALF. This clinical sample, also known as a respiratory specimen, is sent to a clinical microbiology (or pathology) laboratory to be analyzed and evaluated for disease. Microbiological analysis of respiratory specimens is an important tool for the diagnosis and treatment of active pulmonary tuberculosis.<sup>(1)</sup>

**Two groups of mycobacteria:** Mycobacteria are aerobic, gram-positive, rod-shaped bacteria, or bacilli, that do not form endospores. Whereas some species of mycobacteria are "slow-growing" and may take several weeks to multiply on culture media, other species of mycobacteria are (relatively) "fast-growing" and may multiply in culture media within 7 days. (For reference and comparison, *Escherichia coli* and other types of gram-negative bacteria may grow and multiply in 20 minutes.) Mycobacteria are often referred to as acid-fast bacilli, or "AFB," because when colorized with certain dyes during diagnostic testing, their fatty cell walls remain stained after treatment with an acidic solution.

Due to specific differentiating characteristics, mycobacteria are classified into two groups (Table 1). Members of the first group are generally slow-growing, cause tuberculosis, and include *M. tuberculosis*, *M. africanum*, *M. bovis*, and *M. microti*. *M. leprae*, the causative agent of leprosy, is also a member of this group. These mycobacteria usually infect the lungs, although the skin and other tissues may also be affected and damaged.

The mode of transmission of *M. tuberculosis* is primarily from one person to another via the air,<sup>(2-5)</sup> a characteristic that is important to the identification of the source of a nosocomial outbreak of tuberculosis. A patient may become infected with *M. tuberculosis* after inhaling contaminated dust particles or droplet nuclei (5 µm or smaller in size) that were expelled into the air by an infected person during, for example, coughing, talking, or sneezing.<sup>(3)</sup> For its part, the environment is not ordinarily a reservoir for growth, multiplication, and colonization of tuberculocidal mycobacteria. The symptoms of tuberculosis include weight loss, a low-grade fever, a chronic cough, and bloody sputum. Tuberculosis is usually treated over several months using a four-drug regimen of isoniazid, rifampin, pyrazinamide, and ethambutol or streptomycin.

The second group is usually referred to as "nontuberculosis" mycobacteria, or "NTM," because its

#### ■ Mycobacteria that cause tuberculosis:

- Examples: the *M. tuberculosis* complex, which includes *M. tuberculosis*, *M. africanum*, *M. bovis*, and *M. microti*; *M. leprae*
- Generally slow-growing
- Contagious
- Types of diseases: tuberculosis
- Mode of transmission: person-to-person, airborne
- Symptoms of pulmonary infection include weight loss, a low-grade fever, a chronic cough, bloody sputum
- Standard treatment is usually a four-drug antituberculous regimen of isoniazid, rifampin, pyrazinamide, and ethambutol or streptomycin, taken for several months
- Multidrug-resistant strains have been reported

#### ■ Mycobacteria that do *not* cause tuberculosis:

- Known as nontuberculosis, or atypical, mycobacteria
- Examples: *M. avium-intracellulare* (MAI), *M. ulcerans*, *M. gordonae*, *M. kansasii*, and *M. fortuitum*
- Most species are fast-growing (e.g. *M. fortuitum*, *M. gordonae*); some are slow-growing (e.g. MAI, *M. ulcerans*)
- Not considered contagious
- Opportunistic; does not always cause disease
- Types of diseases: most often pulmonary disease, but also skin disease, abscesses
- Mode of transmission: environment-to-person
- Examples of sources, reservoirs: soil, dust, natural water sources, tap water, and other environmental sites
- Symptoms of pulmonary infection may be similar to those associated with tuberculosis and include: cough, fever, night sweats, weight loss
- Treatment may be similar to the drug regimen used to treat pulmonary tuberculosis.

**Table 1. The two types of mycobacteria.** Both groups of mycobacteria are aerobic, rod-shaped, gram-positive bacteria that do not form endospores.

members do not cause tuberculosis, although they may cause other types of lung and skin diseases (Table 1). Examples of mycobacteria in this group, which may also be referred to as "atypical" mycobacteria, include *M. avium-intracellulare* (MAI), *M. gordonae*, *M. kansasii*, and *M. fortuitum*. In addition to being considered relatively fast growing, several species of mycobacteria in this group are important opportunistic microorganisms that can cause significant morbidity and mortality in patients with compromised immune systems, such as patients suffering from AIDS.

The symptoms of infection and the course of treatment associated with some species of NTM may be similar to those associated with tuberculocidal mycobacteria. Rapid identifi-

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cation of the specific species of mycobacteria responsible for an infection is important, however, because the treatment for NTM may be significantly different than for tuberculocidal mycobacteria.<sup>(6)</sup> Unlike *M. tuberculosis* whose mode of transmission is generally from person-to-person,<sup>(3-5)</sup> NTM are not considered contagious, and their mode of transmission is usually from the environment to a patient by way of, for example, a contaminated bronchoscope. Soil, dust, natural water sources, and tap water are common sources and reservoirs for the growth and multiplication of NTM. Patient-to-patient transmission of NTM is rare.

**True infection, pseudo infection:** The identification of respiratory specimens contaminated with *M. avium-intracellulare* (MAI), *M. tuberculosis*, or another type of mycobacterium or microorganism has been reported and is an important clinical finding that can indicate or presage a nosocomial outbreak.<sup>(1,5,7-22)</sup> But this finding warrants caution, because contaminated respiratory specimens (or other types of patient specimens, such as sputum, urine, or stool) do not necessarily indicate a “true” outbreak (see: box article, below). A contaminated specimen collected from a patient who does not exhibit clinical symptoms of infection often suggests a false, or “pseudo,” infection. Microorganisms in the surrounding environment can contaminate patient specimens during their collection, transportation, and processing in a clinical microbiological laboratory, yielding a false-positive result. Prompt sampling of the environment as part of a thorough epidemiological investigation of either a true or a pseudo outbreak is often necessary, therefore, to determine the source of the contaminant and to identify appropriate control measures that will prevent its spread.<sup>(17,23)</sup>

Because a pseudo infection can be confused with a true

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### An example of a pseudo outbreak

Several patients from the same critical care unit of a hospital undergo BAL using the same bronchoscope. Each of these patients is being examined for possible pulmonary malignancy. None of these patients are colonized or infected with *M. tuberculosis*. Respiratory specimens are collected from each patient for pathological analysis. Each patient’s respiratory specimen is also microbiologically evaluated for disease, in accordance with the hospital’s protocol, and is found to grow an identical strain of *M. tuberculosis*. The hospital concludes that it has identified a nosocomial outbreak of *M. tuberculosis* in its critical care unit, and an investigation into the outbreak’s source and cause is initiated. An aggressive course of antibiotic treatment for pulmonary tuberculosis is promptly ordered for each patient. Depending on a number of factors, including the strength of the patient’s

immune system, pulmonary tuberculosis can cause permanent lung damage and, if untreated, it can be fatal.

➔ *What is wrong with this hospital’s conclusion that it has identified an outbreak of pulmonary tuberculosis in its critical care unit? Why would initiation of an aggressive course of antibiotic treatment for each of these patients suspected of infection with *M. tuberculosis* be inappropriate?*

While the conclusion that an outbreak of *M. tuberculosis* has been identified may be understandable, it is erroneous (i.e., a false-positive result). As mentioned previously, none of the patients are colonized or infected with *M. tuberculosis*. Use of aggressive antituberculocidal medications to treat these “infected” patients and to stop the spread of this presumed (if phantom) “outbreak” would, therefore, be inappropriate and unjustifiably preemptive.<sup>(10,24-28)</sup>

To be sure, each patient’s respiratory specimen is contaminated with *M. tuberculosis*. But, as this example demonstrates, contamination of a respiratory specimen does not necessarily indicate an infection. Although the mode of transmission of *M. tuberculosis* is primarily from patient-to-patient,<sup>(3-5)</sup> the environment can contaminate respiratory specimens with *M. tuberculosis*<sup>(5,7,8,10-13,17,21,58)</sup>—a scenario known as a pseudo outbreak of *M. tuberculosis*. Examples of environmental sites and surfaces, which include medical instruments, that have been reported to contaminate respiratory specimens with *M. tuberculosis* and to cause pseudo infections include bronchoscopes and the surfaces, equipment, and solutions used in the clinical microbiology laboratory to process and culture respiratory specimens.<sup>5,7,8,10-13,21</sup>

During the hospital’s investigation to determine the source and cause of this presumed “outbreak” of *M. tuberculosis*, the working channel of the bronchoscope used to perform BAL on each of these patients and to collect a respiratory specimen from each was microbiologically sampled as recommended during an outbreak investigation.<sup>(29)</sup> Sterile water was flushed through the bronchoscope’s working channel via the biopsy port, and a sample of the water, known as the effluent, was aseptically collected at the bronchoscope’s distal tip for microbiological analysis. Cultures of the effluent grew the identical strain of *M. tuberculosis* identified in each patient’s respiratory specimen. Closer examination of the bronchoscope revealed that its biopsy port was damaged and contaminated with this strain of *M. tuberculosis*. The damaged biopsy port protected and shielded the colonies of *M. tuberculosis*, preventing them from being destroyed during cleaning and sterilization of the bronchoscope after each use. Similar scenarios have been previously reported.<sup>(15,16,48)</sup> This investigation confirmed that this damaged bronchoscope was the source of this “outbreak.” During BAL, the bronchoscope contaminated each patient’s respiratory specimen with *M. tuberculosis*, yielding a false-positive, or “pseudo,” result. The aggressive course of antibiotic treatment ordered for each of these patients, therefore, was dubious and inappropriate. ●

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infection (see: box article, p.3), it is important before providing antimycobacterial therapy to correlate each contaminated respiratory specimen with a specific patient displaying clinical symptoms of infection.<sup>(24)</sup> Failure to distinguish and differentiate a pseudo mycobacterial infection from a true mycobacterial infection may result in misdiagnosis, confusion, and the inappropriate treatment of “un-infected” patients with aggressive antituberculosis medications that, in addition to being unnecessary and expensive, have been associated with complications and adverse patient reactions.<sup>(10,24-28)</sup>

Knowledge of the mode of transmission of different types of microorganisms is crucial during an outbreak investigation to the identification of their possible source. Although the environment is not ordinarily a source of, or contaminated with, *M. tuberculosis*, reports of pseudo infections of *M. tuberculosis* (i.e., false-positive cultures) have been published. Most of these reports link pseudo infections to the contamination of bronchoscopes or the equipment and solutions used in the clinical microbiological laboratory to process and analyze respiratory specimens (see: box article, p. 3).<sup>(5,7,8,10-13,17,21)</sup> Reports of pseudo infections of *M. tuberculosis* associated with other types of medical instruments or environmental sites are lacking. In addition to pseudo infections of *M. tuberculosis*, cases of nosocomial (true) infection of *M. tuberculosis*, although not often reported,<sup>(29)</sup> have been published. Several of these reports link contaminated bronchoscopes to the infections.<sup>(5,14,16,21)</sup> Few published reports link nosocomial transmission and infection of *M. tuberculosis* to environmental sites or medical devices other than contaminated bronchoscopes.<sup>(19,30)</sup>

Unlike *M. tuberculosis*, NTM have a predilection for environmental colonization. As a result, NTM have frequently been associated with cross-contamination and pseudo infections. Several reports link pseudo infections of NTM to contaminated bronchoscopes.<sup>(9,25-27,31-35)</sup> Several other reports unrelated to bronchoscopy link pseudo infections of NTM to contaminated tap water, the clinical laboratory, and other environmental sites.<sup>(20,24,28,36-40)</sup> Although few published reports link nosocomial (true) infections of NTM to contaminated bronchoscopes,<sup>(15)</sup> several reports link nosocomial infections of NTM to contaminated tap water and other environmental surfaces unrelated to bronchoscopy.<sup>(41-46)</sup> (True and pseudo infections are not unique to mycobacteria and have been linked to bronchoscopes contaminated with other types of bacteria such as *Pseudomonas aeruginosa*.<sup>(47-52)</sup> Also, lacking are reports of true and pseudo infections associated with GI endoscopes contaminated with either *M. tuberculosis* or NTM.)<sup>(53-56)</sup>

**Mycobacterium avium-intracellulare (MAI):** *M. avium* and *M. intracellulare* are two related species of slow-growing, opportunistic, nontuberculosis mycobacteria (NTM) that are collectively referred to as *M. avium-intracellulare*, or “MAI” (Table 1). This complex of mycobacteria may also be

referred to as *M. avium-intracellulare* complex, or “MAC.” Risk factors for MAI infection include underlying lung disease and a suppressed immune system. MAI primarily infects the respiratory tract and may cause symptoms, and require a course of treatment, similar to tuberculosis. Like other types of NTM, the primary reservoir for MAI is the environment;<sup>(57)</sup> reports of patient-to-patient transmission of MAI are lacking. It has been suggested that respiratory infections of MAI result from the inhalation of infected and aerosolized water.<sup>(57)</sup>

Reports of true and pseudo infections caused by environmental sites contaminated with MAI have been published. For example, pseudo infections of MAI have been linked to contaminated tap water,<sup>(36)</sup> automated endoscope reproprocessors,<sup>(9,26)</sup> and both laboratory surfaces and equipment.<sup>(20,36,37)</sup> Similarly, nosocomial (true) infections of MAI also have been linked to contaminated tap water.<sup>(44-46)</sup> As with *M. tuberculosis* or another potentially pathogenic microorganism, the identification of MAI in a patient’s respiratory specimen, while a significant finding, does not necessarily indicate nosocomial infection. Rather, it may instead indicate a pseudo infection (or pseudo outbreak) caused by a contaminated environmental site, such as a bronchoscope, tap water, or the automated endoscope reprocessor’s rinse water. Whereas the contamination of respiratory specimens with *M. tuberculosis* typically indicates a true infection,<sup>(58)</sup> contamination of respiratory specimens with MAI or another species of NTM usually indicates a pseudo infection. • **LFM To be continued ...**

## References

The references are available at the following website:  
<http://www.myendosite.com/refs010405.doc>

Thank you for your interest in this newsletter. I have addressed each issue to the best of my ability. Respectfully,  
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