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Concise Communication

A bronchoscopy-associated pseudo-outbreak of *Mycobacterium chelonae* and *Mycobacterium mucogenicum* associated with contaminated ice machine water and ice

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Abstract

A pseudo-outbreak of bronchoscopy-associated *Mycobacterium chelonae* and *M. mucogenicum* was traced to contaminated ice machine water and ice. A nonsterile ice bath was used to cool uncapped, sterile, saline syringes used to slow procedural bleeding. Joining the growing evidence of bronchoscopy pseudo-outbreaks, our investigation describes several lessons for future prevention.

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Bronchoscopy is a frequently utilized invasive procedure in the evaluation of pulmonary disease. Although efforts to mitigate infection risk with bronchoscopy are routinely employed, the ability to introduce exogenous microorganisms and possibly nosocomial infection has been well described. Prior reviews have characterized numerous bronchoscopy-related outbreaks and pseudo-outbreaks, highlighting issues such as inadequate disinfection practices and water contamination. Commonly identified organisms include *Mycobacterium tuberculosis*, nontuberculous mycobacteria (NTM), *Pseudomonas aeruginosa*, *Serratia marcescens*, and more recently, carbapenem-resistant *Enterobacterales* and other multidrug-resistant organisms.[1–6] Of the aforementioned organisms, NTM presents unique challenges with its environmental presence in soil and water, including potable water in hospital settings.[6–9]

In this article, we review a pseudo-outbreak of NTM in a large teaching community hospital that was traced to a contaminated water source utilized during bronchoscopy procedures. In total, 15 patients who underwent bronchoscopy in September–October 2019 grew isolates of *M. chelonae* and *M. mucogenicum*. We describe the investigation of a pattern of unusual microbiology culture results, the molecular analysis confirming the link of NTM isolates from bronchial cultures to the contaminated ice machine, and implementation of processes to prevent further ice-machine–associated outbreaks and pseudo-outbreaks. Our investigation and response highlight opportunities to prevent similar bronchoscopy-related pseudo-outbreaks and outbreaks related to nonsterile water and ice.

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Pseudo-outbreak investigation

The infection prevention (IP) team identified routine surveillance culture results from 4 separate bronchoscopy procedures around the same time with *M. mucogenicum*, an organism not previously reported at our institution from bronchoalveolar lavage (BAL) cultures. Given these atypical results, an investigation was triggered to identify whether this was an outbreak or pseudo-outbreak and to determine a potential source of the NTM.

Evaluation of culture methods by the microbiology laboratory revealed no evidence of contaminated cultures plates or other materials as a cause of the NTM. An inspection of the bronchoscopy suite was conducted by the IP and engineering teams with detailed review of the entire bronchoscopy process, facilities, equipment, storage, and staff responsibilities. Thorough examination of the postprocedural processing and high-level disinfection (HLD) was conductedn including precleaning steps, transportation and handling, manual cleaning of bronchoscopes and sinks, adenosine triphosphate testing before HLD, and HLD quality control measures and verification. Airflow in the processing areas was inspected. Maintenance schedules for bronchoscopes and automated endoscope reprocessing (AER) were assessed for adherence. Validation of staff training schedules for sterilization and disinfection, competency evaluations, and certificates showed no deficiencies.

Through this extensive review, an area of concern was the use of nonsterile ice machine water and ice to cool uncapped sterile water

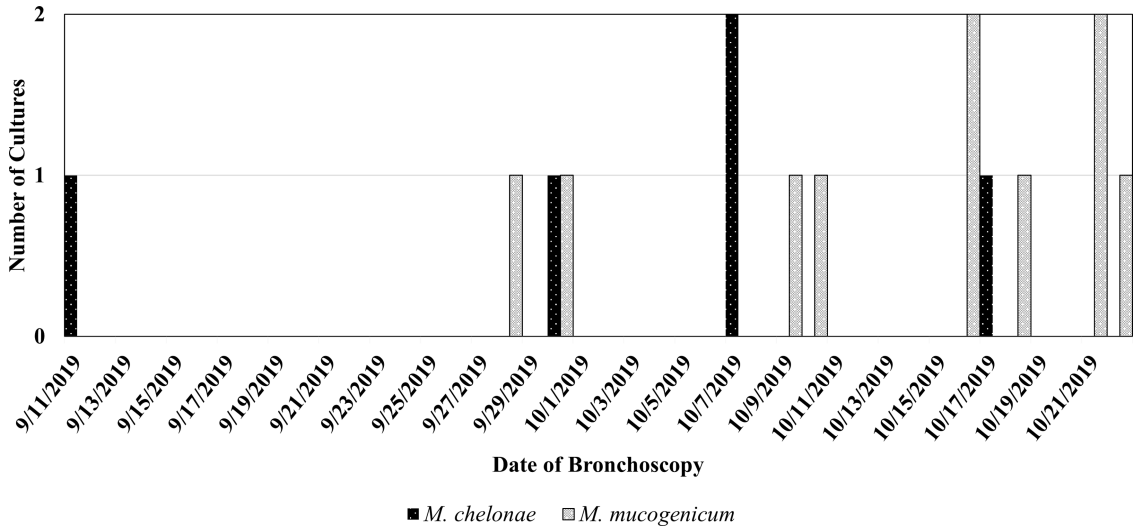

Fig. 1. Outbreak curve of *Mycobacterium mucogenicum* and *Mycobacterium chelonae* bronchosocpy cultures.

syringes in an ice water basin. The intended use of cooled sterile water syringes was to slow procedural bleeding if this occurred. Unfortunately, this process had the unintended consequences of not protecting the sterility of the prefilled syringes because they were ready for use without the cap and placed in the nonsterile ice bath. Notably, the ice-machine maintenance logs were up to date. Another potential source of the NTM was tap water, which was mixed with enzymatic solution during bronchoscope precleaning procedures. Cultures were subsequently collected from different water sources, including procedure room sinks, the ice machine water and ice, and water faucet fixtures, given concern for biofilms. These cultures were performed through Special Pathogens Laboratory (Pittsburgh, PA).

Initially, all bronchoscopies were halted for a couple days, and several steps were taken to prevent further cases. Sterilization of all 9 bronchoscopes was conducted by the central processing department rather than HLD in the endoscopy suite. Water restrictions were implemented; the use of nonsterile ice baths was discontinued; and point-of-use filters were placed on all procedure room faucets.

NTM case detection, molecular analysis, and whole-genome sequencing

Additional NTM cases were identified as the window of culture review expanded. During September–October 2019, 15 NTM isolates were identified from bronchoscopy cultures including 10 *M. mucogenicum* and 5 *M. chelonae*. All NTM were isolated from fungal BAL cultures. No BAL cultures of *M. mucogenicum* were identified prior to September 2019, and the most recent BAL culture prior to the outbreak window showing *M. chelonae* was processed in May 2019. Water testing results revealed *M. mucogenicum* from ice-machine ice (14 CFU/mL) and *M. mucogenicum* (>600 CFU/mL) and *M. chelonae* (>600 CFU/mL) from ice-machine water. With assistance from the Michigan Department of Health and Human Services (MDHHS), the Centers for Disease Control and Prevention (CDC) performed pulse-field gel electrophoresis (PFGE) and whole-genome sequencing (WGS) to evaluate similarities between the bronchial isolates and water and ice samples from the ice machine.

Two different types of NTM were connected to the ice-machine water source (Fig. 1). Overall, 9 bronchial cultures of *M. mucogenicum* had clonal relation to ice and water from the ice machine, and 3 bronchial isolates of *M. chelonae* were traced to water from the ice machine (Table 1). Another 3 isolates of *M. mucogenicum* or *M. chelonae* were not related to any of the other isolates according to PFGE. Of 11 isolates submitted for WGS, all 5 *M. mucogenicum* and 6 *M. chelonae* isolates appeared related to 2 distinct *M. mucogenicum* and *M. chelonae* clusters, respectively.

Cultures from other potable water sources in the bronchoscopy procedure rooms yielded no growth of *M. mucogenicum* or *M. chelonae*. Unfortunately, specimens from the ice-machine water showing *M. mucogenicum* were not sent to the CDC and therefore were not included in the PFGE and WGS reports.

Patient impact and outcomes

Immediate and long-term plans were developed to address affected patients. Overall, there were 11 female and 4 male patients, aged 27–80 years, with wide ranging indications for bronchoscopy. Verbal disclosure to each patient was provided by a board-certified pulmonologist. The primary care physicians were also notified with written correspondence. A pulmonologist conducted medical chart reviews over the ensuing several months, with most patients having close pulmonary follow-up to assess their clinical status. At ~1 year from the procedure, living patients received another follow-up pulmonologist telephone evaluation. No cases of true infection or clinical disease were encountered.

Discussion

Pseudo-outbreaks continue to occur in healthcare settings as previously demonstrated and described in this report. Frequently, these pseudo-outbreaks are bronchoscopy-associated and involve NTM.[1–10] Our experience highlights the importance of the IP team recognizing the anomaly of several BAL cultures showing similar NTM over a short period during routine surveillance. This cluster prompted a review of the entire bronchoscopy process, and an ice machine was found to be the water reservoir of *M. chelonae and M. mucogenicum*.

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Table 1. Results of Pulsed-Field Gel Electrophoresis (PFGE) of 15 Nontuberculous (NTM) Isolates From Patients and an Ice Machine

Source	Collection Date	MALDI-TOF Results	PFGE
Bronchial	9/28/2019	*Mycobacterium mucogenicum*	Pattern 1, cluster A
Bronchial	9/30/2019	*M. mucogenicum*	Pattern 1, cluster A
Bronchial	10/9/2019	*M. mucogenicum*	Pattern 1, cluster A
Bronchial	10/16/2019	*M. mucogenicum*	Pattern 1, cluster A
Bronchial	10/16/2019	*M. mucogenicum*	Pattern 1, cluster A
Bronchial	10/18/2019	*M. mucogenicum*	Pattern 1, cluster A
Bronchial	10/21/2019	*M. mucogenicum*	Pattern 1, cluster A
Bronchial	10/21/2019	*M. mucogenicum*	Pattern 1, cluster A
Bronchial	10/22/2019	*M. mucogenicum*	Pattern 1, cluster A
Ice machine ice	10/24/2019	*M. mucogenicum*	Pattern 1, cluster A
Ice machine ice	10/24/2019	*M. mucogenicum*	Pattern 1, cluster A
Bronchial	9/30/2019	*M. chelonae*	Pattern 2, cluster B
Bronchial	10/7/2019	*M. chelonae*	Pattern 2, cluster B
Bronchial	10/17/2019	*M. chelonae*	Pattern 2, cluster B
Ice machine water	10/24/2019	*M. chelonae*	Pattern 2, cluster B
Ice machine water	10/24/2019	*M. chelonae*	Pattern 2, cluster B
Ice machine water	10/24/2019	*M. chelonae*	Pattern 2, cluster B
Bronchial	9/11/2019	*M. chelonae*	Unique pattern, Unrelated to any others
Bronchial	10/7/2019	*M. chelonae*	Unique pattern, Unrelated to any others
Bronchial	10/10/2019	*M. mucogenicum*	Unique pattern, Unrelated to any others

Note. In total, 15 bronchial specimens had NTM, and 9 bronchial specimens with *M. mucogenicum* had the same genomic pattern as a cluster of *M. mucogenicum* isolated from ice in the ice machine (pattern 1, cluster A). Also, 3 bronchial specimens with *M. chelonae* had the same genomic pattern as *M. chelonae* identified from ice-machine water (pattern 2, cluster B). Furthermore, 3 bronchial specimens with NTM had unique patterns not isolated in any other specimen, either patient derived or from ice-machine testing.

Most healthcare-associated pseudo-outbreaks or infections of NTM are epidemiologically linked to a water source, including ice, ice water, tap water, distilled water, and water-based solutions. *M. chelonae* and *M. mucogenicum*, characterized as rapidly growing mycobacteria, are ubiquitous and are found both in the environment and in public and hospital water systems.[10]

Corrective action included discontinuing any use of a nonsterile ice bath to cool sterile syringes. If medically necessary, cooled sterile saline syringes could be filled aseptically from a refrigerated sterile saline bottle or from a sealed bottle cooled by ice. In addition to the standard water filter (5 μm) for the water intake for the ice machine, a bacterial filter (0.20 μm) was also placed. To reduce the risk of further NTM pseudo-outbreaks and outbreaks, careful scheduled review and training of IP procedures and policies are essential in the bronchoscopy suite.

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