BRIEF REPORT

Faucet aerators: A source of patient colonization with *Stenotrophomonas maltophilia*

David J. Weber, MD, MPH[a,b]
William A. Rutala, PhD, MPH[a,b]
Cherie N. Blanchet, RN, MPH[b]
Michelle Jordan, MT(ASCP)[c]
Maria F. Gergen, MT(ASCP)[c]
Chapel Hill, North Carolina

Background: Multiple nosocomial outbreaks have been linked to contaminated water sources within the hospital. We report in this article a cluster of patients in a surgical intensive care unit who were colonized or infected with *Stenotrophomonas maltophilia*.
Methods: This study was conducted at an acute care academic hospital. Patients colonized or infected with *S maltophilia* were identified by prospective surveillance. Environmental isolates were obtained by culturing multiple water sources by using standard techniques. Patient and environmental isolates were examined by pulsed-field gel electrophoresis.
Results: Patients were colonized with 2 isolates of *S maltophilia,* which were found by pulsed-field gel electrophoresis to be identical to strains isolated from the faucet aerators present in sinks in the patients' rooms. Multiple different strains, as defined by pulsed-field gel electrophoresis, were isolated from patients during this outbreak.
Conclusions: We believe that low level contamination of our potable water led to contamination of the faucet aerators with subsequent bacterial amplification on the aerator, which led to contamination of water after aeration. Cultures should be performed on faucet aerators when water sources are suspected as the reservoir for a nosocomial outbreak. If additional clusters of infected or colonized patients are linked to contaminated aerators, consideration should be given to routine disinfection or removal of the aerators. (AJIC Am J Infect Control 1999;27:59-63)

Multiple nosocomial outbreaks have been linked to contaminated water sources, including potable water, ice, dialysis water, hydrotherapy tanks, water baths used for thawing medications or blood products, and water used in humidifiers and nebulizers.[1] Pathogens associated with potable water have included *Pseudomonas aeruginosa, Burkholderia cepacia, Serratia marcescens, Acinetobacter calcoaceticus, Flavobacterium meningosepticum, Aeromonas hydrophila,* and certain nontuberculous mycobacteria. Faucet aerators have been reported to be contaminated with gram-negative bacilli, including *P aeruginosa, Klebsiella pneumoniae,* and *Escherichia coli*.[2] Faucet aerators contaminated with *P aeruginosa*[3,4] or *Pseudomonas* spp[5] have been epidemiologically linked to colonized or infected patients.

We report in this article, a cluster of patients in a surgical intensive care unit (ICU) colonized or infected with *Stenotrophomonas maltophilia* in which the pathogen acquired by 2 patients was traced by molecular analysis to contaminated faucet aerators.

METHODS

This study was conducted at the University of North Carolina Hospitals, a 650-bed tertiary care university hospital complex. Comprehensive surveillance at UNC Hospitals is conducted by 4 full-time infection control professionals. A modified version of the Centers for Disease Control and Prevention's criteria are used to define nosocomial infections. The major modifications are that asymptomatic bacteriuria is not reported and a chest radiograph with a new or increased infiltrate is required to meet the pneumonia definition. Since 1977, surveillance data has been coded and entered into a computerized database.

From the Division of Infectious Diseases, University of North Carolina School of Medicine,[a] and the Departments of Hospital Epidemiology[b] and Microbiology,[c] University of North Carolina Hospitals.

Reprint requests: David Jay Weber, MD, MPH, Division of Infectious Diseases, 547 Burnett Womack, CB #7030, UNC at Chapel Hill, Chapel Hill, NC 27599-7030.

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Water samples were evaluated by collecting water in a sterile container. The water was then aseptically passed through a 0.45 µm filter. The filter was cultured on sheep blood agar. Bacterial colonies were identified by standard techniques. The faucet aerators used at UNC Hospitals are stainless steel wire mesh structures that screw into the distal end of the sink faucet. These faucet aerators were cultured by swabbing them with a sterile cotton swab premoistened with trypticase soy broth (Becton Dickinson, Cockeysville, Md) and by aseptically removing the aerator and placing it in 5 mL to 10 mL of trypticase soy broth.

Stenotrophomonas maltophilia isolates were compared by using DNA microrestriction analysis by pulsed-field gel electrophoresis (PFGE). All isolates were run on the same gel and each isolate was compared with all other isolates. The DNA fingerprint of each isolate was visually scored for the presence or absence of individual bands by 2 independent observers. Isolates were considered different if they differed by 3 or more bands. In this cluster, all isolates described as identical had corresponding bands.

DESCRIPTION OF A CLUSTER

This cluster involved patients primarily in the surgical ICU, an 8-bed unit primarily used by the trauma and general surgical services. The surgical ICU is adjacent to an 8-bed neurosurgical ICU. Other intensive care units on the same floor, but not physically adjacent, include a cardiothoracic ICU, a medical ICU, and a respiratory ICU. All rooms in the surgical ICU share a common water supply.

In late November, an epidemiologic investigation was initiated after surveillance data revealed that 7 patients in the surgical ICU were colonized or infected with *S maltophilia* in the preceding 3 months. The investigation consisted of a careful review of the medical charts of all colonized/infected patients, which evaluated the frequency of risk factors for gram-negative bacterial infection and potential sources (eg, medical devices, procedures) common to the patients; an environmental assessment, including cultures of all potential sources and reservoirs of *S maltophilia*; evaluation of hospital personnel for potential skin or respiratory colonization, which might have led to employee-to-patient transmission; and molecular analysis of patient and environmental isolates. The surgical ICU was initially visited on December 12, 1995, to evaluate possible common sources of infection. No multidose medication vials were used, and no common equipment was discovered (eg, blood pressure cuffs or respiratory care equipment). No staff members had evidence of skin or respiratory tract infections. A preliminary environmental evaluation was conducted. One hundred milliliter samples of water were cultured from 4 sinks in the surgical ICU (rooms 2736, 2737, 2738, and the handwashing sink at the nurses station). No microorganisms were cultured. In addition, 1 cup of ice from the ice machine was collected, melted, and a culture was performed in a manner similar to that used for the water samples. This culture was negative for *S maltophilia*.

On December 14, a comprehensive environmental evaluation was performed. Two-liter water samples were collected from several sources in the surgical ICU, including the sink in room 2737, the handwashing sink in the staff lounge, ice water output from the ice machine, and the handwashing sink at the nurses station. In addition, a culture was performed on the ice machine drain. All of these cultures were negative for *S maltophilia*. Cultures were performed on faucet aerators from multiple locations, which included the clean utility room sink, the sink at the nurses station, the staff lounge sink No. 1, the staff lounge sink No. 2, and the sinks in patient rooms (2734, 2735, 2736, 2737, and 2738). The faucet aerators in rooms 2735 and 2736 yielded *S maltophilia*.

After the isolation and identification of *S maltophilia* on faucet aerators, all aerators were removed, cultures were performed, and the aerators were replaced with new aerators on December 18. The faucet aerator in room 2735 was again positive.

Follow-up cultures of the aerators in 7 of the 8 surgical ICU rooms were performed on March 20, 1996. All cultures were negative with the exception of the aerator from room 2735. When the culture result became positive, a follow-up culture of 10 L of water from the sink in room 2735 (surgical ICU) was obtained on March 26, 1996. This culture also yielded *S maltophilia*.

Overall, *S maltophilia* was isolated from 7 patients in the surgical ICU during a 5-month period. None of the patients had community-acquired infections as a result of *S maltophilia*. Infectious syndromes associated with *S maltophilia* included 2 patients with *S maltophilia* nosocomial pneumonia, 1 patient with community-acquired pneumonia whose respiratory tract was later colonized with *S maltophilia*, 1 patient with respiratory tract colonization, 1 patient whose bile stent became colonized, 1 patient admitted for peritonitis whose Jackson-Pratt drain was later colonized with *S maltophilia*, and 1 patient with multiple nosocomial infectious sites.

A review of our surveillance records before the outbreak revealed the following incidences of *S maltophilia* nosocomial infections in the surgical ICU during past years: 1990, 1 infection; 1991, 4 infections; 1992, 7 infections; 1993, 4 infections; and 1994, 2 infections. After this outbreak, from mid-January 1996 through December, 1996, only 3 unrelated cases of nosocomial infections as a result of *S maltophilia* occurred in the surgical ICU, a rate similar to the previous baseline.

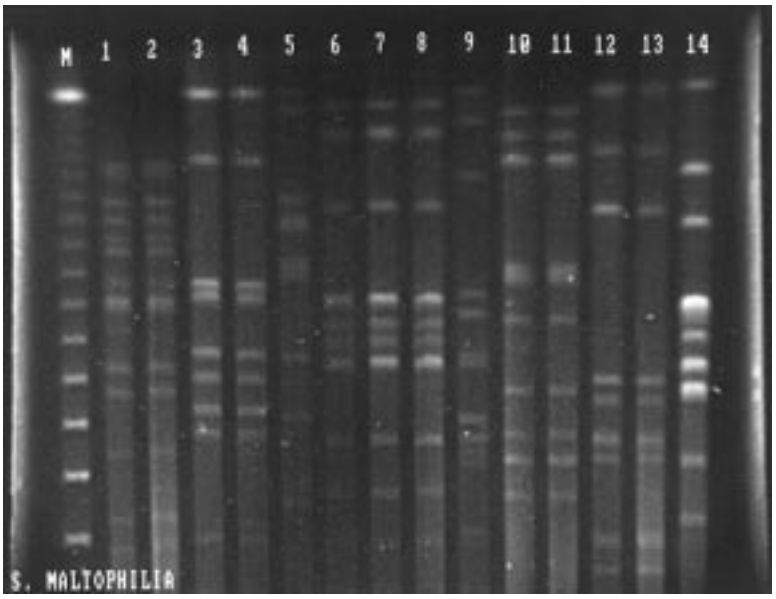

Fig 1. Pulsed-field gel electrophoresis of patient and environmental strains of *S maltophilia*. Lane M, lambda ladder PFGE marker (New England Biolabs); Lane 1, pattern A (handwashing sink surgical ICU, from Dec 14, 1995); Lane 2, pattern A (handwashing sink room 2735, from Dec 18. 1995); Lane 3, pattern B (handwashing sink room 2735, from Dec 12, 1995); Lane 4, pattern B (patient MC); Lane 5, pattern C (aerator, sink room 2735, from Mar 20, 1996); Lane 6, pattern D (aerator, sink room 2736, from Dec 14, 1995); Lane 7, pattern D (patient DM); Lane 8, pattern D (patient NC); Lane 9, pattern E (patient DN); Lane 10, pattern F (patient MM); Lane 11, pattern F (patient CA); Lane 12, pattern G (patient OS); Lane 13, pattern G (patient not housed in surgical ICU); Lane 14, pattern H (patient not housed in surgical ICU).

RESULTS

The location of colonized/infected patients, environmental sources tested for *S maltophilia,* and the results of molecular typing are displayed in Table 1 and Fig 1, respectively. PFGE revealed 5 different strains colonizing or infecting patients and 4 different environmental isolates. S *maltophilia* was isolated from the faucet aerators in 2 patient rooms (rooms 2735 and 2736) and the handwashing sink at the nurses station. Environmental samples from the water or ice did not initially yield *S maltophilia*. A large volume culture of water, 10 L, from the sink in room 2735 in the surgical ICU later yielded *S maltophilia.* A follow-up culture of the aerator in room 2735 had a different PFGE pattern unrelated to any pattern found earlier.

In 2 cases, the strain of *S maltophilia* isolated from the faucet aerator in the patient's room matched the strain colonizing the patient (ie, MC, DM). Two patient isolates (ie, MM, CA) matched each other but did not match any environmental isolates (Fig 1).

DISCUSSION

S maltophilia, a gram-negative bacillus, is an unusual nosocomial pathogen. Data from the National Nosocomial Infection Surveillance system, 1990-1992, have revealed that *S maltophilia* accounts for less than 1% of nosocomial pathogens.[6] Nevertheless, multiple nosocomial outbreaks of *S maltophilia* have been reported.[7-9] *S maltophilia* has recently emerged as an important nosocomial pathogen in patients with severe underlying diseases or immune dysfunction[9-11] and patients receiving intravenous antibiotics.[8-12] It has been documented as a cause of bacteremia, infections of the respiratory and urinary tracts, skin and soft tissue infections, biliary tract infection, meningitis, serious wound infections, mastoiditis, conjunctivitis, and endocarditis.[11]

Recently, several molecular typing schemes have been used to aid in outbreak evaluation including DNA microrestriction analysis by PFGE,[9,13,14] contour-clamped homogeneous electric field gel electrophoresis of chromosomal DNA, polymerase chain reaction with arbitrary primers (random amplified polymorphic DNA),[14,15] polymerase chain reaction with enterobacterial repetitive intergenic consensus sequences as primers,[14] and ribotyping by using the restriction enzymes EcoRI and BamHI. PFGE was chosen for its simplicity, reproducibility, and discriminatory value.

Nosocomial infections have been linked to contaminated potable water.[11] Several studies have epidemiologically linked contaminated faucet aerators to colonization or infection of patients. Recently, PFGE was used to demonstrate that a strain of *S maltophilia* isolated from the throat of a patient matched that isolated from the shower head in the bathroom, and a strain isolated from

Table 1. Epidemiologic and clinical features of patients colonized or infected with *S maltophilia*

Patient	ICU (room No.)	Admit date, discharge date	Date of isolation	Site(s) of isolation	Infectious syndrome	Patient PFGE pattern	Environmental culture(s) from Dec 12 and Dec 14
MM	S-ICU (2740)	Aug 27, 1995-Sep 25, 1995	Sep 13, 1995	Sputum	Pneumonia	F	Sink aerator negative
CA	S-ICU (2737)	Aug 11, 1995-Nov 27, 1995	Oct 11, 1995	Sputum	Pneumonia	F	Sink aerator negative
MC	S-ICU (2735)	Nov 5, 1995-Nov 28, 1995	Nov 11, 1995	Sputum	Colonization	B	Sink aerator, isolates A and B
DN	S-ICU (2738)	Nov 10, 1995-Nov 11, 1995	Nov 10, 1995	Bile stent	Colonization	E	Sink aerator negative
DM	S-ICU (2736)	Nov 22, 1995-Dec 15, 1995	Nov 28, 1995	Jackson-Pratt drain	Peritonitis,* late colonization	D	Sink aerator, isolate D
OS	S-ICU (2737)	Nov 27, 1995-Dec 16, 1995	Dec 9, 1995	Sputum	Peritonitis,* late colonization	G	Sink aerator negative
NC	S-ICU (2734)	Dec 19, 1995-Jan 20, 1996	Jan 6, 1996, Jan 11, 1996,	Blood, sputum, urine	Bacteremia, pneumonia, urinary tract infection	D	Sink aerator negative

S-ICU, Surgical ICU.
*Non–hospital-acquired infection not involving *S maltophilia*.

a different patient matched that isolated from the kitchen sink.[13] *S maltophilia* has been associated with other reservoirs, including a cardiopulmonary bypass pump,[16] chlorhexidine-cetrimide disinfectant,[17] ethylenediaminetetraacetic acid anticoagulant in vacuum blood collection tube,[18] transducer dome and calibration devices,[19] and brushes used for preoperative shaving.[20] Despite reports that highlight reservoirs for *S maltophilia*, the source of *S maltophilia* in most nosocomial infections remains unknown.

Previous studies have linked colonized faucet aerators to patients colonized or infected with the same bacterial pathogen either epidemiologically[3,5] or by using a relatively nondiscriminatory testing method (ie, pyocin typing).[4] Our study is the first study to link colonized faucet aerators with colonized or infected patients by using a highly discriminative molecular epidemiologic method (ie, PFGE). Our data demonstrate that 2 patients were colonized by strains of *S maltophilia* contaminating the faucet aerators in the sink in their room. These strains were probably carried to the patient via transient colonization of the hands of health care providers or during sponge bathing of the patient by using the tap water. As with other investigations, multiple strains of *S maltophilia* were isolated. Two patients (MM, CA) whose ICU stay overlapped had pneumonia with an identical strain of *S maltophilia*, which suggests cross-contamination or common source exposure.

Faucet aerators are commonly used to diffuse the water stream, which leads to decreased splashing. We believe that low-level contamination of our potable water led to contamination of the faucet aerator with bacterial amplification on the aerator and subsequent increased contamination of water after aeration. This study currently provides the best evidence that contamination of faucet aerators may represent a nosocomial hazard. Hospital epidemiologists evaluating nosocomial outbreaks or an increased incidence of endemic infections by organisms capable of multiplying in potable water should consider culturing faucet aerators. If either endemic or epidemic nosocomial infections continue to be linked to faucet aerators, then additional infection guidelines may be required, which could include removal of the aerators or routine disinfection. Decontamination could be achieved by removing the aerators and immersing them in a 1:10 to 1:100 solution of diluted household bleach[21] and then rinsing them in tap water before reinstallation. However, because only a few reports have linked patient infection/colonization to colonized faucet aerators and only our report substantiated the linkage by using a discriminative method of molecular epidemiology, such steps are not warranted at the current time.

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