Postoperative Serratia marcescens Wound Infections Traced to an Out-of-Hospital Source


From 25 August to 28 September 1994, 7 cardiovascular surgery (CVS) patients at a California hospital acquired postoperative Serratia marcescens infections, and 1 died. To identify the outbreak source, a cohort study was done of all 55 adults who underwent CVS at the hospital during the outbreak. Specimens from the hospital environment and from hands of selected staff were cultured. S. marcescens isolates were compared using restriction-endonuclease analysis and pulsed-field gel electrophoresis. Several risk factors for S. marcescens infection were identified, but hospital and hand cultures were negative. In October, a patient exposed to scrub nurse A (who wore artificial fingernails) and to another nurse—but not to other identified risk factors—became infected with the outbreak strain. Subsequent cultures from nurse A’s home identified the strain in a jar of exfoliant cream. Removal of the cream ended the outbreak. S. marcescens does not normally colonize human skin, but artificial nails may have facilitated transmission via nurse A’s hands.

Serratia marcescens are opportunistic gram-negative bacilli that most commonly cause sporadic urinary tract infections and pneumonias, although outbreaks frequently occur, particularly in intensive care units (ICUs) [1, 2]. The overall national surgical site infection rate for patients undergoing cardiac surgery in the United States during 1990–1992 was 1.1 infections per 100 surgeries [3]. S. marcescens was a causative agent in only 1% of surgical site infections [4].

From 25 August to 28 September 1994, 6 of 31 cardiac surgery patients and 1 of 29 vascular surgery patients at a community hospital in northern California developed postoperative S. marcescens infections. Five patients developed only surgical site infections. Two patients developed bacteremia, 1 of whom died. These were the first S. marcescens infections among cardiac or vascular surgery patients at the hospital identified in ≥1 year. The hospital suspended all elective cardiac surgery and requested assistance in its investigation to determine and control the source of the outbreak.

Methods

Cohort Study

We reviewed the medical records of all adults undergoing cardiovascular or vascular surgery (CVS) at the hospital between 16 August (the date of operation for the first patient who developed postoperative S. marcescens infection) and 28 September 1994. A case-patient was a cohort member who developed postoperative S. marcescens infection, identified by review of microbiology and medical records.

For each patient in the cohort, we examined baseline patient characteristics, preexisting medical conditions, duration and number of invasive procedures, patient locations, exposures to medical staff and ancillary personnel, exposures to various devices and medications, postoperative bathing practices, and number of discharge diagnoses (a proxy for severity of illness).
Environmental and Staff Cultures

**Hand cultures.** All cardiac surgeons and cardiac operating room nurses and selected pharmacists and ICU nurses washed their hands for 30 s with one-fourth of a sterile alcohol-impregnated wipe (wipes) pressed into 0.2% Tween 80 (Sigma, St. Louis). The wipe was agitated in 500 mL of 0.1% Tween 80 for 15 min, and the resultant liquid was vacuum-filtered through a 0.45-μm filter (Millipore, Bedford, MA); this filter was plated directly onto trypti-case soy agar (TSA) [5, 6].

**Environmental cultures.** Surfaces in the operative and cardiac catheterization suites, CVS ICU, doctors’ and nurses’ lounges, and the cardioplegia solution preparation areas were passed with wipes soaked in 0.2% Tween. Each wipe was cultured using the method described above. Smaller surfaces were cultured using sterile cotton swabs (Culturettes; Baxter, Deerfield, IL) premoistened with nonbacteriostatic saline and streaked directly onto TSA.

**Water cultures.** We collected 1 L each of cold and hot water from faucets in the operative suites, cardiac catheterization suites, and ICUs.

### Molecular Analysis

Isolates were typed by restriction-endonuclease analysis (REA) using restriction enzymes EcoRI and EcoRV and by pulsed-field gel electrophoresis (PFGE). With PFGE, we used an *Escherichia coli* preparation protocol on a contour-clamped homogeneous electric field electrophoresis apparatus (CHEF II; Bio-Rad, Richmond, CA) and restriction enzymes XbaI and SpeI [7].

### Statistical Analysis

Dichotomous variables were compared using χ² or Fisher’s exact tests (two-tailed). Continuous variables were compared using Student’s *t* test. Stratified (three-way) analysis was done on all risk factors of at least borderline significance *P* < .1) in the crude comparative (bivariate) analysis.

### Results

**Epidemiologic investigation.** There were 55 patients in the cohort: 31 cardiac surgery patients and 24 vascular surgery patients. Seven patients (13%) met the case definition. Two case-patients had wound infections only, 3 had mediastinal or pleural involvement, and 2 developed *S. marcescens* bacteremia. Case-patients did not differ significantly from other cohort members in age, race, gender, weight, body-mass index, and number of discharge diagnoses and were not more likely to have a history of smoking or diabetes mellitus, unstable vital signs or chest pain on admission, or signs of infection before surgery.

Postoperative *S. marcescens* infection was associated with exposure to scrub nurse A (who had worn artificial nails during the entire outbreak period), scrub nurse F, cardioplegia solution prepared by pharmacy technician B, cardiac catheterization nurse C, cardiac surgery ICU nurse G, use of ICU beds D or E, or having surgery on a Monday (vs. other days of the week) or in the afternoon (table 1). In addition, having surgery earlier in the workweek was associated with increased risk of infection (*P* = .01, χ² test for linear trend; figure 1). Exposure to nurse A remained significant in all stratified analyses. However, when the other significant risk factors were stratified by exposure to nurse A, only two factors—exposure to ICU nurse G and having surgery earlier in the workweek—remained significant.

In mid-October, after the hospital suspended cardiac surgery, a patient developed a surgical site infection with *S. marcescens* following splenectomy. This patient was exposed to nurses A and F, but not to ICU nurse G or any other risk factors identified in the cohort study. Since all 7 case-patients were exposed to nurse A but only 4 of 7 were exposed to nurse F, the possibility that nurse A had been a carrier of *S. marcescens* seemed increasingly likely, despite her negative hand cultures. On 25 October, with nurse A’s consent, 25 culture specimens were taken from her home and selected products in it: water supplies, moist surfaces, cosmetics, and soaps.

**Microbiologic studies.** All 600 hospital environment and 30 staff hand cultures, including two sets of hand cultures from nurse A, were negative for *S. marcescens*. Cultures of an exfoliant cream (crushed almond shells and olive pits in an emollient cold cream base) from a widemouth jar kept in a shower at nurse A’s home grew *S. marcescens*; quantitative cultures revealed >200,000 cfu/g. No other cultures from nurse A’s home grew *S. marcescens*. The antibiotic susceptibility profiles of the 7 case-isolates and the isolate from the exfoliant cream were essentially identical (resistant only to ampicillin, ampicillin/sulbactam, and cefazolin).

Isolates from 4 of the 7 case-patients were available for molecular typing. All 4 isolates plus the isolate from the splenectomy patient and the isolate from the exfoliant cream were identical by chromosomal PFGE and REA. Six additional non–

### Table 1. Risk factors for *S. marcescens* infection among cardiac and vascular surgery patients at a northern California hospital, 25 August to 28 September 1994.

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Exposed patients</th>
<th>Unexposed patients</th>
<th>Risk ratio (±95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR nurse A</td>
<td>7/22 (32)</td>
<td>0/33</td>
<td>Undefined</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Technician B</td>
<td>6/16 (38)</td>
<td>1/39 (3)</td>
<td>14.6 (1.9–112.0)</td>
<td>.002</td>
</tr>
<tr>
<td>Cath nurse C</td>
<td>4/7 (57)</td>
<td>3/48 (6)</td>
<td>9.1 (2.6–32.6)</td>
<td>.006</td>
</tr>
<tr>
<td>OR nurse F</td>
<td>4/12 (33)</td>
<td>3/43 (7)</td>
<td>4.8 (1.2–18.5)</td>
<td>.03</td>
</tr>
<tr>
<td>ICU nurse G</td>
<td>4/13 (31)</td>
<td>3/42 (7)</td>
<td>4.3 (1.1–16.8)</td>
<td>.05</td>
</tr>
<tr>
<td>ICU beds D or E</td>
<td>6/16 (38)</td>
<td>1/39 (3)</td>
<td>14.6 (1.9–112.0)</td>
<td>.002</td>
</tr>
<tr>
<td>Monday surgery</td>
<td>4/8 (50)</td>
<td>3/47 (6)</td>
<td>7.8 (2.1–28.6)</td>
<td>.006</td>
</tr>
<tr>
<td>Afternoon surgery</td>
<td>5/17 (29)</td>
<td>2/38 (5)</td>
<td>5.6 (1.2–26.0)</td>
<td>.02</td>
</tr>
</tbody>
</table>

NOTE. CI = confidence interval; OR = operating room; Cath = cardiac catheterization; ICU = cardiac surgery intensive care unit.

* No. infected/no. exposed (%).
including the chief operating room nurse, could not corroborate this.

Discussion

Our investigation of this *S. marcescens* outbreak among CVS patients identified a scrub nurse and her use of a contaminated exfoliant cream as the likely source of the outbreak. Molecular strain typing permitted rapid confirmation that the cream was the outbreak reservoir and, early on, helped direct the investigation away from patients with non-outbreak strains of *S. marcescens*. The quick solution of the outbreak enabled the hospital to resume cardiovascular surgery after a relatively brief, though costly, interruption. After removing her artificial nails and discarding the implicated exfoliant cream, nurse A resumed her duties in November 1994; no additional cases have been identified, despite active surveillance.

We believe this is the first reported nosocomial *S. marcescens* outbreak in which the implicated reservoir came from outside the hospital. In addition, hand carriage of *S. marcescens* (the presumed mode of transmission in this outbreak) has been documented only once, during an outbreak in Australia, in which a nun with patient care responsibilities had paronychia that harbored the organism [8]. The implicated nurse in our outbreak did not have any skin or nail abnormalities but wore artificial fingernails.

Our trace back suggests that the exfoliant cream was contaminated after purchase. We hypothesize that nurse A contaminated the cream by placing her fingers in the jar each time she used the cream. The humid setting in the shower was a favorable environment for proliferation of a moisture-loving bacterium such as *S. marcescens*.

Since nurse A used the exfoliant cream on Sundays, traces of the hydrophobic, gritty exfoliant cream probably remained on her hands or beneath her fingernails overnight, and inoculation of susceptible patients with *S. marcescens* would have been most likely to occur on Mondays. With repeated presurgical scrubbing, the number of organisms would be expected to diminish as the week progressed. This would account for the association between *S. marcescens* infection and having surgery earlier in the week.

The Association of Operating Room Nurses recommends that artificial fingernails not be worn by operating room personnel, citing reports of bacterial and fungal infections [9]. In a small study, Rubin [10] reported a trend toward higher bacterial counts on the hands of operative nurses who wore artificial nails. Pottinger et al. [11] found that hand carriage of gram-negative bacteria was significantly higher after handwashing in nurses wearing artificial nails than in those with natural nails. In addition, nails with cracked or chipped fingernail polish (artificial nails are designed to be worn with polish) can harbor increased numbers of bacteria compared with freshly polished and unpolished nails [12]. Although there have been no controlled trials demonstrating that patients cared for by

---

**Figure 1.** Cardiac and vascular surgeries at outbreak hospital, 25 August through 28 September 1994. Each box represents 1 surgery during outbreak period; shaded boxes indicate surgeries that preceded *S. marcescens* infection.
persons who wear artificial nails are at increased risk for infection, artificial nails clearly present a potential risk.

We traced a nosocomial *S. marcescens* outbreak to an out-of-hospital source. Other unusual organisms associated with home exposures that caused outbreaks in cardiac surgery patients include *Rhodococcus bronchialis* and *Nocardia farcinica* [13, 14]. The *R. bronchialis* infections were traced to a circulating nurse and her colonized dogs; the *N. farcinica* infections were traced to an anesthesiologist whose home was colonized. Outbreaks caused by hospital-acquired pathogens can and do originate in the surrounding community. In this outbreak, the weekly pattern of infections was consistent with an out-of-hospital source. Consideration of community sources could obviate exhaustive in-hospital cultures, when such epidemiologic clues are present.

References