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# Nosocomial Outbreak of Nitrate-Negative *Serratia marcescens* Infections

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Bacteremia due to multiply-antibiotic-resistant *Serratia marcescens* occurred within 1 week in four patients who were in adjacent beds in an intensive care unit. The strains were serotyped as O14:H12 and were nitrate negative. This unusual biochemical marker was useful in the investigation of the outbreak.

*Serratia marcescens* is increasingly recognized as an important opportunistic pathogen. Contaminated intravenous solutions, disinfectants, respiratory therapy equipment, and urethral and intravenous catheters have been identified as causes of nosocomial outbreaks (5). We describe an *S. marcescens* outbreak in which a multiply-antibiotic-resistant strain was isolated from six of seven patients in a medical intensive care unit (MICU). Bacteremia due to the epidemic strain occurred in four patients in adjacent beds who had chronic indwelling urinary catheters; two patients died. This strain had the unusual feature of a negative nitrate reduction test which was used as an epidemiological tool in the investigation of the outbreak.

A 75-year-old man with adenocarcinoma of the colon (patient 1) was admitted to the West Side Veterans Administration Hospital, Chicago, with hypothermia and hypotension. He was transferred to the MICU on 6 February 1981 because of oliguria; *S. marcescens* bacteremia occurred 3 days later. Despite amikacin therapy, the patient expired. Patient 2 was a 64-year-old man with multiple myeloma who had been transferred to the MICU because of respiratory failure secondary to chronic obstructive lung disease; bacteremia occurred on 12 February. Despite amikacin therapy the patient died of purulent meningitis; cerebrospinal fluid cultures grew *S. marcescens*. In two patients, transient bacteremia was secondary to urinary tract infections. Patient 3 was a 74-year-old man who had been admitted to the MICU on 5 January 1981 after a cardiac arrest. Urine cultures were positive for *S. marcescens* on 26 January and during the ensuing 2 months in the MICU; bacteremia occurred on 4 February. Patient 4, a 50-year-old man, was undergoing peritoneal dialysis at the time of bacteremia (9 February). Thus, all four episodes of *S. marcescens* bacteremia occurred within 1 week.

At the time of the outbreak, three other patients were in the MICU. Patient 5 acquired a urinary tract infection, and patient 6 had pneumonia, both due to the epidemic strain of *S. marcescens*. Cultures from body fluids of patient 7 taken while in the MICU were negative for *S. marcescens*; however, 1 week after transfer to a medical ward, asymptomatic bacteriuria due to the epidemic strain was noted. Once the outbreak was recognized, the unit was closed to new admissions. Patients 3, 5, and 6 were segregated to the telemetry room in the MICU because they required further intensive care, whereas patients 4 and 7 were transferred to single private rooms.

Surveillance studies revealed a possible mechanism of cross-infection among the bacteremic patients. All four patients were in adjacent beds and had indwelling urinary catheters. A large graduated cylinder was used by the staff for measuring the urinary output of patients in the MICU; it was often carried from patient to patient and not decontaminated after use. Nurse epidemiologists noted that staff members frequently failed to wash their hands between patient contacts. Cultures of hands, nares, throats, and urine from 25 MICU employees (physicians, nurses, and other support staff) were performed; also cultured were sinks, bedpan hoppers, counter tops, and respiratory therapy equipment. All of these cultures were negative for *Serratia* spp. Only the graduated cylinder described above bore the epidemic strain of *S. marcescens*. Strict enforcement of hospital infection control measures promptly halted further cross-infection of patients. No epidemic strains were further recovered from other patients.

A review of admissions and hospital records revealed that, in addition to patient 7 noted above, in February 1981 two patients (patients 8 and 9) colonized with the epidemic strain were located in medical wards other than the MICU. Moreover, at the time of the outbreak in the MICU, 10 patients (patients 10 to 19) from

TABLE 1. Characteristics of *S. marcescens* strains isolated from patients during outbreak

| Patient no.[a] | Source of isolates[b] | Location of patients[c] | Biological characteristics of isolates | | |
|---|---|---|---|---|---|
| | | | Nitrate reduction[d] | Genta/Tobra resistance[e] | Serotype |
| 1 | B, U, S | MICU | − | Yes | O14:H12 |
| 2 | B, U, S, CSF | MICU | − | Yes | O14:H12 |
| 3 | B, U | MICU | − | Yes | O14:H12 |
| 4 | B, U, D | MICU | − | Yes | O14:H12 |
| 5 | U | MICU | − | Yes | ND[f] |
| 6 | S | MICU | − | Yes | ND |
| 7 | U | Med.[g] | − | Yes | ND |
| 8 | U | Med. | − | Yes | ND |
| 9 | U | Med. | − | Yes | ND |
| 10 | W | Med. | + | No | ND |
| 11 | S | Surg. | + | No | O4:H12 |
| 12 | W | Surg. | + | No | O14:H4 |

[a] Not included are seven patients (patients 13 to 19) from surgical wards with nitrate-positive, gentamicin-tobramycin-susceptible strains of *S. marcescens* recovered mainly from wound cultures.

[b] B, Blood; U, urine; S, sputum; CSF, cerebrospinal fluid; D, peritoneal dialysate; W, wound.

[c] Location at the time that cultures were positive for *S. marcescens*. Med., Medical wards of hospital; Surg., surgical wards of hospital.

[d] −, Negative nitrate reduction tests; +, positive nitrate reduction tests.

[e] Genta, Gentamicin; Tobra, tobramycin.

[f] ND, Not done.

[g] All cultures taken from this patient while in the MICU were negative for *Serratia* spp.

various hospital wards had *S. marcescens* colonization or infection. The isolates recovered from patients in the MICU and from patients 7, 8, and 9 could be distinguished from other strains by the negative nitrate reduction test. The epidemic strain was nitrate negative on Micro-ID (General Diagnostics, Warner-Lambert Co., Morris Plains, N.J.), nitrate agar (Difco Laboratories, Detroit, Mich.) and the optional nitrate test on API 20E (Analytab Products, Plainview, N.Y.). The salient features of the endemic and epidemic strains are summarized in Table 1.

This unique biochemical marker made us suspect that the outbreak was due to a single strain. This possibility was supported by the antibiotic susceptibility pattern. The endemic strains of *S. marcescens* which had been recovered before the outbreak were gentamicin and tobramycin susceptible. The epidemic, nitrate-negative strains were resistant by the Kirby-Bauer disk method to most antibiotics, including gentamicin and tobramycin; however, they were susceptible to amikacin. Broth dilution susceptibility studies done in Mueller-Hinton broth by the microtiter method disclosed the following minimal inhibitory concentrations (micrograms per milliliter): cefoxitin, 15.6; moxalactam, <0.12; cefotaxime, <0.25; gentamicin, 125; tobramycin, 62.5; amikacin, 0.98.

The blood isolates from patients 1 to 4 submitted to the Centers for Disease Control (Atlanta, Ga.) for serotype determination were all type O14:H12. Two randomly chosen nitrate-positive strains (patients 11 and 12) were found to be O4:H12 and O14:H4, respectively (Table 1).

*S. marcescens* shares with other genera of *Enterobacteriaceae* the presence of the enzyme nitrate reductase. When standard methods such as nitrate broth or agar are used, 95.8 to 100% of *S. marcescens* strains are nitrate positive (1–3). Most commercial systems used to identify *Enterobacteriaceae*, such as API, Enterotube (Roche Diagnostics, Div. Hoffman-La Roche, Inc., Nutley, N.J.), and Entero-Set 20 (Diagnostics Division, Fischer Scientific Co., Orangeburg, N.Y.), do not include the nitrate reduction test. However, this reaction is optional on API 20E. The only system that routinely incorporates this reaction in its numerical code is the Micro-ID, which detects enzymatic activity in substrate-impregnated disks (4). Approximately 500 isolates of *S. marcescens* have been tested with Micro-ID, and 97% of the strains were nitrate positive (R. N. Davis, General Diagnostics, Inc., written communication, 1981).

In contrast to most ready-to-use kits, which require overnight incubation, the Micro-ID system can be read after 4 h. This feature was used during our outbreak to rapidly differentiate *S. marcescens* from patients who were infected with the MICU strain from those strains originating from other hospitalized patients. The negative nitrate test also suggested the possibility that the isolates from patients in the MICU were in fact the same strain. This possibility was substantiated by the same antibiotic susceptibility pattern and serotype of the isolates.

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