The Outbreak of *Serratia marcescens* Bacteremia in a Pediatric Ward, Siriraj Hospital 1997

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Abstract

Between October 20 and November 11, 1997, *Serratia marcescens* bacteremia was identified in 8 patients in a pediatric ward at Siriraj Hospital. The organism was isolated from 17 blood and 3 bone marrow specimens. The only common associated factor in these patients was that they all had received an intravenous fluid infusion. In the attempt to investigate the source of *S.marcescens* implicated in the outbreak,108 specimens of intravenous fluid, 3 intravenous fluid bottle caps, 4 specimens from intravenous fluid tubing sets, 21 specimens of antiseptics used on the ward, 28 specimens of rectal swabs from patients on the ward, 1 sample of blood culture media prepared by the hospital for routine use, and 62 environmental specimens including hand swabs of the medical personnel, refrigerator, air conditioning, milk samples, room air, water sink, wooden splint and adhesive tape used to immobilize the intravenous access. Of 227 specimens sent for culture, *S.marcescens* was isolated from only one specimen collected from the in-use intravenous fluid given to a patient with *Serratia* bacteremia. *S.marcescens* was not found in any other surveillance culture. The 8 patients were placed under quarantine in the same room with an exclusive nursing team. With the investigation and intervention including monitoring for meticulous hand washing of the ward staff, the outbreak was stopped within 7 days. Although the investigation failed to discover the environmental reservoir of *S.marcescens* in this outbreak, the data suggested that intravenous fluid was probably the route of transmission and the medical personnel played an important role in spreading the infection.

Key word : *Serratia Marcescens*, Outbreak, Bacteremia, Children, Nosocomial Infection

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Serratia marcescens is a gram negative bacillus in the family of Enterobacteriaceae. *Serratia* thrives well in water and saline solutions even with very minimal nutrients[1,2]. *Serratia* rarely causes infection in normal hosts without risk factors. Nosocomial infection by *Serratia* is often associated with respirators, intravenous catheterization, and urethral catheterization[3-5]. Many nosocomial outbreaks of *Serratia* infections have been reported in various patient care settings[3-9]. Most of the reservoirs of the organism have been related to liquid such as intravenous fluid[3], disinfectant[6], ultrasonic nebulizer[7], urinary catheter[8], and hand lotion[9].

In October 1997, there was an outbreak of *S.marcescens* bacteremia in a pediatric ward in Siriraj Hospital, a tertiary care center with 350 pediatric beds. This report describes the investigation, intervention and the outcome of this outbreak.

METHODS

From October 20 to November 11, 1997, *S.marcescens* was isolated from 17 blood and 3 bone marrow samples from 8 patients in a pediatric ward in Siriraj Hospital. This ward is composed of 5 rooms for patients and a separate room for treatment procedures. The nurse station is in the middle of the floor. The door of each room is open to the walkway in the middle of the ward. Each room contains 3-7 beds for patients according to the space available. The total number of patients in this ward at the time of the outbreak was approximately 30. The patients in this ward were aged from 1 month to 5 years. Every patient was cared for by all of the ward staff without specific designation. All the patients' rooms were similar in environment and bed spacing.

Clinical course, risk factors and outcome

The investigation of this outbreak started on November 4, 1997. The medical records of the patients with *Serratia* bacteremia were reviewed to look for the common associated risk factors. All the *S.marcescens* isolates were tested for antibiogram to determine their relationship. The clinical course and outcome of the patients in the outbreak were analyzed.

Source of *S.marcescens* implicated in the outbreak

All of the potential reservoirs of *S.marcescens* were investigated. The environmental specimens and intravenous fluid samples were collected for culture. The samples investigated are listed in Table 3. The fluid specimens were inoculated in trypicase soy broth at 37°C for 7 days. If any evidence of organism growth was observed, subculture on blood agar and McConkey agar for further isolation and identification was done. All the swab specimens were inoculated directly onto the blood and McConkey agar plates. Five agar plates were placed in different sites on the ward to detect *S.marcescens* in the air.

The agar plates were incubated at 35-37°C for 24-48 h. The identification of *S.marcescens* was done by standard biochemical test.

Intervention to stop the outbreak

All of the patients with *Serratia* bacteremia were placed under quarantine in a separate room with an isolated nurse team. A group discussion among medical personnel of the ward was set up to raise awareness of the potential mode of bacterial transmission and the importance of hand washing. The infection control team also monitored the habit of hand washing among the personnel.

RESULTS

The first 4 patients with *Serratia* bacteremia were in the same room. The remaining 4 patients were in 3 adjacent rooms. Of the 8 patients, 6 were boys and 2 were girls. Six patients were receiving specific treatment for other definitive diagnoses before *Serratia* bacteremia occurred. Two patients (no. 3 and no. 7) were receiving immunosuppressive therapy. The other two patients (no. 2 and no.5) were hospitalized without a definitive diagnosis and later found to have *Serratia* bacteremia. *Serratia* bacteremia was detected by both the BACTEC automated system and conventional system.

Patient no. 2 presented with fever of unknown cause and later developed pancytopenia with *Serratia* bacteremia after 3 days of hospitalization. The bone marrow examination revealed active hemophagocytosis compatible with infectious associated hemophagocytic syndrome (IAHS) and bone marrow culture also grew out *S.marcescens*. Patient no. 5 presented with acute diarrhea with severe dehydration and shock. He was resuscitated with intravenous fluid in the emergency room before being transferred to the ward. He was in profound shock and died soon after arrival in the ward. His postmortem heart blood culture grew out *S.marcescens*. The only common risk factor among these 8 patients was that they

Table 1. Summary of the 8 patients with *Serratia* bacteremia.

No.	Age	Diagnosis	Risk factors	Positive cultures C = Conventional system B = BACTEC system	Duration of hospitalization before *Serratia* bacteremia	Antibiotic therapy	Duration of treatment for *Serratia* bacteremia	Outcome
1.	8 m.o.	1. Down's syndrome 2. Common atrium, common ventricle, pulmonary stenosis 3. Subacute bacterial endocarditis	1. Prolonged hospitalization 2. Intravenous fluid therapy	Blood (C) Oct 20 Blood (C) Oct 23	10 days	-Cloxacillin (Oct 20-30) -Amikacin (Oct 20-31) -Cefoperazone/Sulbactam (Oct 21- Nov 4) -Imipenem (Nov 4- Dec 16)	10 days 11 days 14 days 42 days	Resolved
2.	16 m.o.	Infectious associated hemophagocytic syndrome with abdominal pain	1. IVIG therapy 2. Immune suppression from IAHS 3. Intravenous fluid therapy	Blood (C) Oct 20 Blood (C, B) Nov 6 Blood (B) Nov 7 Bone marrow (B) Oct 30, Nov 7	3 days	-Cefriaxone (Oct 20-22) -Cefperazone/sulbactam (Oct 21-31) -Imipenem (Oct 31- Nov 19) -IVIG (Oct 31, Nov 3-4, 6-7)	2 days 10 days 19 days 5 days	Resolved
3.	2 y.o.	1. Astrocytome S/P frontotemporal craniotomy with total tumor removal 2. Panhypopituitarism	1. Prolonged hospitalization 2. Intravenous fluid therapy 3. Immunocompromised host	Blood (C) Oct 24	119 days	-Cefotaxime (Oct 25-29) -Imipenem (Oct 29- Nov 19)	4 days 21 days	Resolved
4.	5 m.o.	Infantile spasm	1. Prolonged hospitalization 2. Intravenous fluid therapy	Blood (C) Oct 28, 31 Nov 10 Blood (C) Nov 6	7 days	-Cefriaxone (Oct 28-Nov 1) -Cefperazone/sulbactam (Oct 31-Nov 1) -Imipenem (Nov 10-21)	2 days 10 days 11 days	Resolved
5.	15 m.o.	Acute diarrhea with severe dehydration	1. Intravenous fluid therapy 2. Diarrhea, sepsis	Heart blood (C) Oct 28	1 h	-	-	Dead

Table 1. Summary of the 8 patients with *Serratia* bacteremia (Continue).

No.	Age	Diagnosis	Risk Factors	Positive cultures C = Conventional system B = BACTEC system	Duration of hospitalization before *Serratia* bacteremia	Antibiotic therapy	Duration of treatment for *Serratia* bacteremia	Outcome
6.	12 m.o.	Post diarrhea ileus	1. Prolonged hospitalization 2. Intravenous fluid therapy 3. Diarrhea	Blood (C) Oct 30	6 days	- Cefriaxone (Oct 30 - Nov 7)	8 days	Resolved
7.	3 y.o.	Neuroblastoma (admit for chemotherapy)	1. Prolonged hospitalization 2. Intravenous fluid therapy 3. Immunocompromised host	Blood (C) Nov 1, 5, 6 Blooe (B) Nov 6, 10 Blood marrow (B) Nov 10	5 days	-Cefotaxime, Gentamicin (Nov 2 - 5)	3 days	Resolved
						-Ceftazidime (Nov 5 - 6)	1 days	
						-Amikacin (Nov 5 - 19)	14 days	
						- Cefperazone/sulbactam (Nov 6 - 7)	1 days	
						-Imipenem (Nov 7 - 14)	7 days	
						-Ciprofloxacin (Nov 14 - 22)	8 days	
8.	13 m.o.	TB meningitis with hydrocephalus with status epilepticus	1. Prolonged hospitalization 2. Intravenous fluid therapy	Blood (C) Nov 11	20 days	-Vancomycin (Nov 11 - Dec 4)	23 days	Resolved
						-Cefotaxime (Nov 11 - Dec 4)	23 days	

m.o.= month-old
y.o. = year-old

had received an intravenous fluid infusion. All of the 8 patients had symptomatic infections. Except for patient no. 5, all recovered without sequelae. Mean duration of antibiotic therapy was 14.14 days (range 8-42 days). There were 3 patients (no. 2, 4 and 7) who had persistent bacteremia despite appropriate antibiotic therapy according to the antibiograms. The antibiotics were changed, from cefoperazone-sulbactam to imipenem in patient no. 2 and 4 and from imipenem plus amikacin to ciprofloxaxin in patient no. 7, with satisfactory outcomes.

The test for antibiogram of the *S.marcescens* isolates was performed in 11 out of 17 isolates (Table 2). Most of the isolates were resistant to ampicillin, co-trimoxazole, gentamicin and all cephalosporins but sensitive to netilmycin, amikacin, imipenem, cefoperazone-sulbactam and ciprofloxacin. The antibiograms of all the isolates tested were similar in 91 per cent of antibiotic tested.

During this outbreak, there was no excessive recovery of *S.marcescens* in other patients' wards in the hospital. Of the 227 environmental and intravenous fluid samples investigated, only one revealed *S.marcescens* contamination. The only specimen that grew colonies of *S.marcescens* was from the in-use intravenous fluid drawn from the extension tube of the i.v. set, approximately 12 inches away from the patient. That patient also had *Serratia* bacteremia.

With intervention including quarantine of the infected patients and personnel, education with monitoring of hand washing, the outbreak was contained within 7 days.

DISCUSSION

Serratia marcescens is an opportunistic bacteria. The patients at risk for *Serratia* infections are usually immunocompromised, diabetics, post operation or suffering chronic illness. *S.marcescens* rarely causes community acquired infection. *Serratia* is not a common pathogen isolated in a general setting. From 1996 to 1997, *S.marcescens* was found in only 0.013-0.39 per cent of blood cultures performed in Siriraj Hospital and the incidence of *Serratia* infections was 4-11 episodes per year. In this outbreak, 8 patients were identified within 20 days. Therefore, it was an urgent situation that required optimal intervention.

Serratia infections may involve multiple organs. In this outbreak all of the patients were febrile and varied in severity. There was an earlier report of IAHS caused by *S.marcescens* in a newborn baby[11]. The diagnosis of *Serratia* induced IAHS in patient no. 2 was confirmed by resolution of hemophagocytosis with the treatment of the bacteremia. *S.marcescens* might not have been the cause of death in patient no. 5. It could be that he acquired *S.marcescens* just before he died. The supportive

Table 2. Antibiograms of the *Serratia marcescens* isolates.

Antibiotic	No. tested	No. sensitive	% Sensitive
Ampicillin/amoxycillin	11	1	9.1
Cotrimoxazole	11	0	0
Cefazolin	11	0	0
Gentamicin	11	4	36.4
Chloramphenicol	11	10	91.9
Ampicillin/sulbactam	11	0	0
Amoxycillin/clavulanate	6	0	0
Cefuroxime	11	0	0
Cefoxitin	11	1	9.1
Amikacin	10	10	100
Piperacillin	7	0	0
Cefotaxime	11	2	18.3
Ceftazidime	11	0	0
Netilmycin	11	11	100
Ciprofloxacin	6	5	83.3
Imipenem	11	11	100
Ceftibuten	11	5	45.5
Sulbactam/cefoperazone	11	11	100

Table 3. Outreak investigation for sources of *Serratia marcescens*.

Specimens	Number	Culture results
1. Rectal swabs of the patients in the ward	28	No growth of *S.marcescens*
2. Personnel		
- Hand swabs	11	No growth of *S.marcescens*
- Nasal and throat swabs	10	No growth of *S.marcescens*
3. Intravenous fluid		
- In-use fluid (draw from extension tube)	13	*S.marcescens* was found in one specimen
- Stored unused bottles	48	No growth of any organism
- Parenteral nutrition	1	No growth of any organism
- Intravenous fluid tube used in 17 patients	46	No growth of any organism
A = before infusion		
B = during infusion (collect at the end of the I.V. set)		
C = left over fluid		
4. Milk for the patients	21	No growth of *S.marcescens*
5. Environment		
- Water-sink swabs	8	Nonfermentative gram negative bacilli, *P. aeruginosa, Aeromonas hydrophila, Enterobacter cloacae, Citrobacter diversus*
- Swabs of splints to fix I.V. aceess	4	No growth of *S.marcescens*
- Swab from air-conditioner	1	No growth of *S.marcescens*
- Open plates at different sites on the ward	5	No growth of *S.marcescens*
- Bandage to fix I.V. site	1	
- New tubing IV set	4	No growth of *S.marcescens*
- Bottle caps of intravenous fluid	3	No growth of any organism
- Disinfectants		
• Alcohol 70%	4	No growth of *S.marcescens*
• Alcohol 90%	2	No growth of any organism
• Hibiscrub	10	No growth of any organism
• Povidine	4	No growth of any organism
• Tincture iodine	1	No growth of any organism
- Swab from refrigerator	1	No growth of *S.marcescens*
- Blood culture media (home-made conventional bottle)	1	No growth of *S.marcescens*

evidence was that the antibiogram of the isolate recovered from him was similar to that from the other patients. The three patients who had persistent bacteremia despite appropriate antibiotic therapy could have been due to re-introduction of the organism while on therapy.

Outbreaks of *Serratia* are mostly nosocomial infections associated with water or fluid. The sources or reservoirs of the organism in reported outbreaks were intravenous solution[3], scalp vein needles[10], urinary catheters[7,8,11], irrigated saline solutions[3], ultrasonic nebulizers[7], shaving brushes [12], hand-washing brushes[13], and disinfectants [6,14]. Moreover, the organism has also been found on the hands of medical personnel[5,15,16] and on equipments[17]. *S.marcescens* is not a gastrointestinal colonizer like other *Enterobacteriaceae*. However, there was an outbreak in a newborn nursery where *S.marcescens* was found in the stools of patients in the same ward.

In this study, the authors were unable to find *S.marcescens* in any environmental samples. The only isolate recovered in this investigation from the in-use intravenous fluid suggested that intravenous infusion was probably the route of transmission. However, it was inconclusive whether the sources or reservoirs of the organism were the fluid, the tubing set, the needles, or the patients' skin. The antibiograms suggested that all of the isolates were probably from the same source.

Although the authors did not find the organism from hand swabs of the ward staff, the intervention to improve hand washing helped stop the outbreak. This suggested that medical personnel were the key factor of transmission. Continuation of education and monitoring for hand washing will help prevent nosocomial outbreaks.

SUMMARY

An outbreak of *Serratia marcescens* bacteremia in a pediatric ward in Siriraj Hospital was investigated. Eight patients were infected and one patient died. The only common risk factor among these patients was that they had all received an intravenous fluid infusion. Environmental specimens did not reveal the source of the organism. *S.marcescens* was detected in one in-use intravenous fluid sample; this suggested that the route of transmission was *via* intravenous infusion. Medical personnel were probably an important factor in the transmission because the outbreak stopped rapidly with the quarantine of patients and strict hand washing of the personnel.

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การระบาดของเชื้อ*เซอร์ราเทีย มาร์เซสเซนส์* ในกระแสเลือด ในหอผู้ป่วยเด็ก ณ โรงพยาบาลศิริราช พ.ศ. 2541

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ระหว่างวันที่ 20 ตุลาคม ถึง 11 ธันวาคม 2541 ได้เกิดการระบาดของการติดเชื้อ*เซอร์ราเทีย มาร์เซสเซนส์* ในกระแสเลือดในผู้ป่วย 8 ราย ในหอผู้ป่วยเด็กในโรงพยาบาลศิริราช โดยสามารถแยกเชื้อได้จากเลือด 17 ตัวอย่างและจากไขกระดูก 3 ตัวอย่าง ปัจจัยเสี่ยงที่ผู้ป่วยทั้ง 8 รายมีร่วมกันคือการได้รับสารน้ำทางหลอดเลือดดำ คณะผู้วิจัยได้ทำการสืบสวนหาแหล่งที่มาของเชื้อโดยการส่งตัวอย่างต่าง ๆ ไปเพาะเชื้อ ได้แก่ น้ำเกลือ 108 ตัวอย่าง ฝาปิดขวดน้ำเกลือ 3 ตัวอย่าง ชุดสายน้ำเกลือ 4 ตัวอย่าง น้ำยาฆ่าเชื้อที่ใช้ในหอผู้ป่วย 21 ตัวอย่าง rectal swab จากผู้ป่วยในหอเดียวกัน 28 ตัวอย่าง น้ำยาสำหรับส่งเพาะเชื้อในเลือด 1 ตัวอย่าง และสิ่งส่งตรวจโดยการป้ายมาจากสิ่งแวดล้อมอีก 62 ตัวอย่าง ได้แก่ จากมือบุคลากร, จากตู้เย็น, แอร์, นมที่ให้ผู้ป่วยดื่ม, อ่างน้ำ, ไม้ดามแขนเวลาให้น้ำเกลือ, รวมทั้งฝุ่นละอองในอากาศ ในบริเวณหอผู้ป่วย จากสิ่งตรวจทั้งหมดรวม 227 ตัวอย่าง พบเชื้อ*เซอร์ราเทีย มาร์เซสเซนส์* จากตัวอย่างเดียวซึ่งเป็นตัวอย่างจากน้ำเกลือที่กำลังให้ผู้ป่วยรายหนึ่ง ซึ่งพบเชื้อนี้ในกระแสเลือดด้วย แต่ไม่พบเชื้อจากแหล่งอื่นใด หลังจากได้แยกผู้ป่วย 8 ราย ไว้ด้วยกันและมีการเฝ้าระวังการล้างมือของบุคลากรอย่างเคร่งครัด พบว่าการระบาดได้หยุดไปภายใน 7 วัน แม้จะไม่สามารถหาแหล่งเชื้อที่ทำให้เกิดการระบาดได้แน่นอน แต่พอจะบอกได้ว่าทางเข้าของเชื้อน่าจะมาจากน้ำเกลือ และบุคลากรทางการแพทย์ น่าจะเป็นตัวการสำคัญที่ช่วยให้มีการแพร่เชื้อ

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