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Molecular Epidemiology of *Serratia marcescens* in a Hospital

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Serratia marcescens is an important nosocomial pathogen, particularly regarding catheter-related bacteremia, urinary tract infections, and respiratory infections. Pulsed-field gel electrophoresis (PFGE) is useful in determining the molecular epidemiology of various pathogens including *S. marcescens* (1).

In May 2003, two inpatients (P1 and P2) successively developed sepsis in a surgical ward of a hospital with 925 beds. Blood cultures of the two patients revealed the presence of *S. marcescens*. Both patients P1 and P2 had been inserted with vascular catheters for 12 days and 4 days, respectively, before developing sepsis. The two isolates from the respective patients had identical PFGE patterns. Epidemiological investigation conducted by the infection control team in the hospital, however, was unable to identify the source of the infection. PFGE-based surveillance of *S. marcescens* was then conducted to assess the possible risk of an outbreak of *S. marcescens* infections.

A total of 23 clinical isolates of *S. marcescens*, including the above two isolates and 21 isolates obtained from 21 inpatients during August and September 2003, were analyzed for chromosomal DNA typing by using a counter-clamped homogeneous electric field system (CHEF Mapper™: Bio-Rad Laboratories, Hercules, Calif., USA), and for antibiotic resistance (WalkAway™: Dade Behring, Deerfield, Ill., USA).

Twenty different PFGE patterns of the *Spe*I DNA digests of the isolates were detected (Figs. 1A and 1B). PFGE patterns A, J, and K (Fig. 1A) were shared respectively by

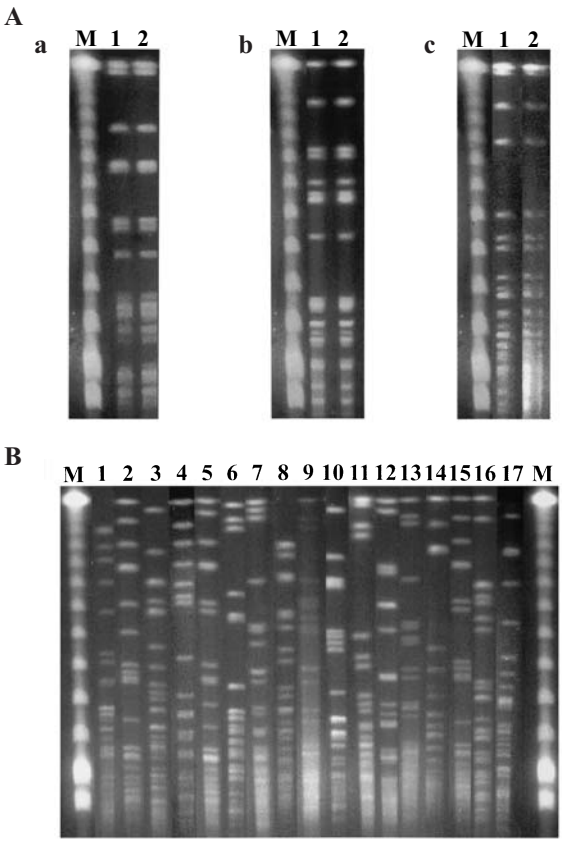

Fig.1. Pulsed-field gel electrophoresis of *Spe*I-digested genomic DNA from *S. marcescens* isolates.
A: a) PFGE pattern K (isolates No. S6 and S7), b) PFGE pattern J (isolates No. S15 and S18), c) PFGE pattern A (isolates No. S21 and S38), M: low range PFG Marker.
B: lane 1: isolate No. S14, lane 2: No. S16, lane 3: No. S19, lane 4: No. S23, lane 5: No. S24, lane 6: No. S25, lane 7: No. S27, lane 8: No. S28, lane 9: No. S29, lane 10: No. S31, lane 11: No. S32, lane 12: No. S33, lane 13: No. S34, lane 14: No. S36, lane 15: No. S37, lane 16: No. S39, lane 17: No. S40.

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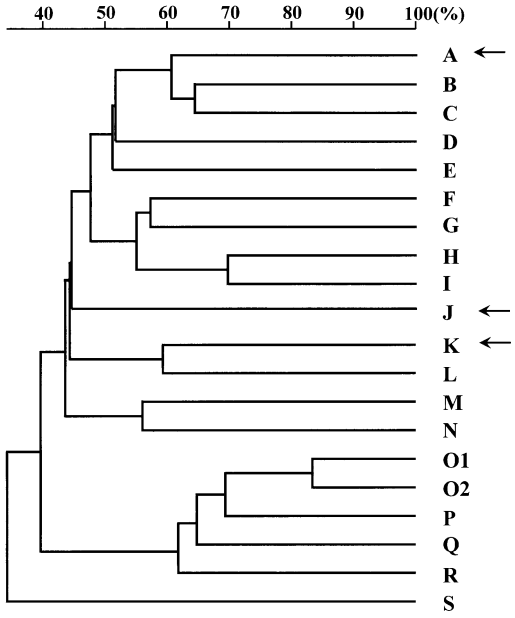

Fig. 2. Band-based cluster analysis of PFGE patterns of *S. marcescens* isolates.

Table 1. Antibiotic pattern classified by antibiotic pattern of 18 antibiotics against *S. marcescens*

Antibiotic pattern	Antibiotics										
	ABPC	PIPC	CTM	CMZ	CTX	CAZ	FMOX	AZT	S/C	AMK	MINO
a	R	R	R	R	R	S	R	S	R	R	S
b	R	S	R	S	R	S	R	S	S	S	S
c	R	I	R	R	S	S	R	S	S	S	S
d	R	I	R	R	R	I	I	I	S	S	S
e	R	R	R	S	S	R	S	R	S	S	S
f	R	R	R	S	S	S	S	S	S	I	S
g	R	I	R	S	S	S	S	S	S	S	S
h	R	S	R	S	S	S	S	S	S	S	S
i	R	S	R	S	I	S	I	S	S	S	S
j	I	S	R	S	S	S	S	S	S	S	S
k	I	S	R	S	S	S	I	S	S	S	S
l	R	S	I	S	S	S	S	S	S	S	S
m	S	S	R	S	I	S	S	S	S	S	R
n	S	S	S	S	S	S	S	S	S	S	S

All isolates were resistant to CCL and CEZ, but sensitive to CPR, GM, IPM, LVFX, and ST.
ABPC: ampicillin, PIPC: piperacillin, CTM: cefotiam, CMZ: cefmetazole, CTX: cefotaxime, CAZ: ceftazidime, CCL: cefaclor, CEZ: cefazolin, CPR: cefpirome, FMOX: flomoxef, AZT: aztreonam, S/C: sulbactam/cefoperazone, AMK: amikacin, MINO: minocycline, GM: gentamicin, IPM: imipenem/cilastatin, LVFX: levofloxacin, ST: sulfametazole/trimethoprim, R: resistant, S: sensitive, I: intermediate.

Table 2. Phenotypic and genotypic characterization of *S. marcescens* isolates

Patient no.	Isolates no.	Specimen	Date	Ward	PFGE pattern	Antibiotic pattern
P1	S6	Venous blood	12-May	8N	K	k
P2	S7	Venous blood	19-May	8N	K	i
P3	S14	Venous blood	12-Aug	16	H	c
P4	S15	Venous blood	15-Aug	12S	J	d
P5	S16	Sputum	20-Aug	8N	O1	h
P6	S18	Urine	22-Aug	12S	J	j
P7	S19	Sputum	25-Aug	12N	F	o
P8	S21	Urine	27-Aug	7N	A	i
P9	S23	Sputum	28-Aug	7N	L	h
P10	S24	Sputum	29-Aug	11N	P	h
P11	S25	Sputum	1-Sep	ICU	I	k
P12	S27	Urine	8-Sep	6N	B	a
P13	S28	Sputum	8-Sep	7N	G	i
P14	S29	Sputum	8-Sep	9S	R	e
P15	S31	Urine	10-Sep	7N	S	l
P16	S32	Sputum	9-Sep	5S	C	i
P17	S33	Sputum	16-Sep	10N	Q	i
P18	S34	Urine	16-Sep	9S	D	f
P19	S36	Urine	18-Sep	7S	M	i
P20	S37	Venous blood	22-Sep	7N	O2	m
P21	S38	Urine	22-Sep	7N	A	b
P22	S39	Pleural cavity drain	24-Sep	12N	N	k
P23	S40	Urine	26-Sep	9S	E	n

isolates from different pairs of the patients (see below). The other 17 PFGE patterns were unique to each isolate (Fig. 1B). Band-based cluster analysis of these patterns (Molecular Analysis™: Bio-Rad) revealed a low level of similarity among the isolates except for patterns O1 and O2 that formed a cluster (a cluster was defined as a group of patterns sharing more than 70% similarity) (Fig. 2).

The majority of the *S. marcescens* isolates were resistant to ABPC, CCL, and CEZ, but sensitive to CAZ, IMP, and LVFX. They were resistant to 2-10 of 18 tested drugs (Table 1). Fifteen different drug resistance patterns were observed. No correlation was found between the antibiotic patterns and PFGE patterns (data not shown).

Three pairs of isolates having identical PFGE patterns were obtained from different patients in the same ward on similar dates. The strains with pattern K (isolate Nos. S6 and S7) were isolated from patients P1 and P2 in ward 8N in May. Those with pattern J (Nos. S15 and S18) were from patients P4 and P6 in ward 12S in August. Those with pattern A (Nos. S21 and S38) were from patients P8 and P21 in ward 7N in August and September. It was noteworthy that all these pairs of patients had undergone catheterization concurrently. The patients may have been infected with the pathogen from the same source related to cathters.

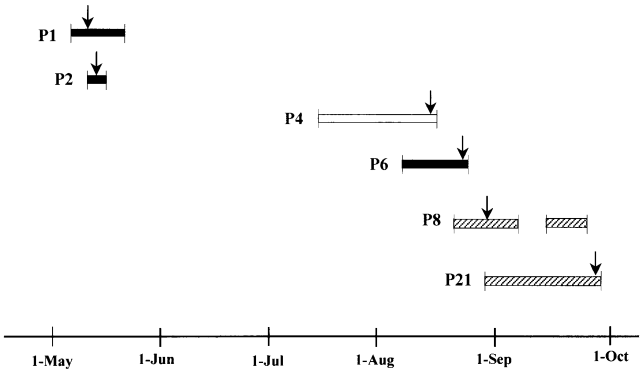

Fig. 3. Duration of catheterization. Intravenous, central venous, and urinary tract catheterization are represented by filled, open, and hatched boxes, respectively. Vertical arrows indicate the date of isolation of *S. marcescens*.

Catheterization was thus found to have a high risk of *S. marcescens* infection. In the hospital, its application including its duration was revised and a single use of heparin solution for the heparin lock technique was implemented. None of the patients involved in the above outbreak suffered serious consequences.

REFERENCE

1. Miranda, G., Kelly, C., Solorzano, F., Leanos, B., Coria, R. and Patterson, J. E. (1996): Use of pulsed-field gel electrophoresis typing to study an outbreak of infection due to *Serratia marcescens* in a neonatal intensive care unit. J. Clin. Microbiol., 34, 3138-3141.