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Bacteremia Associated with *Enterobacter sakazakii* (Yellow-Pigmented *Enterobacter cloacae*)

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A case report of bacteremia due to *Enterobacter sakazakii*, listed previously as yellow-pigmented *Enterobacter cloacae* (R. Sakazaki, *in* R. E. Buchanan and N. E. Gibbons, ed., *Bergey's Manual of Determinative Bacteriology*, 8th ed., p. 325, 1974), occurred in a 7-day-old, Caucasian male who responded successfully to ampicillin therapy. The source of the infection was not known; however, because of the time lapse between birth and the onset of symptoms, the infection was thought to have occurred postnatally.

According to *Bergey's Manual of Determinative Bacteriology* (4), only *Enterobacter aerogenes* and *E. cloacae* are recognized as species in the genus *Enterobacter*. Both species are typically nonpigmented, although a yellow pigment may be produced by some strains of *E. cloacae* (4). Steigerwalt and co-workers (6) have presented evidence that the pigmented and nonpigmented strains of *E. cloacae* are not closely related, based on deoxyribonucleic acid studies. Recently the Enteric Section of the Center for Disease Control (1) has shown that these two organisms can be further separated on the basis of acid production from D-sorbitol and plans to propose that these pigmented strains be named *Enterobacter sakazakii* (yellow-pigmented *Enterobacter cloacae*).

As new species of microorganisms are described, it is important to document their occurrence to gain a better understanding of their relationship with disease (2). Only three cases of disease due to this organism have been reported, and all were associated with neonatal meningitis (3, 8). This paper describes the first reported case of neonatal bacteremia in the absence of meningitis associated with *E. sakazakii*, previously described as a pigmented strain of *E. cloacae*.

MATERIALS AND METHODS

Case report. The patient was a 7-day-old Caucasian male born at term after an uneventful first pregnancy. His birth weight of 2,600 g placed him in the fifth percentile for his gestational age. He did well in the newborn nursury on routine formula feedings and was only 30 g below birth weight when discharged at 4 days of age.

At 6 days of age the baby became slightly irritable, and on the following day took less formula than usual. Later that day he became febrile, with an axillary temperature of 102°F (38.9°C), and was hospitalized for work-up and treatment for possible sepsis.

The admission physical examination was unremarkable except for slight irritability. His umbilicus and circumcision were healing well and showed no signs of infection. The vital signs were abnormal, with a heart rate of 192, respiration rate of 40, and a rectal temperature of 101°F (38.3°C). Initial laboratory studies included a normal hemoglobin and hematocrit (16.6 g/dl and 51.6%, respectively), normal platelet count (284,000/mm^3), and a normal urinalysis. The leukocyte count was abnormally low (3,900/mm^3), with an abnormal differential count of 41% neutrophiles, 11% bands, 46% lymphocytes, 1% monocytes, and 1% eosinophiles. These findings suggested a possible bacterial infection.

Blood was collected by venipuncture in the forearm, using an aseptic technique, and was cultured aerobically and anaerobically in tryptic soy broth from vials manufactured by Johnston Laboratories, Inc., Cockeysville, Md. The patient was begun on intramuscular (i.m.) injections of ampicillin (75 mg every 12 h) and gentamicin (7.5 mg every 12 h), pending culture and antimicrobial susceptibility results. The baby became afebrile within 24 h. The blood culture was positive for *E. sakazakii* and was susceptible to ampicillin (2.00 μg/ml). For this reason, gentamicin was discontinued, and ampicillin was increased to 125 mg i.m. every 12 h. On hospital day 6 (age 2 weeks), the dosage of ampicillin was changed to 100 mg i.m. every 8 h, and a repeat blood culture collected after 1 week of therapy grew no organisms. The leukocyte count (10,900/mm^3) and differential (29% neutrophiles, 4% bands, 59% lymphocytes, 4% monocytes, and 4% eosinophiles) performed at this time had returned to normal.

The patient continued to do well, and after 10 days of therapy ampicillin was discontinued. The child was observed for another 24 h in the hospital and was discharged on hospital day 11. At his 2-month checkup, he was found to have normal growth and development, with a weight of 5,120 g and no apparent recurrence of the infection.

RESULTS AND DISCUSSION

The blood culture vials (types 6B and 7B) were tested on a BACTEC 460 (Johnston Laboratories), and the aerobic vial was detected as having increased $^{14}CO_2$ production 30 h after collection. Gram-negative bacilli were noted microscopically, and the vial was subcultured to 5% sheep blood agar and incubated at 35°C in a 5% CO_2 environment. The isolate was identified as *E. sakazakii* by using Enterotube II and the Computer Coding and Identification Manual (profile no. 64321; Roche Diagnostics, Nutley, N.J.). The organism identification was confirmed by the Center for Disease Control. The Enterotube II reactions of the isolate are compared with reference strains of *E. sakazakii* (1) in Table 1. Minimal inhibitory concentration studies were performed, using a frozen, prediluted, microtiter system (Micro-Media System, Campbell, Calif.), and *E. sakazakii* was interpreted as susceptible or moderately susceptible to all antimicrobial agents tested (Table 2).

The epidemiological aspects concerning the reservoir and route of transmission of the organism in relationship to this case are uncertain. The natural reservoir of *E. sakazakii* is unknown; however, other members of this genus are normally recovered from the feces of humans and animals, sewage, water, and soil (4). Stool cultures from the patient and both parents collected approximately 2 weeks after discharge were negative for *E. sakazakii*. Unfortunately, environmental cultures of the nursery or fecal cultures of other babies or nursery personnel were not performed. Only two other isolates of *E. sakazakii* have occurred in our 500-bed hospital. Neither isolate was cultured from patients in the nursery, nor were the antibiograms the same. This infection either occurred prenatally (early onset) from vaginal contamination during delivery or postnatally (late onset) from exogenous sources (5, 7). We favor the late onset because 6 days lapsed between birth and the onset of symptoms.

TABLE 1. *Biochemical reactions of E. sakazakii*

Test	Patient isolate[a]	Reference strains[b]	
		Reaction	% Positive
Indole	−	−	16
Voges-Proskauer	+	+	97
Simmon's citrate	+	+	100
H_2S	−	−	0
Urea	−	−	0
Phenylalanine deaminase	−	Weak[c]	Weak[c]
Lysine decarboxylase	−	−	0
Ornithine decarboxylase	+	+	97
Gas from glucose	+	+	97
Acid from D-glucose	+	+	100
Lactose	+	+	100
Dulcitol	−	−	6
Adonitol	−	−	0
D-Sorbitol	−	−	0
L-Arabinose	+	+	100
Deoxyribonuclease	−[d]	+[e]	19[e]
Yellow pigment on tryptic soy agar at 25°C			

[a] All tests were performed at 35°C unless otherwise stated. All tests, with the exception of deoxyribonuclease and pigment production, were performed by using Enterotube II. +, Positive reaction in 24 h; −, negative reaction in 24 h.

[b] See reference 1. All tests were performed by conventional methods; temperature not specified. +, Positive reaction in 48 h; −, negative reaction in 48 h.

[c] Reaction is much weaker than that given by *Proteus* and *Providencia*.

[d] Positive in 4 days.

[e] Most reactions were delayed. All strains were positive by day 14.

TABLE 2. *Antimicrobial susceptibility test results for E. sakazakii*

Antimicrobial agent	MIC, (μg/ml)[a]	Interpretation[b]
Ampicillin	2.00	S
Cephalothin	16.00	MS
Gentamicin	0.50	S
Tetracycline	0.50	S
Carbenicillin	16.00	S
Chloramphenicol	2.00	S
Kanamycin	2.00	S
Tobramycin	0.50	S
Amikacin	2.00	S

[a] MIC, Minimal inhibitory concentration.

[b] S, Susceptible; MS, moderately susceptible.

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