

## Isolation of *Corynebacterium aquaticum* from Spinal Fluid of an Infant with Meningitis

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**A 4-week-old female was hospitalized because of vomiting, irritability, and nuchal rigidity. A spinal fluid culture yielded *Corynebacterium aquaticum*. The diagnosis of *C. aquaticum* meningitis in this infant was supported by the following cerebrospinal fluid findings: Gram stain, elevated protein, hypoglycorrhachia, positive C-reactive protein, and polymorphonuclear leukocytosis. Antigen studies for common bacterial causes of meningitis were negative. *C. aquaticum* is a rare cause of human disease and may be initially confused with *Listeria monocytogenes*, which is a more common gram-positive, motile rod associated with meningitis in infants.**

The neonate is at risk for acute or delayed-onset meningitis caused by organisms acquired during passage through the birth canal or acquired perinatally in the hospital. Meningitis may be evident days or weeks after birth depending on the virulence of the pathogen and the immune status of the infant. *Listeria monocytogenes* is the gram-positive bacillus most commonly associated with neonatal meningitis of both delayed and acute onset. Most cases of delayed-onset listeria meningitis occur at about 2 weeks after birth, although occasional cases 1 month after birth have been reported. A recent report has documented the occurrence of another gram-positive rod, a *Lactobacillus* species, as the cause of acute neonatal meningitis (2). This report documents the isolation of *Corynebacterium aquaticum* from the spinal fluid of a 4-week-old infant hospitalized with meningitis. This motile, gram-positive rod resembles *L. monocytogenes* in certain ways and needs to be distinguished from *Listeria* species when it occurs in clinical specimens.

We believe this report is the first documented case of meningitis caused by *C. aquaticum*. *C. aquaticum* was first described by Leifson in 1962 from samples of distilled water (4). The organism has been reported from blood cultures of a patient with endocarditis (F. L. Jackson, Y. E. Goodman, and T. Steele, Abst. Annu. Meet. Am. Soc. Microbiol. 1974, M15, p. 69) and a diabetic patient with septicemia (6). The organism has been identified at the Centers for Disease Control reportedly from sputum, blood, and spinal fluid although no case details are given (3).

A 4-week-old female was hospitalized with a history of weight loss, vomiting, failure to thrive, and irritability. On examination she appeared wasted and had marked opisthotonos. Temperature was 34°C. The remainder of the examination was unremarkable with the exception of a full fontanel and nuchal rigidity. Admission laboratory results were hemoglobin, 15.2 g/dl; hematocrit, 46.5%; leukocytes,  $44.3 \times 10^3$  per  $\text{mm}^3$  with a differential of 76% segmented neutrophils, 6% band neutrophils, 12% lymphocytes, and 4% monocytes. The serum glucose was 112 mg/100 ml. A spinal tap demonstrated a leukocyte count of 1,500 cells per  $\text{mm}^3$ , with 96% segmented neutrophils and 4% lymphocytes. The cerebrospinal fluid protein was 975 g/100 ml, and the glucose

was 36 mg/100 ml. The Gram stain demonstrated 0 to 10 segmented neutrophils per high power field and no bacteria. An India ink preparation was also negative. Cultures of blood and cerebrospinal fluid were ordered, and the patient was started on ampicillin and gentamicin. Culture of the spinal fluid was negative. A computerized axial tomography scan was done and showed marked hydrocephalus involving all ventricles. A spinal tap performed on day 2 of hospitalization demonstrated 500 leukocytes per  $\text{mm}^3$ , 88% segmental neutrophils, and 12% lymphocytes. The cerebrospinal fluid protein was 297%, and the glucose was 17 mg/100 ml. A qualitative cerebrospinal fluid C-reactive protein was positive (4+) with a latex reagent (Hyland). Cultures were obtained. Latex agglutination antigen studies for *Haemophilus influenzae* type B, *Streptococcus pneumoniae*, and *Neisseria meningitidis* (A, B, and C) were negative.

The Gram stain of spinal tap 2 was quite different from that of tap 1, with 75 to 100 small, pleomorphic, gram-positive to gram-variable bacilli seen in the smear. No growth occurred in the first 24 h. However, on day 2 a BACTEC resin bottle (16B; Johnston Laboratories, Inc., Towson, Md.) inoculated with the spinal fluid was slightly turbid, and Gram stain revealed gram-positive coccobacilli. Initially, *L. monocytogenes* was considered because the patient's age was consistent with delayed onset listeria meningitis. A wet mount of the broth demonstrated motility, although typical tumbling motility did not predominate. An umbrella-like growth pattern just below the surface and along the stab in semisolid medium also prompted suspicion that the isolate was *Listeria* species. On day 1 very scant growth was noted on subculture of the resin-containing BACTEC bottle, less than would have been suspected for *Listeria* species. By 48 h the primary streak area had a definite yellow hue. The biochemical test results of the isolate and those of *L. monocytogenes* are presented in Table 1. Acid production from carbohydrates was determined with CTA sugars (BBL Microbiology Systems, Cockeysville, Md.) at 5 days. The isolate was identified as *C. aquaticum*.

The identification of our isolate was confirmed by the Commonwealth of Pennsylvania Laboratory and the Centers for Disease Control. The Pennsylvania Bureau of Laboratories reported only five referred isolates of *C. aquaticum*. Interestingly, three isolates were from blood cultures from the same hospital in which this child was born, and all were

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TABLE 1. Characteristics of *C. aquaticum* and *L. monocytogenes*

Test	Result of test with <sup>a</sup> :	
	<i>L. monocytogenes</i>	<i>C. aquaticum</i>
Gram stain	Gram-positive rods or coccobacilli	Gram-positive rods or coccobacilli
Motility (25°C)	+	+
Type of hemolysis (sheep blood)	Beta (ground glass-like)	Gamma
Catalase	+	+
Umbrella growth in semisolid motility medium	+	+
Nitrate reduction	-	-
Arginine hydrolysis	-	-
Esculin hydrolysis	+	+
Hippurate hydrolysis	+	+
Acid from glucose	+	+
Acid from salicin	+	-
Acid from rhamnose	+	-
Acid from xylose	-	+
Acid from maltose	+	+
Acid from mannitol	+	+
Yellow pigment (48 h)	-	+

<sup>a</sup> +, Positive reaction; -, negative reaction.

clustered in the same time frame. This raises the question of whether *C. aquaticum* could have been acquired nosocomically by the neonate at birth.

The patient in our case responded dramatically to therapy with gentamicin and ampicillin. Our isolate was susceptible to ampicillin, cephalothin, penicillin, chloramphenicol, erythromycin, clindamycin, and vancomycin and was resistant to nafcillin by disk diffusion testing.

Fortunately, neither the EBC + card (Vitek Systems, Inc., Hazelwood, Mo.) nor the API-20S strip (Analog Laboratories, Inc.) erroneously identified this isolate as *L. monocytogenes*. *C. aquaticum* produced a positive test result only in the  $\beta$ -glucosidase cupule of the API 20S strip and did not grow sufficiently in the EBC + card to give a positive result. Hence, a misidentification would not occur if either of these rapid systems, which identify *L. monocyto-*

*genes* reliably, were used. However, when examined by conventional tests there is sufficient resemblance to *L. monocytogenes* that a mistaken identification could occur.

It is probable that *C. aquaticum* was the causative agent of this child's meningitis. The combination of spinal fluid cell count, protein, glucose, and C-reactive protein are consistent with bacterial meningitis. Antigens related to common bacterial causes of meningitis were absent. The culture of spinal tap 1 most likely failed to reveal organisms because of suspected aqueductal inflammation. When appropriate therapy was administered the infection began to resolve, and organisms could be seen in the spinal fluid. The organisms were isolated only from a BACTEC resin bottle because of the proven capability of BACTEC blood culture bottles containing absorbent resins to neutralize the effect of antibiotics (1).

*C. aquaticum* is mentioned less and less in textbooks that deal with clinical microbiology, although Lipsky et al. (5) included the species in their recent review of infections caused by nondiphtheria corynebacteria. *C. aquaticum* is an uncommon isolate from human sources and can be confused with *L. monocytogenes* on initial examination.

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