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CASE REPORTS

Rahnella aquatilis Bacteremia from a Suspected Urinary Source

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A 76-year-old male with prostatic hyperplasia presented with acute pyelonephritis. Blood cultures yielded *Rahnella aquatilis*. Treatment with intravenous followed by oral levofloxacin resulted in cure. Important characteristics of this organism include its biochemical similarities to *Enterobacter agglomerans*, its apparent ability to cause bacteremia from a renal focus, and its response to quinolone therapy.

CASE REPORT

A 76-year-old male presented to the emergency room complaining of nausea, vomiting, and "shaking." His medical history was significant for benign prostatic hypertrophy and a urinary tract infection 6 months previously. Physical examination revealed a fever of 103.7°F, a blood pressure of 109/57 mm Hg, a pulse of 112 beats/min, and a respiratory rate of 18 breaths/min; the physical examination was otherwise unremarkable. The complete blood count was significant for 18,700 white blood cells and 94% granulocytes with a left shift. Urinalysis revealed "many" bacteria and red and white blood cells and was leukocyte esterase positive. One dose (500 mg) of intravenous levofloxacin and fluids were administered for pyelonephritis. The patient was discharged on 500 mg of oral levofloxacin daily for 7 days. Two days later, blood cultures from separate sites grew gram-negative bacilli, which were subsequently identified as *Rahnella aquatilis* using the API system (bioMérieux). The isolate was sensitive to amoxicillin-clavulanic acid, amikacin, aztreonam, ceftazidime, cephalothin, cefoperazone, cefonicid, ciprofloxacin, ceftriaxone, cefotaxime, cefuroxime (axetil and sodium), cefazolin, cefoxitin, gentamicin, imipenem, mezlocillin, tobramycin, ofloxacin, piperacillin, ampicillin-sulbactam, trimethoprim-sulfamethoxazole, and ticarcillin-clavulanic acid. It was resistant to ampicillin and ticarcillin. The patient recovered without sequelae. Though a urine culture was not performed upon admission of the patient, clinical findings and urinalysis strongly suggested pyelonephritis as the source of the patient's bacteremia.

Discussion. A member of the family *Enterobacteriaceae*, *Rahnella aquatilis* is a facultatively anaerobic, nitrogen-fixing, gram-negative rod. Using 11 freshwater isolates, Gavini and his colleagues at the Institut Pasteur first described the organism in 1976 (9). In 1979, DNA hybridization studies by Izard et al. confirmed that Gavini's "group H2" represented a previously unknown member of the family *Enterobacteriaceae* (12). The genus *Rahnella* was named in honor of German-American bacteriologist Otto Rahn, and the species was called *aquatilis* because it was isolated from water. Although the organism has been widely recognized in environmental samples, it remains an infrequent, and previously underdiagnosed (5), pathogen. The Centers for Disease Control and Prevention received its first clinical isolate in 1985; the specimen came from a burn wound (8). *Rahnella* bacteria have since been isolated from blood, surgical wounds, urine, sputum, bronchial washings, and stool. Most cases have occurred in compromised hosts or in young children, although sepsis was reported in a healthy adult following iatrogenic inoculation (5). I report what is, to the best of my knowledge, the first documented case of *Rahnella*-induced bacteremia from a suspected urinary source.

The clinical spectrum of disease caused by *Rahnella* infection is far from understood, in part because the organism has been recognized only recently. No single biochemical feature differentiates *Rahnella* from the other *Enterobacteriaceae*, and prior to its inclusion in the databases of automated gram-negative identification systems, the species was often confused with *Enterobacter agglomerans* due to similarities in the organisms' biochemical test results (8). However, *Rahnella* does have a few distinguishing traits. Characteristically, it is motile at 22°C but nonmotile at 36°C, and it can grow at 4 to 10°C, probably because it has evolved to live in soil. It is also negative for lysine and ornithine decarboxylases and arginine dehydrolase, and it does not produce yellow pigment. The species usually grows well under standard conditions. In 2003, however, Domann et al. detected *Rahnella* by 16S rRNA analysis after the specimen did not grow on MacConkey or blood agar after 24 h at 37°C in an aerobic environment (6). It is possible that they described a fastidious strain or that patient factors made isolation difficult.

Now that *Rahnella* has been included in many commercial databases, it is detected more easily and more frequently in both clinical and environmental samples. Exposure to the organism is probably very common, and its public health significance should not be underestimated. High concentrations of *Rahnella* have been discovered in minced meat, freshwater fish, and dairy products (14), and *Rahnella* is considered a potential

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contaminant in lager beer breweries (10). One strain that was isolated from fish harbored the gene for *Escherichia coli* heat-labile toxin (14), and *Rahnella* contamination has been associated with unsafe histamine levels in fish products (20). The psychrotrophic bacterium has been known to corrupt even properly refrigerated milk (13) and one vial of total-parenteral-nutrition solution (4) before their expiration dates. In addition to its role as a food contaminant, aerosolized *Rahnella* and its by-products have been identified as likely allergens. *Rahnella* and other nitrogen-fixing bacteria grow symbiotically in plant root nodules or rhizospheres, so workers exposed to wood dust (especially pine dust) are at high risk for *Rahnella* allergy (7). High rates of positive skin reaction (up to 98%) have been reported among paper mill (17), sawmill, and furniture factory (18) workers.

Rahnella's adaptation to life in tree roots facilitates not only its role as an allergen but also its role as a pathogen. *R. aquatilis* CF3 lacks the fimbriae that mediate adhesion by other bacterial pathogens, but it expresses a 38-kDa major outer membrane protein which functions as a root adhesin and porin (1). As the outer membrane protein shares high sequence similarity with those of other gram-negative pathogens (1), it seems possible that *Rahnella*'s root adhesin mediates adherence to epithelial cells during bacterial invasion. Another virulence factor is lipopolysaccharide endotoxin, the structure of which has recently been explored (22). Varbanets et al. found *Rahnella* lipopolysaccharide to be both toxic and pyogenic, with a 50% lethal dose of 0.20 to 0.33 mg/kg of body weight for experimental animals (21). Finally, *Rahnella* elaborates a homoserine lactone-based autoinducer molecule thought to function in quorum sensing (11). Similar molecules have been shown to mediate surface motility and biofilm production among other gram-negative pathogens, and *Rahnella*'s signaling molecules likely play an important role in its pathogenicity (11). As the organism's clinical significance and spectrum of infection evolve, new virulence factors will almost certainly be discovered.

In addition to these virulence factors, *Rahnella* naturally expresses a chromosomally encoded extended-spectrum Ambler class A beta-lactamase (2). Penicillin- and cephalosporin-dependent regimens should probably be avoided, but ceftazidime, imipenem, and piperacillin-tazobactam remain active against all current isolates (2). The most definitive studies have found *Rahnella*'s beta-lactamase to be noninducible and clavulanic acid inhibited (2), although a single paper reported contradictory findings for a clinical isolate (15). It has been suggested that the chromosomally encoded beta-lactamase found in *Rahnella* may be a progenitor of plasmid-encoded beta-lactamases found in other species (2). For example, it has been demonstrated that *Rahnella* can transmit fosfomycin resistance to *Serratia marcescens* at low frequency (16).

As all current isolates demonstrate sensitivity to carbapenems, trimethoprim-sulfamethoxazole, and quinolones (19), these drugs may represent attractive treatment choices. Two *Rahnella* genomospecies were described in 1998, but they are not readily distinguishable from *R. aquatilis*, and they have not yet been named (3). Reference strains of genomovar 1 are pyrase positive and are more susceptible to quinolones than those of genomovar 2, which are pyrase negative (19). The clinical significance of these findings is not established, however, as all known strains are intermediate or sensitive to quinolones (19). Documented *Rahnella* urinary tract infection is probably best treated with fluoroquinolone therapy.

While the organism remains poorly understood, the astute microbiologist must rule out *Rahnella* when confronted with unusual *Enterobacteriaceae* in clinical specimens. As of this publication, there have been no reports of *Rahnella*-associated mortality.

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