First Report of Peritoneal Dialysis–Related Peritonitis Caused by *Citrobacter amalonaticus*

Editor:

Citrobacter is a gram-negative coliform bacterial genus in the Enterobacteriaceae family, comprising 11 species well known for an ability to use citrate as their sole carbon source. They are generally considered organisms of low virulence and have only rarely been reported to cause serious human infections in immunocompromised patients. In particular, *Citrobacter amalonaticus* has seldom been isolated from humans.

In 2009, a 47-year-old Chinese woman was admitted to hospital for generalized abdominal pain and turbid dialysate fluid for 1 day. She had immunoglobulin A nephropathy with end-stage renal failure, and in 1998, she had undergone renal transplantation (living related donor), which was complicated by chronic graft rejection. She also had diabetes mellitus and was taking prednisolone and cyclosporine A because of the renal graft.

For the preceding 6 months, this patient had been regularly receiving intermittent peritoneal dialysis (IPD) because of worsening renal function. She was afebrile on admission. The total cell count in peritoneal effluent was 14 200$\times 10^6$/L. Gram stain of the effluent revealed the

presence of numerous leukocytes, but no organisms were seen. A diagnosis of IPD-related peritonitis was made.

The patient was treated empirically with intraperitoneal cefazolin and tobramycin, but clinical response was poor. Culture of the effluent yielded pure growth of a motile, gram-negative rod, which was identified as *C. amalonaticus* based on biochemical tests and 16S rRNA gene sequencing (1) with 99.7% nucleotide identity. The isolate was susceptible to ceftriaxone, ceftazidime, piperacillin–tazobactam, imipenem, cotrimoxazole, amikacin, and gentamicin, but resistant to ampicillin, amoxicillin–clavulanate, cephalothin, and cefuroxime. After 2 days of the cefazolin and tobramycin, the patient's antibiotic regimen was switched to intraperitoneal ceftazidime and amikacin for 1 week. The patient showed good response after the change of antibiotics, with a progressive drop in peritoneal fluid cell count to zero within 5 days. She was then transferred to another hospital for training in continuous ambulatory peritoneal dialysis. There has been no recurrence of peritonitis on follow-up for 2 years.

C. amalonaticus is a gram-negative, oxidase-negative, motile bacillus with peritrichous flagella. Other members of the *Citrobacter* species, such as *C. freundii* and *C. koseri,* are commonly found in water, soil, fish, animals, and food, but a possible environmental reservoir of *C. amalonaticus* is largely unknown, with only one report describing its isolation from catfish (2). *C. amalonaticus* is seldom isolated from humans; previous isolates were reported mainly from feces and occasionally from invasive infections, including enteric fever-like illness, osteomyelitis or arthritis, and polymicrobial abdominal abscesses (3–5). No dialysis-related peritonitis attributable to *C. amalonaticus* has previously been reported.

Citrobacter species are often resistant to first- and second-generation cephalosporins, and so third-generation cephalosporins or broad-spectrum beta-lactams such as carbapenems should be used in suspected *Citrobacter* peritonitis instead of the first-generation cephalosporins commonly used as first-line empiric therapy for dialysis-related peritonitis. Those suggestions accord with the facts in the present case, in which the patient did not initially respond to intraperitoneal cefazolin and tobramycin, but improved dramatically after a switch to ceftazidime and amikacin.

The bacterium probably gained entry to our patient's peritoneum by transmural invasion from the gastrointestinal tract. Common micro-organisms causing dialysis-related peritonitis are those that can enter the abdominal cavity because of contamination during dialysate exchanges, pericatheter access from the exit site, and transluminal spread from the gastrointestinal tract or, less commonly, from a hematogenous source (6). Because *C. amalonaticus* is present in human feces, the gastrointestinal tract is most likely the primary source in our patient, who did not have symptoms of tunnel tract infection or systemic sepsis.

DISCLOSURES

The authors have no conflicts of interest to declare.

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