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Emergence of KPC-2-Producing *Salmonella enterica* Serotype Schwarzengrund in Argentina

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KPC-producing *Klebsiella pneumoniae* isolates were first reported in the United States in 2001 (1), and since then, KPC-producing *Enterobacteriaceae* have been isolated as causes of nosocomial and community-acquired infections in various countries (2, 3). The genetic background facilitates spreading of the bla_{KPC} gene, which is located in transposon Tn*4401* and may then be carried by different transferable plasmids. Several isoforms of Tn*4401* (a, b, c, d, e) have been identified, and plasmids of several incompatibility types have been identified as genetic vehicles of bla_{KPC} in enterobacterial species (4).

In Argentina, bla_{KPC-2} was first described in 2006 in clinical isolates of *K. pneumoniae* and *Citrobacter freundii* (5). Starting in August 2009, there were dramatic increases in the number of bla_{KPC-2}-producing isolates and in the number of hospitals affected, mostly owing to *K. pneumoniae* strains recovered in Buenos Aires City and Province (6). For the first time, we report here the isolation of KPC-2-producing *Salmonella* spp. in Argentina.

Isolate 75.534 was recovered from a catheter urine sample from an 18-year-old man in November 2013, 6 months after he was hospitalized with polytrauma caused by a serious accident. During repeated hospital stays, he received several intravenous courses of antibiotic therapy, including ceftriaxone, ceftazidime, and carbapenems. The patient had no history of travel in Argentina or abroad and was not screened for carbapenemase producer colonization.

The isolate was identified as *Salmonella enterica* using API 20E microbial identification strips (bioMérieux, Marcy l'Etoile, France). Serotyping according to the White-Kauffmann-Le Minor scheme using antisera (Bio-Rad, Marnes-La-Coquette, France) identified serotype Schwarzengrund (antigenic formula 4,12:d:1,7). Multilocus sequence typing (MLST) (7) identified ST96. The antimicrobial susceptibility pattern was established with the disc diffusion method and interpreted as specified by document M100-S24 of the Clinical and Laboratory Standards Institute (CLSI) (http://www.ctmperu.org.pe/anexos/bibliotecavirtual/exposiciones/guia%20CLSI%202014.pdf), except for tigecycline and fosfomycin results, which were interpreted according to the breakpoints proposed by Pasteran et al. (8) (tigecycline, ≥21 or ≤16 mm, and fosfomycin, ≥17 or ≤15 mm, for susceptible or resistant isolates, respectively).

The isolate was highly resistant to β-lactams, including expanded-spectrum cephalosporins (cefotaxime, ceftazidime, cefepime) and aztreonam, and showed low-level resistance to carbapenems, with inhibition zone diameters of 20 mm for imipenem and 19 mm for meropenem. The isolate also displayed low-level resistance to fluoroquinolones but susceptibility to gentamicin, amikacin, chloramphenicol, trimethoprim plus sulfamethoxazole, tigecycline, and fosfomycin. The modified Hodge test (9, 10) suggested carbapenemase production. MICs of β-lactams (including penicillins, expanded-spectrum cephalosporins, aztreonam, and carbapenems), aminoglycosides, ciprofloxacin, and colistin were determined by the Etest method (bioMérieux) (Table 1).

Multiplex PCR screening and sequencing performed as described previously (11) confirmed the presence of bla_{KPC-2}. Using previously published methods (11), β-lactamase genes of the bla_{TEM}, bla_{SHV}, bla_{CTX-M}, and bla_{OXA} types were not found. Using specific primers and sequencing (12), a *qnrB19* gene was detected in the parental strain. These results were similar to those of previous reports which demonstrated that KPC-producing isolates are resistant not only to all β-lactam antibiotics, including carbapenems, but also to some non-β-lactam antibiotics, such as fluoroquinolones (13, 14).

Conjugation experiments were performed with Mueller-Hinton broth (bioMérieux) with the sodium azide-resistant strain *Escherichia coli* J53 as the recipient. Transconjugants were selected on Drigalski agar containing sodium azide (100 μg/ml) and meropenem (2 μg/ml). MICs of carbapenems and ciprofloxacin for the transconjugant were lower than those for the parental strain (Table 1). The presence of bla_{KPC} and *qnrB19* was confirmed by PCR. Plasmid relaxase gene typing performed with the transconjugant revealed an IncL/M plasmid (15). bla_{KPC} genes have been identified on plasmids of various incompatibility types, including IncN, IncF, IncFIIk, and IncL/M, and also on mobilized, small, rolling-circle, replicating plasmids (4). The variety of plasmids encoding KPC genes is likely to contribute to their wide dissemination.

KPC-producing *Salmonella* strains remain extremely rare. Imipenem resistance due to KPC production in this species was first reported in a clinical isolate of *S. enterica* serotype Cubana from human feces in the United States in 1998 (16). Recently, a KPC-producing *S. enterica* serotype Typhimurium strain was identified in the blood culture of a patient in Colombia (17). *S. enterica* serotype Schwarzengrund is one of the causative agents of human salmonellosis and animal infections. This serotype has

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TABLE 1 Antimicrobial susceptibility profiles of the *Salmonella* Schwarzengrund clinical isolate, the recipient *E. coli* J53 strain carrying the conjugative plasmid, and *E. coli* J53

Antibiotic	MIC (μg/ml) for:		
	S. enterica serotype Schwarzengrund 75.534	Recipient *E. coli* J53 (p75.534)	*E. coli* J53
Amoxicillin	>128	>128	4
Amoxicillin-clavulanic acid	128	64	2
Piperacillin	>128	>128	2
Piperacillin-tazobactam	>128	>128	1
Cefoxitin	8	8	2
Cefotaxime	>32	>32	0.064
Ceftazidime	16	16	0.25
Cefepime	8	8	0.064
Aztreonam	64	64	0.064
Imipenem	8	6	0.125
Ertapenem	8	4	0.064
Meropenem	4	2	0.125
Gentamicin	2	2	0.25
Amikacin	1	0.25	0.25
Nalidixic acid	4	2	2
Ciprofloxacin	0.75	0.25	0.015
Colistin	0.25		

already been described as an extended-spectrum β-lactamase producer in Brazilian poultry farms (bla_{CTXM-2}) (18) and in a Japanese clinical sample ($bla_{CTX-M-15}$) (19) but never as a carbapenemase producer. The emergence of KPC-2-producing *Salmonella* spp. in Argentina provides further evidence for dissemination of bla_{KPC} among enterobacterial species. National surveillance and early detection of these isolates are of paramount importance for the implementation of appropriate infection control measures.

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