First Report of Salmonella Isolates with the DHA-1 AmpC β-Lactamase in the United Kingdom

Organisms expressing high levels of AmpC β-lactamases are a major clinical concern, since they are resistant to all β-lactams except for aminocillin, cepfime, cepofime, and carbapenems. Plasmid-borne AmpC β-lactamases are increasingly reported among gram-negative bacteria worldwide. Some species of Enterobacter, Citrobacter, Morganella, and Hafnia produce chromosomal β-lactamases copiously. AmpC enzymes encoded by genes that have escaped from these chromosomal locations are now plasmid encoded in a range of pathogens, including Salmonella (11).

More than 20 different plasmid-borne ampC genes have been identified (10). One of the encoded enzymes, DHA, was first described for Salmonella enterica serovar Enteritidis in Saudi Arabia in 1997 (3). A detailed study demonstrated that blaDHA-1 was located on an integron that originated from Morganella morganii (12). Plasmid-borne blaDHA genes have also been found in Klebsiella pneumoniae in France (2), Taiwan (13), and the United States (1, 7) and in Salmonella enterica serovar Montevideo in Korea (5).

The first reports of AmpC enzymes from humans in the United Kingdom were of blaDHA-1 for Escherichia coli in 1992 (9) and blaCMY-3 for K. pneumoniae in 1995 (4); also, blaDHA-1 was reported for E. coli in 1997 (8). Recently, we have reported the isolation of a blaCMY-2-positive Salmonella enterica serovar Bredeney isolate from an avian source (6). Most plasmid-mediated ampC genes identified up to 1998 in the Mediterranean area belonged to the groups CMY-2 to CMY-4 and LAT-1 to LAT-4, but recently other types, such as FOX-3 and FOX-4, have been reported (11). Globally, the majority of AmpC-like enzymes reported to date for Salmonella have been CMY-2.

During screening for antimicrobial resistance of 246,969 Salmonella isolates from humans in the United Kingdom between 1993 and 2003, we identified 104 isolates with resistance to ampicillin plus at least one of the following cephalosporins: cephalexin, cephradine, cefuroxime, ceftriaxone, and cefodoxime. A AmpC producer phenotype (AmpC enzymes, except ACC-1, DHA-1, and TEM, confer resistance to cephamycins and to amoxicillin/clavulanate; these are currently being investigated. Two of these isolates had different XbaI–pulsed-field gel electrophoresis and plasmid profiles. Isolates A and B carried plasmids of approximately 200 and 205 MDa, respectively.

The blaDHA-1 ampC gene was sequenced, indicating 100% homology with blaDHA-1. The two isolates differed in prophage content and plasmid profiles. Isolates A and B carried plasmids of approximately 98 and 99 MDa, respectively. Transferability of cefotaxime resistance was assessed by conjugation. Isolate A transferred a 98-MDa plasmid (coding cefotaxime resistance) to an E. coli recipient. Attempts to transfer the plasmid from isolate B by conjugation failed. However, it was successfully transferred to ElectroMAX DH10B E. coli cells (Invitrogen) by electroporation. This represents the first report of blaDHA-1 in the United Kingdom and for serotype Senftenberg worldwide.

Laboratories should institute procedures for recognizing AmpC producers in cases where primary screening indicates resistance to expanded-spectrum cephalosporins. In addition, there should be routine surveillance to identify emerging genes which may present a threat to the treatment of invasive pathogens.

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REFERENCES


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