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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 amdinocillin, cefepime, cefpirome, 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 *amp*C 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 $bla_{\text{DHA-1}}$ was located on an integron that originated from *Morganella morganii* (12). Plasmid-borne bla_{DHA} 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 $bla_{\text{BIL-1}}$ for *Escherichia coli* in 1992 (9) and $bla_{\text{CMY-3}}$ for *K. pneumoniae* in 1995 (4); also, $bla_{\text{BIL-1}}$ was reported for *E. coli* in 1997 (8). Recently, we have reported the isolation of a $bla_{\text{CMY-2}}$-positive *Salmonella enterica* serovar Bredeney isolate from an avian source (6). Most plasmid-mediated *amp*C 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 cefotaxime. This panel was subjected to further detailed phenotypic characterization, and 11 isolates presented a suggestive AmpC producer phenotype (AmpC enzymes, except ACC-1, confer resistance to cephamycins and to amoxicillin/clavulanate); these are currently being investigated. Two of these isolates, both of *Salmonella enterica* serotype Senftenberg, originating from patients hospitalized in London in 1996 (isolate A) and 1999 (isolate B), were positive for bla_{DHA} in a multiplex AmpC-PCR (10). Subsequently, the bla_{DHA} amplicon was sequenced, indicating 100% homology with $bla_{\text{DHA-1}}$. The two isolates had different XbaI–pulsed-field gel electrophesis and plasmid profiles. Isolates A and B carried plasmids of approximately 98 and 99 MDa, respectively. Transferability of cefoxitin resistance was assessed by conjugation. Isolate A transferred a 98-MDa plasmid (codifying cefoxitin 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 $bla_{\text{DHA-1}}$ 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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