CNA+ medium did not identify intestinal carriage of ESBL-negative but mcr-1—positive enterobacteria in the index case-patient. On the basis of these results, rectal screening of 39 contacts was performed by using an ESBL-screening medium (BLSE agar [MacConkey agar and Drigalski agar]; bioMérieux). All of the tests showed negative results.

The origin of the mcr-1 strain remains unknown. Nosocomial acquisition cannot be ruled out because colistin-resistant strains harboring the mcr-1 gene might have been isolated in the hospital but not identified because this resistance mechanism was initially reported in February 2016. Food might also be incriminated (I); one study identified a 21% mcr-1 prevalence among ESBL-producing *E. coli* in calves in France (10).

Multiple antimicrobial drug therapy for this patient might have selected for this multidrug-resistant bacteria. The presence of a plasmid containing the mcr-1 and ESBL or other resistance genes in the same strain might be involved in selection of colistin-resistant strains during administration of any ineffective antimicrobial drug (3). Development of efficient tools for rapid detection of mcr-1—harboring strains should be a priority to prevent dissemination of these strains in hospital settings.

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References


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**Chromosomal 16S Ribosomal RNA Methyltransferase RmtE1 in *Escherichia coli* Sequence Type 448**

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We identified *rmtE1*, an uncommon 16S ribosomal methyltransferase gene, in an aminoglycoside- and cephalosporin-resistant *Escherichia coli* sequence type 448 clinical strain co-harboring *bla*<sub>CMY-2</sub>. Long-read sequencing revealed insertion of a 101,257-bp fragment carrying both resistance genes to the chromosome. Our findings underscore *E. coli* sequence type 448 as a potential high-risk multidrug-resistant clone.

RmtE (*RmtE1* and its variant *RmtE2*) is an uncommon plasmid-mediated 16S rRNA methyltransferase (16S RMTase) found in gram-negative bacteria; only 4 strains have been reported to produce RmtE, all *Escherichia coli*, including 1 from the University of Pittsburgh Medical
Center (Pittsburgh, PA, USA) (1–3). We report the genetic context of rmtE (rmtE1) in another E. coli clinical strain identified at this hospital.

E. coli YDC774 was identified in 2016 in the urine of a local elderly man with a history of bladder cancer for which he had undergone transurethral resection of the bladder and completed chemotherapy. He had E. coli urinary tract infection treated with ciprofloxacin 3 months earlier; further details were unavailable. E. coli YDC774 was resistant to cefotaxime, levofloxacin, ciprofloxacin, and trimethoprim/sulfamethaxozole and susceptible to ceftazidime, cefepime, piperacillin/tazobactam, imipenem, meropenem, minocycline, and colistin. The strain was highly resistant to amikacin (MIC >32 µg/mL), gentamicin (MIC >16 µg/mL), and tobramycin (MIC >8 µg/mL). Because the positive culture was believed to represent asymptomatic bacteriuria, the patient was not treated with antimicrobial drugs.

We aimed to elucidate the genetic context of rmtE in E. coli YDC774. Although rmtE has been identified exclusively on plasmids, neither broth conjugation with E. coli J53 nor transformation of E. coli TOP10 with purified plasmids mobilized rmtE, leading us to speculate that the gene might be located on the chromosome. We therefore sequenced the YDC774 genome with PacBio RS II sequencing instrument (Pacific Biosciences, Menlo Park, CA, USA) as described (4). Sequencing with a single SMRT cell yielded 64,878 reads averaging 10,991 bp. De novo assembly generated 8 contigs; the largest was ≈4.3 Mbp, which had ≈122× coverage and was consistent with a large portion of the E. coli chromosome.

E. coli YDC774 belonged to sequence type (ST) 448 by in silico multilocus sequence typing. E. coli ST448 has been reported in recent years among extended-spectrum β-lactamase– and New Delhi–type metallo-β-lactamase–producing strains (5,6). The chromosomal contig contained rmtE (rmtE1 allele), blaCMY-2, aac(3)-Vla, aadA, strA/B, floR, sul1, sul2, tet(A), and dfrA7 as determined by ResFinder (https://cge.cbs.dtu.dk/services/ResFinder/). We identified no resistance genes on the other contigs, including those representing a 96-kb IncY plasmid resembling p12579.1 (GenBank accession no. CP003110.1) in enteropathogenic E. coli strain RM12579 (99% identity over 83% coverage). Several other 16S RMTase genes, such as rmtB, rmtC, and rmtF, have been found on the chromosome of gram-negative bacteria (7,8).

The region surrounding rmtE1 was annotated with Rapid Annotations by using Subsystem Technology server (http://rast.nmpdr.org) and curated manually by using blastn and blastp (http://blast.ncbi.nlm.nih.gov/blast) to elucidate the context of its chromosomal integration. Using E. coli ATCC 25922 as the reference genome, we determined that a 101,257-bp sequence was inserted in an intergenic region between the 4′-phosphopantetheinyl transferase gene and the NAD(P)H nitroreductase gene on the E. coli chromosome.

This inserted sequence can be divided into 2 regions. The first comprises several inserted sequences, such as IS186, ISCR1, and 1 antimicrobial resistance gene, aadA. Downstream of this first region, the inserted fragment is similar to that in pYDC637, an IncA/C plasmid carrying rmtE1 also found at the University of Pittsburgh Medical Center in 2012 (online Technical Appendix Figure, https://wwwnc.cdc.gov/EID/article/23/5/16-2000-Techapp1.pdf) (2). However, the second region comprises 3 small fragments. The first contains aadA1-bx, 4 mobile elements, and several other genes and is in reverse orientation from that of pYDC637. The second small fragment harboring blaCMY-2 is identical to that found in the core region in pYDC637 (online Technical Appendix Figure) and also is in reverse orientation from the corresponding region of pYDC637. The third small fragment harboring rmtE is located in the acquired region of pYDC637. This finding suggests that, on mobilization into the chromosome, gene rearrangements occurred among these fragments. The region between 2 hypothetical proteins appears to have been deleted at or after integration, which includes genes involved in plasmid replication and conjugative transfer (online Technical Appendix Figure).

rmtE1 is bound by an ISCR20-like element and an IS1294-like insertion sequence. This immediate unit is identical to that found in pYDC637. ISCR20 and IS1294 belong to IS91 family, which is considered related to some antimicrobial drug resistance genes, including 16S RMTase genes, which appears to have been the case in the mobilization of rmtE1 as well. We could not identify direct repeats upstream and downstream of the unit that would define the exact boundary of this unit. In comparing the genetic context of rmtE1 and rmtE2, ISCR20-like transposase is located upstream of rmtE1 and rmtE2 (GenBank accession nos. KT428293 and NZ_LRIX01000127). However, the transposase genes located downstream of the 2 16S RMTase genes are distinct. The genetic environment of rmtE2 is identical between the 2 plasmids from China (GenBank accession no. KT428293) and Canada (GenBank accession no. NZ_LRIX01000127).

In summary, we identified chromosomal integration of rmtE1, an unusual 16S RMTase, and blaCMY-2, a commonly observed acquired AmpC β-lactamase, in an E. coli ST448 clinical strain, an event that generated stable co-resistance to aminoglycosides and oxyiminocephalosporins. We found no evidence of further spread of this strain in the hospital. Nonetheless, the findings underscore E. coli ST448 as a potential high-risk multidrug-resistant E. coli clone.
Carbapenem-Resistant Enterobacter cloacae in Patients from the US Veterans Health Administration, 2006–2015

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We analyzed carbapenem-resistant Enterobacteriaceae (CRE) trends among patients from the US Veterans Health Administration (VHA). After the emergence of CRE in the eastern United States, resistance rates remained stable in Klebsiella pneumoniae but increased in Enterobacter cloacae complex, suggesting a “second epidemic.” VHA offers a vantage point for monitoring nationwide CRE trends.

Carbapenem-resistant Enterobacteriaceae (CRE) have become a global public health threat. The epidemic of CRE began in the early 2000s with an outbreak of carbapenem-resistant Klebsiella pneumoniae harboring K. pneumoniae carbapenemase (KPC) in the eastern United States. Since then, KPC-producing K. pneumoniae have emerged in various communities across the country (1). Carbapenem resistance also occurs in other Enterobacteriaceae species and can be mediated by other enzymes, such as OXA-48 and metallo-β-lactamases, especially New Delhi metallo-β-lactamase and Verona integron–encoded metallo-β-lactamase (1). Carbapenem-resistant Escherichia coli occurs infrequently, but recent outbreaks of KPC-producing Enterobacter cloacae raise concerns about the emergence of carbapenem resistance in the E. cloacae complex (1–4).

The Veterans Health Administration (VHA) is the largest integrated healthcare system in the United States. Clinical and microbiologic data for the entire VHA network are accessible through its informatics platforms (5). We used this infrastructure to observe national trends of carbapenem resistance and nonsusceptibility in K. pneumoniae and E. cloacae complex during the past decade.

We identified 224,651 K. pneumoniae and 71,462 E. cloacae complex (E. cloacae, E. asburiae, E. kobei,
Chromosomal 16S Ribosomal RNA Methyltransferase RmtE1 in *Escherichia coli* Sequence Type 448

Technical Appendix

**Technical Appendix Figure.** Comparative analysis of the *rmtE1*-carrying region of the chromosome of *Escherichia coli* YDC774 (GenBank accession number no. MIGD0000000.0) and pYDC637 (GenBank accession no. KP056256) from *E. coli* YDC637. Red arrows indicate antimicrobial resistance genes. Green arrows indicate mobile elements. Gray arrows indicate other genes. ST, sequence type.