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## First NDM-Positive *Salmonella* sp. Strain Identified in the United States<sup>▽</sup>

Antimicrobial resistance among *Enterobacteriaceae* is growing, largely due to  $\beta$ -lactamase production. NDM, carried on the *bla*<sub>NDM</sub> gene, is the latest addition to this bacterial armamentarium and is a worrisome resistance mechanism (9). Increasing resistance to antimicrobials has been reported for *Salmonella* spp., due in part to extended-spectrum  $\beta$ -lactamase (ESBL) and AmpC production, often combined with other resistance mechanisms (4, 7). Carbapenemase production in *Salmonella* spp. has rarely been reported (5), and neither the *bla*<sub>NDM</sub> gene nor any other metallo-beta-lactamase (MBL) in *Salmonella* spp. has been described yet. We report the first case to our knowledge of NDM-producing *Salmonella* spp. likely acquired in India but detected in the United States.

On 25 January 2011, a sixty-year-old American was transferred from India by air ambulance to a hospital in Maryland. The patient was originally hospitalized in late December 2010 with a catastrophic intracranial bleed in India. Less than 24 h after his arrival at the U.S. hospital, he sustained a fever of 38.5°C; urine, blood, and endotracheal secretions were cultured. His sputum grew a carbapenem-resistant *Klebsiella pneumoniae*, positive for carbapenemase production by the modified Hodge test using meropenem (3), and the Etest MBL (AB bioMérieux, Durham, NC) revealed MBL production as per the package insert (1). The organism was susceptible to colistin only (MIC of 0.12  $\mu$ g/liter by broth microdilution) (Table 1) (3) and was sent to both the Maryland Department of Health and Mental Hygiene (MDHMH) and Centers for Disease Control and Prevention (CDC) for confirmation. The *bla*<sub>NDM</sub> gene was identified in the *K. pneumoniae* isolate by real-time PCR at the CDC (<http://www.cdc.gov/HAI/settings/lab/kpc-ndm1-lab-protocol.html>).

On February 12, a perirectal surveillance culture for carbapenem-resistant gastrointestinal isolates grew non-typhoid *Salmonella* spp. positive by the modified Hodge test, with an imipenem/imipenem plus EDTA) ratio of 4/<1 by the Etest MBL. Serotyping at the MDHMH Laboratories Administration identified the isolate as *Salmonella enterica* subsp. *enterica* serovar Senftenberg (2), described as monophasic, with the antigenic formula 3,19:g,s,t:–. The identification was confirmed at the CDC. The CDC also concluded that the strain was *bla*<sub>NDM</sub> positive and only susceptible to tetracycline, tigecycline, and trimethoprim-sulfamethoxazole (Table 1). Others have raised the possibility that plasmids carrying *bla*<sub>NDM</sub> can easily transfer from one species of *Enterobacteriaceae* to another via genetic conjugation (6, 9). That does not appear to have happened in this case, as the *bla*<sub>NDM-1</sub> plasmids carried by *K. pneumoniae* and *Salmonella* Senftenberg had different restriction profiles, as determined at the CDC.

Considering the potential for food-borne spread of *Salmonella* carrying NDM, this finding is worrisome and emphasizes the need for epidemiological studies and scrutiny of antimicrobial susceptibility reports from salmonellosis cases identified in or imported from countries where *Salmonella* is endemic and where NDM is spreading. A recently published study identified numerous NDM-1-positive bacteria, including *Shigella boydii* and *Vibrio cholerae* but not *Salmonella* spp., in water and seepage samples in New Delhi, India (8). Prompt recognition of carbapenem-resistant *Enterobacteriaceae* and initiation of appropriate infection control measures is essential to avoid spread of these organisms. Thus, clinicians should obtain travel history from patients and initiate infection control measures when carbapenem-resistant organisms are identified.

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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TABLE 1. Susceptibility results as reported by the BD-Phoenix instrument (BD Diagnostics, Inc., Sparks, MD) using the NMIC/ID 132 panel on the organisms identified

Antimicrobial <sup>a</sup>	MIC ( $\mu$ g/ml) <sup>b</sup>	
	<i>Klebsiella pneumoniae</i>	<i>Salmonella</i> Senftenberg
Amikacin	>32	>32
Ampicillin	>16	>16
Ampicillin-sulbactam	>16/8	>16/8
Aztreonam	>16	>16
Cefazolin	>16	>16
Cefepime	>16	>16
Cefoxitin	>16	>16
Ceftriaxone	>32	>32
Ciprofloxacin	>2	>2
Colistin	0.12*	ND
Ertapenem	>8	>8
Gentamicin	>8	>8
Imipenem	>8	2
Meropenem	>8	2
Moxifloxacin	>4	>4
Piperacillin-tazobactam	>64/4	>64/4
Tetracycline	8	4
Ticarcillin-clavulanic acid	>64/8	>64/2
Tigecycline	>8	2
Tobramycin	>8	>8
TMP-SMX	>2/38	<0.5/9.5

<sup>a</sup> TMP-SMX, trimethoprim-sulfamethoxazole.

<sup>b</sup> MICs in bold are not reported to clinicians. \*, colistin MIC determined using the broth microdilution method.

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