NDM-1-producing *Klebsiella pneumoniae* in Mauritius

The carbapenemase NDM-1 initially identified in *Escherichia* and *Klebsiella pneumoniae* in Sweden from a patient transferred from India (15) has been now identified in many enterobacterial species and isolates from patients mainly in the UK, India and Pakistan (6), but also from many different countries in Europe, Asia, Africa, and North America (10).

Most of these reports indicated a link with the Indian subcontinent, either corresponding to hospital or community acquisitions. Balkan countries have been also recently considered as an additional reservoir for NDM producers (8).

Here we report a 39-year-old male patient who was admitted at the surgery department of the Victoria hospital, city of Quatre Bornes, Mauritius, in 2009. Urine samples grew a multidrug resistant *K. pneumoniae*, and susceptibility testing performed and interpreted according to the updated CLSI guidelines (3) showed that it was resistant to all ß-lactams including carbapenems, to all aminoglycosides, to fluoroquinolones, nitrofurantoin, chloramphenicol, and trimethoprim-sulfamethoxazole. It was susceptible only to tigecycline and colistin (MICs at 0.5 µg/ml for both). According to phenotypic test results (synergy...
between aztreonam and clavulanate), *K. pneumoniae* CL produced an extended-spectrum β-
lactamase (ESBL). Metallo-β-lactamase (MBL) detection performed by using the Etest
combining imipenem and EDTA (AB bioMérieux, Solna, Sweden) gave a positive result.

MICs of imipenem, ertapenem, doripenem, and meropenem determined by Etest for
*K. pneumoniae* isolate CL were at respectively 4, 12, 3, and 4 µg/ml. According to the CLSI
updated guidelines (3), it could therefore be considered as resistant to those molecules, except
an intermediate susceptibility to doripenem. Unfortunately no information was available on
treatment and outcome of this patient.

PCR, sequencing and plasmid analysis revealed that *K. pneumoniae* CL harbored the
*bla*<sub>NDM-1</sub> carbapenemase gene (9), in addition to the ESBL gene *bla*<sub>CTX-M-15</sub>, both being
located on different plasmids (120 and 160 kb in size, respectively) (13). Screening for
additional β-lactamase genes (13) and for 16S RNA methylase genes as reported (1) showed
that *K. pneumoniae* CL was co-harboring the *bla*<sub>CMY-6</sub>, *bla*<sub>OXA-1</sub>, *bla*<sub>SHV-28</sub> and *bla*<sub>TEM-1</sub> gene (a
total of five β-lactamase genes) and the *rmtC* gene encoding high level resistance to all
aminoglycosides. Mating-out assays performed as described (14) allowed to obtain an *E. coli*
transconjugant expressing NDM-1, exhibiting resistance to all β-lactams, except aztreonam
remaining susceptible and a reduced susceptibility to carbapenems (MICs of 3, 1, 0.75 µg/ml
for imipenem, ertapenem, and meropenem, respectively), but also to all sulfonamides and all
aminoglycosides. This transconjugant harbored a single 120-kb plasmid that was of IncA/C
type as identified by PCR-based replicon typing (2) and that carried the blaCMY-6 and rmtC
genes in addition to blaNDM-1. Interestingly, the exact same resistance determinants had been
identified on an IncA/C-type and 120-kb plasmid from *K. pneumoniae* in Kenya (14),
suggesting that both plasmids could be related.

Multilocus sequence typing was performed as described (4) and results analyzed by
eBURST (http://pubmlst.org). It showed that isolate CL belonged to the ST231 sequence type
that corresponds to the ST type of one NDM-1-positive *K. pneumoniae* isolate recently
identified from India (7), but not to that of the NDM-1-producing *K. pneumoniae* isolates
from Kenya (14). Nevertheless, it does not correspond to the most common ST types
identified from NDM-1-positive *K. pneumoniae*, being ST14, and ST147 (7, 13). It may be
speculated that isolate CL would have a link with India, considering the geographical and
cultural links between the two countries, the Indian diaspora being quite numerous in
Mauritius. Corresponding medical authorities in Mauritius have therefore to be alerted about
the threat of such multidrug resistant strain and should implement adequate measures in order
to control their spread. This study further underlines the occurrence of NDM-1 producers in
countries from the African continent, after the recent identifications made in Kenya (14), Egypt (5) and Morocco (12).

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Laurent Poirel

INSERM U914 “Emerging Resistance to Antibiotics”, Hôpital de Bicêtre, K.-Bicêtre, France

Christine Lascols

International Health Management Associates, Inc., Schaumburg, IL 60173, USA

Sandrine Bernabeu

Patrice Nordmann*

Service de Bactériologie-Virologie, INSERM U914 “Emerging Resistance to Antibiotics”, Hôpital de Bicêtre, Assistance Publique/Hôpitaux de Paris, Faculté de Médecine et Université Paris-Sud, K.-Bicêtre, France

*Corresponding author. Phone: 33-1-45-21-36-32. Fax: 33-1-45-21-63-40.
E-mail: nordmann.patrice@bct.aphp.fr
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