Misidentification of pan drug-resistant Klebsiella pneumoniae clinical isolates as a metallo-β-lactamase producers by the EDTA/DDST test

Dear Editor,

Carbapenemase-producing Enterobacteriaceae may exhibit susceptibility to carbapenems. For this reason with the recent spread of NDM-1 among Enterobacteriaceae, the phenotypic detection of metallo-beta-lactamase (MβL)-producing has been recommended by Brazilian Agency of Sanitary Surveillance (ANVISA).1

In 2013, two pan drug-resistant Klebsiella pneumoniae (KPN1 and KPN2) isolates were recovered from urine (cystostomy) of a 75-year-old male patient hospitalized in a tertiary teaching hospital in Florianópolis, Santa Catarina, Brazil. Both isolates were phenotypically identified as MβL producers by ethylenediamine tetracetic acid (EDTA)/double-disk synergy test (DDST) and forwarded to our laboratory for further characterization. Identification of both isolates as K. pneumoniae was confirmed by MALDI-TOF MS (Bruker Daltonics, Germany), according to the manufacturer’s recommendations. Both isolates showed an identical pattern by ERIC-PCR. The minimal inhibitory concentrations (MICs) for selected antimicrobial agents were determined by broth microdilution according to Clinical and Laboratory Standards Institute – CLSI. The MICs were interpreted according to the CLSI guidelines,2 except for tigecycline, which interpretation was performed according to the European Committee on Antimicrobial Susceptibility Testing – EUCAST. Both isolates were fully resistant to all broad-spectrum cephalosporins, aztreonam, gentamicin, fluoroquinolones, meropenem, ertapenem, and polymyxin B as shown in Table 1. The isolates showed intermediate resistance to imipenem and amikacin. While KPN1 was susceptible to tigecycline, KPN2 became resistant to this agent.

The isolates were also screened for ESβL production by disk approximation and the synergism was observed only when amoxicillin/clavulanic acid disk was tested 15 mm a part of ceftriaxone, ceftazidime and cefepime disks. The phenotypic detection of MβL was carried out by the EDTA/DDST and confirmed by ertapenem hydrolysis assay using MALDI-TOF MS (Bruker Daltonics, Germany) as previously reported.3 Although both isolates showed an increase in the inhibition zone of ceftazidime/EDTA (6 mm) and meropenem/EDTA (7 mm) disks compared to the ceftazidime and meropenem disks, respectively, hydrolysis of ertapenem was not observed, suggesting that both isolates were not MβL producers.

The search for β-lactamase encoding genes was carried out by PCR followed by DNA sequencing of amplicons. Both K. pneumoniae isolates carried blaCTX-M-15, and the narrow spectrum β-lactamases encoding genes, blapsSHV-11, blapsTEM-1 and blapsOXA-1. The presence of the plasmid mediated qnrS1 gene and a mutation Ser83lle in gyrA were also detected, justifying the quinolone resistance exhibited by both KPN isolates. The analysis of the outer membrane proteins profile by SDS–PAGE showed that both isolates lost the major porins OmpK35 and OmpK36. Sequencing analysis of the ompK35 and ompK36 genes revealed the presence of the insertion sequence IS121 between the promoter region and the start codon of the ompK35 gene, and the presence of the IS908 disrupting the ompK36 gene. These results corroborated with the absence of the major porins on the SDS–PAGE gels, since the presence of the IS resulted in non-functional OmpK35 and OmpK36 porins.

The misidentification of two pan-resistant K. pneumoniae isolates as MβL producers by the EDTA/DDST is in agreement with previous study that reported false-positive results when EDTA was employed for identification of the MβL production.4 This may result from the bactericidal effect of EDTA which acts increasing the membrane permeability.5 Based on that, a disk contained only 100 mM of EDTA was also tested in the present study, confirming their bactericidal effect, since considerable inhibition diameter zones of 18 mm for KPN1 and 16 mm for KPN2 were observed.

This study reported a misidentification of MβL producers by EDTA/DDST in K. pneumoniae clinical isolates, as recommended by ANVISA.1 The pan-resistant phenotype observed between the two K. pneumoniae strains isolated in our territory is worrisome, since very few therapeutic options are
### Table 1 – Antimicrobial susceptibility profile and resistant determinants among the *K. pneumoniae* isolates misidentified as MβL producers by EDTA/DDST.

<table>
<thead>
<tr>
<th>Isolate</th>
<th>MALDI-TOF MS ID</th>
<th>CEP</th>
<th>CAZ</th>
<th>CTX</th>
<th>FEP</th>
<th>AZT</th>
<th>IPM</th>
<th>MEM</th>
<th>ETP</th>
<th>AK</th>
<th>GEN</th>
<th>LEV</th>
<th>CIP</th>
<th>TGC</th>
<th>PO</th>
</tr>
</thead>
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<table>
<thead>
<tr>
<th>Isolate</th>
<th>MALDI-TOF MS ID</th>
<th>Diameter variation with EDTA (mm)</th>
<th>Porin lesion type&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Resistant determinants</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPN 1</td>
<td><em>K. pneumoniae</em></td>
<td>7</td>
<td>6</td>
<td>IS&lt;sub&gt;1&lt;/sub&gt;(−)</td>
</tr>
<tr>
<td>KPN 2</td>
<td><em>K. pneumoniae</em></td>
<td>7</td>
<td>6</td>
<td>IS&lt;sub&gt;1&lt;/sub&gt;(−)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Abbreviations: CEP, cephalotin; CAZ, ceftazidime; CTX, cefotaxime; FEP, cefepime; IPM, imipenem; MEM, meropenem; ETP, ertapenem; AK, amikacin; GEN, gentamicin; LEV, levofloxacin; CIP, ciprofloxacin; TGC, tigecyclin; PO, polymyxin B.

<sup>b</sup> Porin lesion type: + and − indicate the position upstream and downstream of start codon; numbers between parentheses correspond the nucleotide insertion position; IS<sub>n</sub>, indicate the mutation in the promoter region and presence of insertion sequences, respectively.
clinically available for treating such infections. Probably, the isolates also possess other resistance mechanisms that had contributed to their multi-drug resistant profile. The chelating agents such as EDTA can increase the outer membrane permeability, facilitating the entry of antibiotics. Based on that, disk contained only 100 mM of EDTA should be used additionally, to confirm their bactericidal effect; therefore attention should be taken by the routine laboratories to avoid the report of false positive results.

Conflicts of interest

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