Brief communication

Emergence of Klebsiella pneumoniae-producing KPC-2 carbapenemase in Paraíba, Northeastern Brazil

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ABSTRACT

The emergence of KPC-2 producing K. pneumoniae in hospitalized patients at the intensive care unit (ICU) of a teaching hospital located in the city of João Pessoa, Paraíba, Brazil, is reported. Seven carbapenem-resistant K. pneumoniae recovered from different body sites of infection were analyzed. Most isolates showed a multidrug-resistance phenotype. Genotypic analysis demonstrated the presence of two genotypes, with the predominance of genotype A, which belongs to ST 437. These isolates also carry the encoding genes of five other beta-lactamases.

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Table 1 – Clinical features of the patients who had *K. pneumoniae* KPC-2-producing isolates at Hospital University Lauro Wanderley, João Pessoa, Paraíba, Brazil.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Isolate</th>
<th>PFGE pattern</th>
<th>ST</th>
<th>Gender</th>
<th>Age (y)</th>
<th>Underlying disease</th>
<th>Primary infection</th>
<th>Treatment</th>
<th>Antimicrobial resistant</th>
<th>MIC carbapenems (CLSI 2010)*</th>
<th>Bacteria isolation (day/mo/yr)</th>
<th>Beta-lactamases</th>
<th>ICU admission (day/mo/yr)</th>
<th>Death (day/mo/yr)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>335</td>
<td>A1</td>
<td>437</td>
<td>F</td>
<td>52</td>
<td>Bowel cancer</td>
<td>Blood-stream</td>
<td>CS, MEM, AMG</td>
<td>ERT, CAZ, CRO, CFO, CIP, ATM</td>
<td>1 (S) 1 (S)</td>
<td>20/02/2010</td>
<td>KPC-2; TEM-1; OXA-1; CTX-M-15; SHV-11</td>
<td>19/02/2010</td>
<td>22/02/2010</td>
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</tr>
<tr>
<td>3</td>
<td>337</td>
<td>B1</td>
<td>70</td>
<td>F</td>
<td>29</td>
<td>HIV</td>
<td>Blood-stream</td>
<td>CS, MEM, AMG, FUN</td>
<td>ERT, CAZ, CRO, CIP, ATM</td>
<td>2 (I) 1 (S)</td>
<td>13/02/2009</td>
<td>KPC-2; SHV-27</td>
<td>21/02/2009</td>
<td>16/03/2009</td>
</tr>
<tr>
<td>5</td>
<td>341</td>
<td>A1</td>
<td>437</td>
<td>F</td>
<td>52</td>
<td>Post gastrectomy</td>
<td>Wound</td>
<td>MEM</td>
<td>ERT, CAZ, CRO, CIP, ATM</td>
<td>4 (R) 1 (S)</td>
<td>17/08/2009</td>
<td>KPC-2; TEM-1; OXA-1; CTX-M-15; SHV-11</td>
<td>12/08/2009</td>
<td>18/08/2009</td>
</tr>
</tbody>
</table>

AMG, aminoglycosides; ATM, aztreonam; CAZ, ceftazidime; CFO, cefoxitin; CIP, ciprofloxacin; CLI, clindamycin; CRO, ceftriaxone; CS, 3th and 4th cephalosporins; ERT, ertapenem; F, female; FUN, antifungal; HIV, human immunodeficiency virus infection; I, susceptibility reduced; ICU, intensive care unit; IMI, imipenem; M, male; MEM, meropenem; R, resistant; S, susceptible; ST, sequence type; VAN, vancomycin.

* MICs were determined by agar dilution.
imipenem, meropenem, and piperacillin/tazobactam. Minimum inhibitory concentrations (MICs) for tigecycline and polymyxin B were determined by Etest (bioMérieux – Marcy l’Étôile, France) and interpreted according to the European Committee on Antimicrobial Susceptibility Testing’s (EUCAST) guidelines. The Modified Hodge Test (MHT) with ertapenem disk (10 μg) was used for phenotypic detection of carbapenemase activity. 

Specific primers were used under standard polymerase chain reaction (PCR) conditions to detect the genes \( \text{bla}_{\text{KPC}}, \text{bla}_{\text{GES}}, \text{bla}_{\text{CTX-M}}, \text{bla}_{\text{SHV}}, \text{bla}_{\text{TEM}}, \text{bla}_{\text{OXA-1}}, \text{bla}_{\text{OXA-2}}, \text{bla}_{\text{OXA-10}}, \text{bla}_{\text{OXA-18/45}}, \) and \( \text{bla}_{\text{OXA-161}} \), followed by DNA sequencing (ABI sequencer - Applied Biosystems, Foster City, CA). Clonal relatedness among isolates was examined by pulsed field gel electrophoresis (PFGE) using SpeI (New England, Beverly, MA). The band patterns were analyzed by visual interpretation, applying the criteria established by Tenover et al. In addition, the PFGE patterns were analyzed using Bionumerics version 5.10 (Applied Maths, Sint-Martens – Latem, Belgium) for comparison with other KPC-2-producing strains previously identified in Brazil. Multilocus sequence typing (MLST) of \( \text{K. pneumoniae} \) was performed as described previously. Experimentally determined DNA sequences were uploaded into the MLST database (http://www.pasteur.fr/recherche/genopole/PF8/mlst/Kpneumoniae.html), and allelic numbers and sequence types (ST) were obtained.

\( \text{K. pneumoniae} \) isolates were more frequently collected from bloodstream infections (n = 4; 57.1%) (Table 1). Amikacin, polymyxin B, and tigecycline showed the highest susceptibility rates (100%) against the isolates studied, followed by meropenem (57.1%), imipenem (14.3%), and cefepime (14.3%). In contrast, 100% of the isolates were resistant to ertapenem, cetfrixzone, and aztreonam. Resistance to ceftazidime, cefoxitin, and ciprofloxacin was observed in six isolates (87.5%). All isolates showed positive MHT results and were found to carry the \( \text{bla}_{\text{KPC-2}} \) gene. Two PFGE patterns, A and B, were found among the seven KPC-KPN; the genotype A was the most frequent (n = 5; 71.3%). Besides the presence of \( \text{bla}_{\text{KPC-2}} \), genotype A (ST 437) isolates also carried \( \text{bla}_{\text{TEM-1}}, \text{bla}_{\text{OXA-1}}, \text{bla}_{\text{CTX-M-15}}, \) and \( \text{bla}_{\text{SHV-15}} \), while genotype B (ST 70) carried only \( \text{bla}_{\text{GIV-27}} \). Using the dendrogram, a similarity of nearly 79.3% was detected between genotype A and B. The similarity of the KPC-producing isolates evaluated in this study compared to those previously isolated in Recife was 74.5%.

For the first time, \( \text{K. pneumoniae} \) isolates resistant to ertapenem were detected in the Hospital Lauro Wanderley, which were further confirmed as KPC producers. Among the isolates studied, one (335) showed susceptibility to meropenem and imipenem, whereas three isolates (337, 339, and 341) were only susceptible to meropenem, according to the CLSI breakpoints. The discrepancy observed in the susceptible categories to carbapenems may be attributed to production of carbapenemases like KPC. The co-production of KPC with other beta-lactamases, such as TEM-1, OXA-1, SHV-11, SHV-27 and CTX-M-15, was observed among KPC-KPN isolates. These findings are in agreement with previous Brazilian reports which showed that KPC-KPN isolates also possessed the \( \text{bla}_{\text{CTX-M}}, \text{bla}_{\text{TEM}}, \) and \( \text{bla}_{\text{SHV}} \) genes. Although CTX-M-2 is a widespread variant in South America, the isolates evaluated carried \( \text{bla}_{\text{CTX-M-15}} \), a frequently found worldwide CTX-M-type. Additionally, according to the authors’ knowledge, this is the first description of co-production of KPC-2 and OXA-1 in Brazilian isolates. ST 437, the most prevalent among the KPC-KPN evaluated, is a ST related to the clonal complex 258, which is widely disseminated among KPC-KPN in Brazil, and associated with the dissemination of KPC worldwide.

Since the therapeutic options are limited and the appropriate empirical antimicrobial treatment is of crucial importance to patient outcome, we suggest that the clinical laboratory perform accurate susceptibility testing for KPC producers, including the determination of MICs for tigecycline, aminoglycosides, polymyxins, and carbapenems, since KPC-KPN isolates with low carbapenems MICs and/or isolates with discrepancy for susceptible category among carbapenems tested were observed. In addition, regional surveillance studies that monitor the dissemination of ESBL and carbapenemase enzymes are crucial, since most of these genes are located on mobile genetic elements, which are easily transferred to other bacteria species. Because four of the five isolates were clonally related, suggesting a patient-to-patient transmission, implementation of infection control measures is necessary to restrain the dissemination of resistant genes.

Conflict of interest

All authors declare to have no conflict of interest.

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REFERENCES