

## Severe conflict-associated wound infections complicated by the discovery of carbapenemase-coproducing *Pseudomonas aeruginosa* in Ukraine

We commend the report by Dennis Nurjadi and colleagues in *Lancet Microbe* of highly unusual findings of *Pseudomonas aeruginosa* coproducing *Klebsiella pneumoniae* carbapenemase (KPC) and New Delhi metallo- $\beta$ -lactamase (NDM) enzymes from a patient in Viet Nam.<sup>1</sup> The authors rightly highlight concerns about the shifting evolution of carbapenem-resistant *P. aeruginosa* in southeast Asia, and we strongly agree with the need for enhanced molecular and genomic surveillance of this development.<sup>1</sup>

Our work supporting Ukrainian bacterial surveillance activity in the ongoing conflict raises grave concerns about the widespread distribution of KPC-producing *P. aeruginosa*, NDM-producing *P. aeruginosa*, or both. Among patients with conflict-associated wound infections, we identified 12 patients with multidrug-resistant *P. aeruginosa* infection across three different Ukrainian healthcare sites. Eight of the 12 patients were infected with *P. aeruginosa* producing metallo- $\beta$ -lactamases, including infections involving *P. aeruginosa* coproducing KPC and NDM (one of eight), producing NDM only (four of eight), coproducing NDM and OXA-48-type carbapenemases (one of eight), coproducing NDM and an imipenemase-type metallo- $\beta$ -lactamase (one of eight), and producing an imipenemase-type metallo- $\beta$ -lactamase (one of eight).

The metallo- $\beta$ -lactamases were detected using a novel 90+-target carbapenem-resistant Enterobacteriaceae (CRE) reference panel (AusDiagnostics). However, such assays require elaborate

laboratory infrastructure, which could hinder their routine deployment in low-resource settings. Therefore, positive samples were repeated on the NG-test Carba-5 lateral flow immunoassay (Una Health) to confirm the initial findings. The NG-test Carba-5 immunoassay is a simple device for the rapid identification and differentiation of the five most prevalent carbapenemase families and offers a practical option for large-scale testing in more resource-challenged environments.

According to the European Committee on Antimicrobial Susceptibility Testing breakpoint guidelines,<sup>2</sup> all eight isolates were resistant to first-line antibiotics, one was susceptible to gentamicin, and seven were resistant to ceftazidime-avibactam. Similar to the findings of Nurjadi and colleagues, all samples were susceptible to colistin.<sup>3</sup> In contrast, seven of the eight samples were also susceptible to cefiderocol according to microbroth dilution, thus indicating variations in NDM expression or phenotypic resistance conferred by different NDM types.<sup>3</sup> Recently, aztreonam-avibactam has become available, with particular emphasis on its activity against metallo- $\beta$ -lactamase-producing bacteria.<sup>4</sup> Given these unusual findings, the understanding of the potential of aztreonam-avibactam in cases of infections caused by *Pseudomonas* species is quite poor. Regarding its unavailability, using ceftazidime-avibactam in combination with aztreonam could offer a viable treatment option in the short term.<sup>5</sup>

Our findings not only support the potential evolution of carbapenemase-producing *P. aeruginosa* but also strongly suggest its distribution beyond southeast Asia. Identification of these organisms in multiple patients with infection of severe bone and soft-tissue injuries is particularly concerning. Enhancing the capacity for global surveillance of carbapenemase-producing Gram-negative organisms is paramount and will most likely require suitably efficient options for use in resource-limited settings.

LSPM has consulted for or received speaker fees from bioMérieux (2013–24), Eumedica (2016–24), Pfizer (2018–24), Sumitovant (2021–23), Shionogi (2021–24), Qiagen (2023), Gilead Sciences (2024), BioNTech (2024), and Insmed (2024); and received research grants from the National Institute for Health and Care Research (2013–24), CW+ Charity (2018–24), North West London Pathology (2022–24), LifeArc (2020–22), Shionogi (2024), InfectoPharm (2022–24), the Joint Programming Initiative on Antimicrobial Resistance (2023–24), and the Healthcare Infection Society (2024). SJCP has received grants from the John Muir Trust, Drummond Foundation, and Hospital Infection Society, but not in connection with this work. SJCP has a role as a British Society for Antimicrobial Chemotherapy Parliamentary Intern to the Office of Dr Danny Chambers MP. Funding for this work was provided by the Chelsea Infectious Diseases Research Group, a part of the CW+ Charity. SJCP, MKO, LSPM, and OM devised the study. OM conducted the initial antimicrobial susceptibility testing in Ukraine and prepared samples for transport. SJCP and AM conducted testing in the UK. SJCP, LSPM, and OM drafted the initial manuscript. All authors contributed to revisions of the manuscript and agreed on the final version for submission. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication. This work is supported by a collaboration between Chelsea and Westminster Hospital, London, UK, and the Institute of Molecular Biology and Genetics of the National Academy of Sciences, Kyiv, Ukraine. The authors recognise the support of biomedical scientists at both the locations, including Viktoria Potochilova and Kateryna Rudnieva, who helped to identify and prepare suitable isolates in Ukraine for further testing; and Zoe Lambert and Vincent Sgro, who provided testing support within the UK.

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\**Scott J C Pallett, Anna Morkowska, Stephen D Woolley, Matthew K O'Shea, Luke S P Moore, Olena Moshynets*  
scott.pallett@nhs.net

Clinical Infection Department, Chelsea and Westminster Hospital National Health Service Foundation Trust, London, UK (SJCP, LSPM); Centre of Defence Pathology (SJCP, SDW, MKO) and Academic Department of Military Medicine (SDW, MKO), Royal Centre for Defence Medicine, Queen Elizabeth Hospital Birmingham, Birmingham B15 2WB, UK; North West London Pathology, Charing Cross Hospital, London, UK (AM); Department of Clinical Sciences, Liverpool School of Tropical Medicine, Liverpool, Merseyside, UK (SDW); Institute of Immunology and Immunotherapy, College of Medical and Dental Sciences, University of Birmingham, Birmingham, UK (MKO); National Institute for Health Research Imperial Biomedical Research Centre, Imperial College London, Hammersmith Campus, London, UK (LSPM); Institute of Molecular Biology and Genetics of National Academy of Sciences of Ukraine, Kyiv, Ukraine (OM)



Lancet Microbe 2024

Published Online  
<https://doi.org/10.1016/j.lanmic.2024.101046>

See [Comment](https://doi.org/10.1016/j.lanmic.2024.100958) <https://doi.org/10.1016/j.lanmic.2024.100958>

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