



## Short report

# Screening for carbapenemase-producing Enterobacteriaceae in previous carriers readmitted to hospital: evaluation of a change in screening policy

A. Tucker<sup>a,\*</sup>, R. George<sup>b</sup>, W. Welfare<sup>a</sup>, P. Cleary<sup>c</sup>, J. Cawthorne<sup>b</sup>, A. Dodgson<sup>b</sup>

<sup>a</sup> Public Health England North West, Manchester, UK

<sup>b</sup> Manchester University NHS Foundation Trust, Manchester, UK

<sup>c</sup> Field Service North West, Liverpool, UK

## ARTICLE INFO

*Article history:*

Received 15 February 2019

Accepted 23 April 2019

Available online 27 April 2019

*Keywords:*

Carbapenem-resistant  
Enterobacteriaceae  
Carbapenemase-producing  
Screening  
Hospitals  
Evaluation



## SUMMARY

Carbapenemase-producing Enterobacteriaceae (CPE) are a growing problem in UK hospitals. Preventing transmission requires early detection. This study evaluates a new screening policy for patients with a history of blaKPC-associated CPE (KPC-CPE) in a higher incidence hospital. Previous policy assumed 'once positive always positive'. New policy uses rapid screening and risk assessment. Results show that most (76.5%) patients with a history of KPC-CPE do not have detectable KPC-CPE on readmission or during their subsequent hospital stay but that repeat screening after an initial negative result is required. The new policy takes a risk-based approach while prioritizing isolation facilities in a higher incidence trust.

© 2019 Published by Elsevier Ltd on behalf of The Healthcare Infection Society.

## Introduction

Enterobacteriaceae are a frequent cause of hospital-acquired infection. Carbapenemase-producing Enterobacteriaceae (CPE) infections are challenging to treat and therefore effective infection control strategies are important [1].

\* Corresponding author. Address: Public Health England, Cumbria and Lancashire Health Protection Team, County Hall, Preston PR1 8XB, UK. Tel.: +44 (2)0344 225 0562.

E-mail address: [angela.tucker@phe.gov.uk](mailto:angela.tucker@phe.gov.uk) (A. Tucker).

<https://doi.org/10.1016/j.jhin.2019.04.012>

0195-6701/© 2019 Published by Elsevier Ltd on behalf of The Healthcare Infection Society.

In England, detections of CPE have risen significantly over the last decade [2]. Numbers in Greater Manchester are considerably higher than elsewhere in England [3]. Parts of Manchester University NHS Foundation Trust (MFT), one of the largest hospital trusts in North West England, have experienced an ongoing multi-species blaKPC-associated CPE outbreak since 2009, with *Klebsiella pneumoniae* the most frequently isolated organism [4]. Intensive local infection prevention and control (IPC) measures, in line with national and international recommendations, have been implemented in response [5,6].

Until April 2016, MFT policy assumed that all patients admitted with a documented history of KPC-CPE colonization remained positive and therefore required isolation. This was a

precautionary measure owing to uncertainties regarding the natural history of CPE carriage [7]. This created significant demand on limited isolation capacity and impacted patient flow.

From April 2016, MFT piloted a new KPC-CPE screening policy at Manchester Royal Infirmary, a large general acute hospital within MFT. Under the new policy, all patients previously identified as KPC-CPE positive are admitted to a side room on readmission on the receiving ward and offered screening for CPE using Cepheid Xpert Carba-R rapid screening test, a highly sensitive and reliable molecular method for detecting the presence of carbapenemase genes [8]. All samples found to be PCR positive for a carbapenemase gene are subsequently cultured on chromogenic media and any suspect colonies identified and susceptibility tested [9]. Patients with an initial positive screen for KPC-CPE, and those who refuse screening, are admitted to an isolation room or CPE cohort ward for the duration of their inpatient stay. Patients with an initial negative screen are classified as 'CPE not detected' and a risk assessment is undertaken to establish the presence of factors that may increase the risk of transmission such as diarrhoea, incontinence, confusion, or non-compliance with screening requirements. If low risk, the patient may be transferred to a general ward where they are monitored by a dedicated member of the IPC team who repeats the screening test and the risk assessment every 72 h. Dependent on the outcome of the initial or subsequent risk assessments, additional infection control measures may be implemented such as nursing in a side-room on a general ward or transfer to a CPE cohort ward.

Patients colonized with non-blakKPC carbapenemases are managed outside of this policy. They are not re-screened on admission and are nursed in a side-room for the duration of their inpatient stay.

This study aimed to evaluate the outcomes of this new KPC-CPE screening policy in a large general acute hospital with a high incidence of CPE.

## Methods

Patients with previously detected CPE at MFT are flagged on the patient administration system for bed management purposes. Data on all adult patient admissions to MFT between April 1<sup>st</sup>, 2016 and August 15<sup>th</sup>, 2017 with a KPC-CPE flag

(indicating a previous CPE detection) were extracted from the hospital patient administration system and linked with the laboratory information management system containing all CPE-positive laboratory results for the same period. The analysis included all admissions during the period for patients who had been identified as KPC-CPE positive on a previous admission and who, when readmitted, had been rescreened as part of the KPC-CPE screening policy pilot. Patients with a history of CPE other than KPC, and admissions to areas of the trust not included in the screening policy pilot, were excluded from the analysis.

We performed a descriptive analysis to assess:

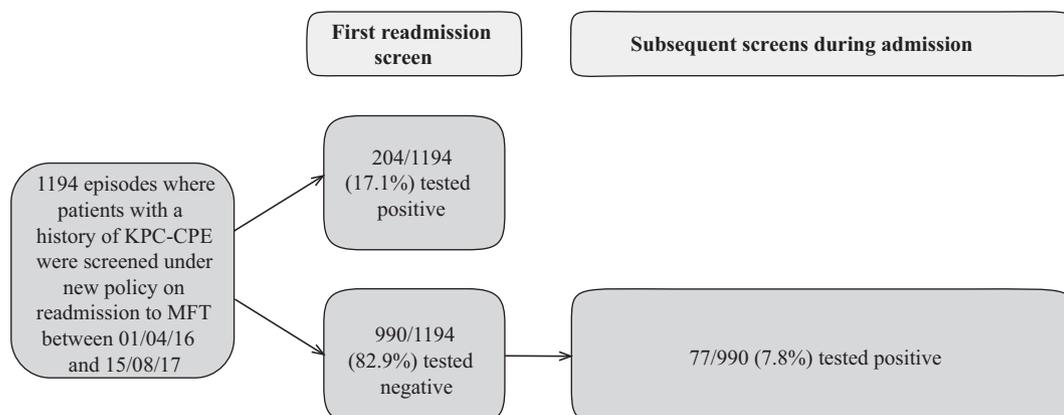
- (1) the proportion of readmission episodes where the patient tested positive on the initial readmission screen;
- (2) the proportion of readmission episodes where the patient converted from 'CPE not detected' to positive during the admission;
- (3) the proportion of readmission episodes where the patient had any KPC-CPE detection during the admission;
- (4) the number of screens conducted before testing positive in episodes where the patient had a subsequent positive screen during admission.

Individual participant consent and research ethics committee approval was not required as this study used routinely collected hospital admission and laboratory data for a service evaluation. Data were anonymized prior to analysis.

## Results

During the study period, there were 1194 readmission episodes (607 patients) where patients previously positive for KPC-CPE were readmitted to the trust and screened under the new KPC-CPE screening policy. Of the 607 patients, 273 (45%) had multiple readmissions during the study period (median: 1; range: 1–13).

Patients tested positive for KPC-CPE on their first readmission screen in only 204/1194 (17.1%) readmission episodes (Figure 1). Of the 990 readmission episodes where the patient had no detectable KPC-CPE on the initial readmission screen, 77 (7.8%) had a detectable level of KPC-CPE on a subsequent screen during the admission (Figure 1).



**Figure 1.** blaKPC-associated carbapenemase-producing Enterobacteriaceae (KPC-CPE) screening outcomes for previously positive patients who were readmitted to Manchester University NHS Foundation Trust (MFT) between April 1<sup>st</sup>, 2016 and August 15<sup>th</sup>, 2017.

Overall, there were 281/1194 (23.5%) readmissions where the patient had detectable KPC-CPE at some point during admission: 204/1194 (17.1%) had detectable KPC-CPE on initial readmission screen and 77/1194 (6.4%) on subsequent screens during admission.

For those readmissions in which the patient had detectable KPC-CPE during admission, 204/281 (72.6%) were positive on the initial readmission screen, 27/281 (9.6%) were positive on the second screen (72 h), and 18/281 (6.4%) were positive on the third screen (six days). Thirty-two (11.4%) were detected after four or more screens (Figure 2). Of readmissions with detectable KPC-CPE during the admission, 249/281 (88.6%) were detected within three screens.

## Discussion

In most (83%) readmissions the patient did not have detectable KPC-CPE on initial screening. Only 7.8% of readmissions with no detectable KPC-CPE on initial screening had KPC-CPE detected on subsequent screens during the admission. Most readmissions (76.5%) with a previous history of KPC-CPE did not have detectable KPC-CPE at any point during the admission. For those with detectable KPC-CPE at any time during the admission, most (89%) were detected within three screens.

The large proportion of readmissions that had no detectable KPC-CPE on readmission, combined with the finding that only a small proportion of these subsequently had a detectable level during admission, supports the decision to adopt the new screening policy at MFT. Under the new policy, many patients who would previously have been placed in isolation or nursed on a CPE cohort ward are now managed within the general ward environment. This allows isolation and cohort facilities, which are used for both CPE and other requirements, to be appropriately prioritized. In addition, rapid turnaround times for the

PCR screening test facilitate efficient bed management and improved patient flow.

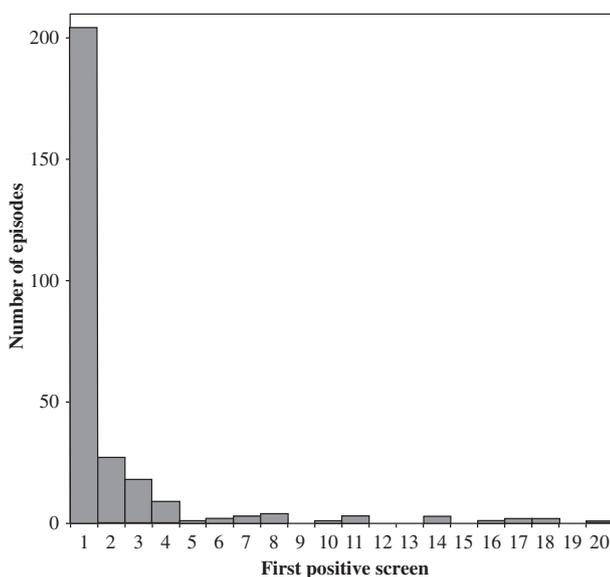
There are, however, potential risks from the change in policy. Some (7.8%) readmissions with no detectable KPC-CPE on initial screening subsequently tested positive during their admission. Nursing these patients on a general ward without follow-up or subsequent screening may therefore pose a risk of onward transmission to other patients. However, it is reassuring that this proportion is small, and the frequent rescreening and risk assessment of these patients allows timely detection of patients reverting to positive and implementation of appropriate control measures to reduce the risk of onward transmission. In addition, 89% of readmissions with detectable KPC-CPE at some time during admission were detected within three screens. The potential value of serial screens found here is in contrast to the lack of benefit of three serial culture-based screens identified in a recent study in all admissions in a low prevalence trust in London [10]. The different findings may be in part due to the molecular testing used in MFT which is likely to increase the sensitivity of the serial screens and to the higher risk population assessed at MFT (admissions with a previous history of CPE).

This was a pragmatic service evaluation using routine data. The strength of the evaluation is the large number of patients with a history of KPC-CPE screened on readmission. There are several limitations. First, from the available data we were unable to determine the reason why patients had no detectable KPC-CPE on admission. Potential explanations include: they were no longer carrying KPC-CPE, they had low level undetectable carriage, or a poor quality screening sample was taken, although implementation of quality control based on visible faecal matter on swabs should have reduced the risk of the latter [9]. Second, we were unable to distinguish between continued colonization from an endogenous source and new colonization in patients who initially tested negative and subsequently tested positive during admission. It is possible that some patients acquired KPC-CPE following admission. Finally, we were unable to quantify how many patients discharged shortly after their initial negative screening test would have subsequently tested positive had they undergone further screening.

This evaluation suggests that for most readmissions with a history of KPC-CPE the risk of onward transmission is likely to be small, but that there is a need to screen regularly after an initial negative result. This screening policy provides a pragmatic and risk-based approach to patients with previous KPC-CPE carriage and enables the trust to prioritize the limited isolation facilities. Though additional isolation facilities are desirable in almost all healthcare facilities, the change in policy allows a more appropriate use of existing isolation facilities mitigating the difficulties of changing the current infrastructure. A more detailed analysis is planned with a focus on assessing the impact of the new policy on transmission of KPC-CPE in the hospital and determining the risk factors associated with reversion to a detectable level of KPC-CPE during admission. Results of further studies will be used to inform national, risk factor-based screening policies.

## Acknowledgements

We thank and acknowledge the work of the Infection Prevention and Control Team and clinical staff at MFT; the laboratory staff at Manchester Medical Microbiology Partnership;



**Figure 2.** Number of screens to first positive result in readmissions where the patient tested positive for blaKPC-associated carbapenemase-producing Enterobacteriaceae during admission ( $N = 281$ ).

V. Decraene and V. Watts at Public Health England Field Service North West; and R. Puleston and B. Patel at Public Health England National Infection Service.

#### Conflict of interest statement

None declared.

#### Funding sources

None.

#### References

- [1] Munoz-Price LS, Poirel L, Bonomo RA, Schwaber MJ, Daikos GL, Cormican M, et al. Clinical epidemiology of the global expansion of *Klebsiella pneumoniae* carbapenemases. *Lancet Infect Dis* 2013;13:785–96.
- [2] Public Health England. Carbapenemase-producing Enterobacteriaceae: laboratory confirmed cases, 2003 to 2015. London: PHE; n.d.
- [3] Donker T, Henderson KL, Hopkins KL, Dodgson AR, Thomas S, Crook DW, et al. The relative importance of large problems far away versus small problems closer to home: insights into limiting the spread of antimicrobial resistance in England. *BMC Med* 2017;15:86.
- [4] Poole K, George R, Decraene V, Shankar K, Cawthorne J, Savage N, et al. Active case finding for carbapenemase-producing Enterobacteriaceae in a teaching hospital: prevalence and risk factors for colonization. *J Hosp Infect* 2016;94:125–9.
- [5] Public Health England. Acute trust toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae. London: PHE; 2013.
- [6] European Centre for Disease Prevention and Control. Rapid risk assessment: carbapenem-resistant Enterobacteriaceae. Stockholm: ECDC; 2016.
- [7] Lim YJ, Park HY, Lee JY, Kwak SH, Kim MN, Sung H, et al. Clearance of carbapenemase-producing Enterobacteriaceae (CPE) carriage: a comparative study of NDM-1 and KPC CPE. *Clin Microbiol Infect* 2018;24:1104. e5–8.
- [8] Kost K, Yi J, Rogers B, Jerris R. Comparison of clinical methods for detecting carbapenem-resistant Enterobacteriaceae. *Pract Lab Med* 2017;8:18–25.
- [9] Shorten RJ, Ashcroft P, Dodgson AR. Rectal swab screening for the detection of carriage of carbapenemase-producing Enterobacteriaceae. *J Hosp Infect* 2016;94:131–2.
- [10] Mookerjee S, Dyakova E, Davies F, Bamford K, Brannigan ET, Holmes A, et al. Evaluating the benefit of serial screening cultures to detect carbapenemase-producing Enterobacteriaceae (CPE) following hospital admission. *J Hosp Infect* 2018;100:15–20.