UK Health Security Agency

Framework of actions to contain carbapenemase-producing Enterobacterales

September 2022

Contents

Executive summary

This framework focuses on carbapenemase-producing Enterobacterales (CPE); these organisms spread rapidly in healthcare settings and lead to poor clinical outcomes because of limited therapeutic options. The increased incidence of CPE has significant cost and operational implications for healthcare providers.

Unless action is taken and we learn from experiences elsewhere in the world, rapid spread of CPE will pose an ever increasing threat to public health and medical treatment pathways in the UK.

The framework sets out a range of measures, that if implemented well, will help health and social care providers minimise the impact of CPE. These include:

- active patient admission screening of risk groups
- rapid detection of patients colonised or infected with CPE, with appropriate surveillance systems to enable ongoing monitoring
- consistent implementation of infection prevention and control practices and contact precautions
- minimisation of CPE reservoirs by effective environmental cleaning and decontamination
- antimicrobial stewardship programmes to minimise inappropriate use of broad-spectrum antibiotics, including carbapenems
- optimised laboratory methods to detect carbapenemase-producing Gram-negative bacteria, including Enterobacterales
- prompt recognition of outbreaks to enable effective management
- organisational ownership to support the implementation of this framework

We recognise that the evidence base for some recommendations is limited and that local risk assessment is important for building a CPE policy relevant to the local situation that can be implemented based on the Framework.

Where there is an evidence base we have referred to this explicitly, other recommendations are based on expert guidance or opinion.

Key recommendations

Based on this developing evidence base there are 8 areas with core recommendations that all settings should introduce or further develop:

Framework of actions to contain CPE in health and social care settings	
Patient screening*	• Active screening for CPE is recommended to minimise transmission from CPE positive patients. • Patient screening, the scope of which should be guided by local and regional prevalence, specific patient populations and risk factors, must be implemented alongside infection prevention and control interventions.
Surveillance	• Surveillance systems are needed to rapidly detect and monitor patients either colonised or infected with CPE.
Standard infection control and contact precautions	• Consistent implementation of standard infection control precautions and contact (transmission based) precautions should be employed to reduce the spread of CPE.
Cleaning and decontamination	• Enhanced cleaning processes are required when CPE positive patients are detected. • This must be undertaken before disinfection.
Antimicrobial stewardship (AMS)	• Antimicrobial usage and audit data should be reviewed at regular intervals by local antimicrobial stewardship committees (or equivalent). • Specific actions should be taken where there are early signals of increasing antimicrobial resistance or antimicrobial consumption trends, particularly broad-spectrum agents including carbapenems.
Laboratory methods*	• Implement molecular or immunochromatographic assay in frontline diagnostic laboratories for the detection of KPC, OXA-48-like, NDM and VIM carbapenemases to complement culture-based testing. • Refer carbapenem resistant isolates with local negative tests to detect IMPs and other rarer carbapenemase families to UKHSA's Antimicrobial Resistance and Healthcare Associated Infections Reference Unit.

Outbreaks and clusters	• A prompt response following detection of CPE in health and social care settings is required to minimise onwards transmission. • Environmental samples should only be taken when epidemiologically indicated.
Organisational responsibilities	• Organisational leadership should support the infection prevention and control programme by providing organisational and administrative support.

* Not applicable outside of acute providers of care

For specialist rehabilitation setting please see BSRM document.

Section 1. Context and background

1.1 Rationale for update

This document is an update of the Acute trust toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae[1] and the Carbapenemase-producing Enterobacteriaceae: non-acute toolkit.[2] Stakeholders had requested one document to replace the 2 toolkits that provides a framework of actions for all health and social care providers in a simplified format. An evaluation of the acute toolkit was undertaken in 2016 (1). The results of this have informed the development of this framework. The objectives of the framework are to:

- provide a framework of actions and tools to support health and social care providers
- support development of local guidance and tools for the early detection of CPE with the aim of preventing transmission and containing their spread for the safety of patients and the wider population
- direct health and care professionals to the relevant guidelines for laboratory methods, including reporting of results to the UK Health Security Agency (UKHSA)

1.2 Document scope

There is significant uncertainty regarding the most effective measures to minimise the transmission of CPE, and the evidence base is constantly evolving. This framework aims to provide health and social care organisations with a useful and pragmatic set of actions to support the implementation and monitoring of interventions to prevent and control the spread of CPE.

This document refers to CPE alone; although some interventions may be common to other carbapenem-resistant Gram-negative bacteria such as carbapenem-resistant Pseudomonas spp. and Acinetobacter spp., these are not included within the document given the differences in epidemiology, microbiology, transmission, and environmental persistence. In 2017, the World Health Organization (WHO) produced detailed guidance (2) on prevention and control of these organisms in healthcare settings, in addition to CPE.

Many elements of the framework are equally applicable to all providers of health and social care; where actions relate to a specific sector this will be clarified.

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[1] Acute trust toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae

[2] Toolkit for managing carbapenemase-producing Enterobacteriaceae in nonacute and community settings

CPE advice for community settings such as care homes, mental health facilities and hospices is provided under the heading of non-acute setting throughout this integrated framework. Key points to consider include:

- non-acute settings should not refuse admission or readmission of service users on the grounds that they are colonised with CPE
- Individuals can be colonised or infected with CPE: individual who are colonised have the bacteria on a body surface (such as skin, or in the gut) without causing disease in the person
- in a shared care environment, a CPE carrier requires an individual risk assessment (Appendix C) those who are not at high risk of spreading CPE to others do not need to be isolated and should be allowed to use communal facilities. If possible, the individual should be accommodated in a single room with en-suite facilities
- standard infection control precautions (SICP) and contact (transmission based) precautions should be used for patients suspected or known to be CPE positive, refer to boxes 5 and 6 page 25 and 26 for advice on PPE
- those at high risk of infecting others for example with uncontrolled faecal incontinence and uncontrolled urinary incontinence and CPE in urine should have their care activities undertaken in a single room with en-suite facilities
- determining if someone is a high risk of infecting others is based on a risk assessment (see Appendix C, how to conduct a risk assessment in non-acute settings (page 63)
- where suspected transmission occurs in non-acute settings such as rehabilitation units or care homes, contact your local Health Protection Team or Consultant in Public Health Infection (who is located with the local Field Service Team) for help with conducting a risk assessment

1.3 What are carbapenemase-producing Enterobacterales?

Recent taxonomy changes have included the family *Enterobacteriaceae* within the order Enterobacterales. Enterobacterales are a large family of bacteria that usually live harmlessly in the gut of humans and animals. They include species such as *Escherichia coli*, *Klebsiella* spp. and *Enterobacter* spp. However, these organisms are also some of the most common causes of infections, including urinary tract infections, intra-abdominal and bloodstream infections.

Carbapenems are a valuable family of β-lactam (penicillin-like) antibiotics normally reserved to treat serious life-threatening multidrug-resistant Gram-negative infections in hospitals. They include meropenem, ertapenem and imipenem.

Resistance to some or all carbapenems is an intrinsic (natural) characteristic of some Gram-negative bacteria. Others can produce carbapenemases, which are enzymes that

destroy carbapenem antibiotics, conferring resistance. This document focuses on acquired carbapenemases, a particular concern as these genes (usually located on mobile elements such as plasmids) can move vertically (within a strain) and horizontally (between strains, species and genera).

Enterobacterales producing acquired carbapenemases are referred to as CPE. KPC, OXA-48-like, NDM, VIM, and IMP enzymes are the most prevalent enzymes in the UK. Increasing gut colonisation with these resistant bacteria will inevitably lead to an increase in difficult-to-treat infections. Figure 1 illustrates the relationship between CPE and other carbapenem-resistant and carbapenemase-producing Gram-negative bacteria.

1.4 Importance of controlling CPE

Unless action is taken and lessons are learnt from experiences elsewhere in the world, rapid spread of CPE will pose an increasing threat to public health and medical treatment pathways in the UK. These resistant bacteria can spread rapidly in healthcare settings. Almost all acute healthcare providers in England have identified at least one new patient colonised with CPE in the last year; at least half have identified multiple positive patients (3).

Invasive infections with CPE increase both patient length of stay, as a consequence of morbidity, and mortality, compared to bacteria not carrying resistance markers (4, 5). Additionally, large outbreaks in the UK have led to substantial costs (both healthcare, staffing and other resources) given the time taken to achieve control once the outbreak is established. In some health and social care organisations in England, CPE are now endemic.

An understanding of local epidemiology and context is key, as public health actions will differ depending on:

- the prevalence of CPE in patients being admitted to healthcare settings
- prior outbreaks within the region
- the patient population mix including number of overseas patients or repatriations of patients from hospitals abroad
- individual risk assessments of areas where transmission is most likely to occur

Healthcare providers who have considerable experience of CPE outbreaks may develop contextualised screening strategies reflecting their local epidemiology.

1.5 Implementation of the CPE Framework: benefits and costs

The operational challenges of implementing this framework cannot be underestimated. It will require board and senior management level commitment and support to ensure capital and recurrent funding required to sustain the range of recommended interventions.

It is widely acknowledged that the cost of managing episodes of CPE in healthcare settings can be considerable. A US study estimated the cost of managing a single case to be between $22,484 to $66,031 for hospitals (6). A European study that assessed the cost of implementing strict measures to eradicate multi-drug resistant infections (including CPE) estimated that this ranged from €285 to €57,532 per positive patient (7). One UK study estimated the cost of a CPE outbreak where 40 patients identified as infected or colonised over 10 months at £1 million (8). The cost included the actual expenditure to control the outbreak as well as the 'opportunity' costs such as lost revenue due to ward closures.

Modelling work from Canada suggests universal CPE screening is potentially cost-effective, even at a lower prevalence than currently reported in England, and identified conditions where a colonised patient infects one other patient at a very low prevalence under which it would become cost saving compared to not screening (9). More generally, it is expected that suitable selection criteria would enhance the cost-efficiency of screening.

While there are no studies determining the optimal measures to prevent and control CPE, managing CPE outbreaks carries considerable costs – financial, logistical, and reputational.

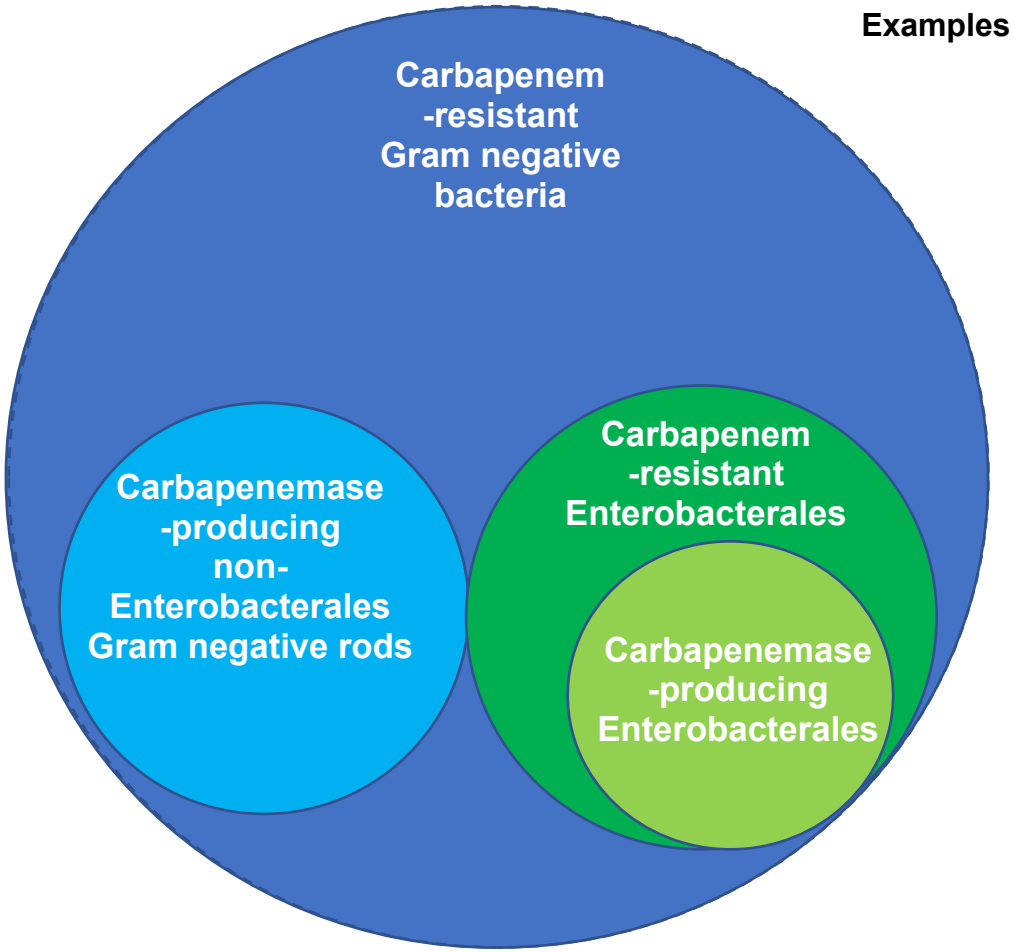
Figure 1: Explanation of different terminology for various carbapenem resistance mechanisms and nomenclature

Carbapenem-resistant Gram negative bacteria can be naturally resistant to carbapenems such as *Stenotrophomonas maltophilia* or they can acquire carbapenemase genes, which typically (but not always) confer carbapenem resistance.

Carbapenem-resistant Enterobacterales (CRE) refers to a particular type of Gram negative bacteria.

Resistance can be caused by carbapenemases, which would make them carbapenemase producing Enterobacterales (CPE).

There are also other carbapenemase producing non-Enterobacterales Gram negative rods.



Examples

Carbapenemase-resistant Gram negative bacteria:

- *Stenotrophomonas maltophilia*
- *Pseudomonas aeruginosa* with *OprD* porin loss + efflux

Carbapenemase-producing non-Enterobacterales Gram negative rods:

- *Acinetobacter baumannii* producing OXA-23 carbapenemase
- *Pseudomonas aeruginosa* producing VIM carbapenemase

CRE:

- *Enterobacter cloacae* resistant to carbapenems but does not have a carbapenemase gene

CPE:

- *E. coli* producing NDM carbapenemase
- *Klebsiella pneumoniae* producing KPC carbapenemase

CPE are regarded as the biggest threat as the resistance genes can transmit vertically and horizontally, thereby rapidly spreading between different strains of bacteria.

CRE = carbapenem-resistant Enterobacterales. CPE = carbapenemase-producing Enterobacterales. KPC = *Klebsiella pneumoniae* carbapenemase. OXA = OXA carbapenemase. NDM = New Delhi metallo-beta-lactamase. VIM = Verona Integron-Mediated metallo-ß-lactamase.

* Modified from 'Antimicrobial Resistance & Prescribing Programme (HARP team), Public Health Wales. All Wales Guidance for Developing Policies and Procedures to Manage Multi Drug Resistant Organisms (MDRO) including MRSA. Cardiff: PHW, 2018'.
This is a visual representation and circle size/alignment may not fully represent specific characteristics.

Section 2. Who to screen and why

Box 1: New evidence and recommendations for screening patients for CPE
New evidence since publication of previous guidance
• Patients are colonised with CPE prior to developing an invasive infection (10 to 12). • The aim of active screening is to prevent transmissions and the number of colonised patients at risk of invasive infection.[3] • CPE screening can be cost effective (9). • Serial admission screening for CPE does not improve the rate of detection (13). • Identifying patients colonised with CPE is optimised by taking rectal swabs (14). • Increasing evidence of colonisation with CPE following travel abroad (10, 15 to 18).
Key recommendations
• Acute care providers should actively screen patients at risk of colonisation. • Screening strategies (including ongoing screening) should be based on local epidemiology and patient mix. • Close contacts of cases should be screened. • Enhanced screening should be conducted during outbreaks. • Rectal swabs should be taken for screening purposes (include wounds and urine [if catheterised]). • Include CPE status (that is positive or negative) on discharge summary if patient has been screened during admission. • Screening of staff is not recommended.

2.1 Introduction

Colonisation usually precedes infection. Early identification of patients colonised or infected with CPE can help minimise transmission and inform therapy and early interventions to prevent invasive infections. (9 to 11, 19).

[3] Approximately 1 in 200 patients with ESBL colonisation progress to ESBL blood stream infection each year; applying similar proportions to CPE, with the currently detected 100 BSI each year there are approximately 20,000 colonised patients in England.

2.2 Active screening for CPE

Each patient should have a clinical risk assessment to determine those at higher risk of CPE colonisation on admission, readmission or transfer from another healthcare facility (20). Active screening for CPE is recommended to:

- minimise transmission from CPE positive patients
- minimise the risk that colonised patients will develop clinical infections for example from invasive devices
- ensure appropriate surgical prophylaxis and prescribing of effective antibiotic therapy if clinical infection develops (see section 6.5)
- minimise environmental contamination and the development of potential reservoirs

Note: Healthcare providers may wish to treat patients that have been previously identified as CPE positive as persistently colonised regardless of screening, though the evidence base for this is limited and is likely to change as knowledge evolves.

The evidence to inform CPE screening strategies is limited and the recommendations included in this framework are consistent with international guidelines (2, 20 to 23) and UK expert consensus.

2.3 Key risk factors for CPE colonisation or infection

2.3.1 Admission screening to acute care providers

Acute trusts will need to make their own risk assessment based on regional prevalence, patient mix, and linkages with other care providers.

The following patients should be strongly considered for screening on admission if they are likely to stay in hospital overnight (22, 24), if:

- in the last 12 months, they have
  - been previously identified as CPE positive (13, 25, 26)[4]
  - been an inpatient in any hospital, in the UK or abroad (25, 27 to 30)
  - had multiple hospital treatments for example are dialysis dependent (25, 29, 31)
  - had known epidemiological link to a known carrier of CPE (25, 32)
  - they are admitted into augmented care or high-risk units (29, 33 to 35) (see Box 2)

[4] A previously positive patient may be negative on the first screen but may become positive later in admission for example after a course of antibiotics.

Box 2: Definition of augmented care/high risk settings and comorbidities (adapted from DH MRSA 2014 and Water systems – Health Technical Memorandum 04-01)

For the purposes of this document, the patient groups in augmented care or high risk scenarios include:

- those patients who are severely immunosuppressed because of disease or treatment: this will include haematology/oncology and transplant patients and similar heavily immunosuppressed patients during high-risk periods in their therapy;
- those cared for in units where organ support is necessary, for example critical care (adult, paediatric and neonatal), renal (including dialysis settings), respiratory or other critical care or intensive care situations;
- those patients who have extensive care needs such as liver units and patients with breaches in their dermal integrity, such as in those units caring for burns.

An increased prevalence of CPE in a hospital in the same region (specifically with the same referral network of patient referrals) increases the risk of positivity (36).

Based on the epidemiology of the admission unit, patients that may be at an increased risk and should also be considered for screening include those:

- with immunosuppression (29)
- with exposure to broad-spectrum antibiotic courses (such as cephalosporins, glycopeptides, and piperacillin or tazobactam) (31, 34), and in particular carbapenems (29) within the past one month (37), not covered in other risk groups for example those receiving OPAT
- admitted from long-term care facilities where higher levels of interventional care are provided for example long-term ventilation (24, 29)

There is also increasing evidence that international travel is a risk for acquisition of resistant Gram-negative organisms including CPE in many countries across Europe (10, 15, 37), including the United Kingdom (16), and particularly from the Asian subcontinent (17, 18). Though this does not form part of taking a routine patient history outside of infectious disease settings, acute healthcare providers should make efforts to capture this information when conducting admission screening risk assessments.

Appendix A provides a reminder acronym for admission screening and Figure 2 provides a summary for admission and on-going screening strategies.

Routine screening for primary care settings or on admission to a care or residential home is not recommended. Acute healthcare providers need to undertake a risk

assessment to determine if other groups of patients require admission screening based on the local incidence of CPE, patient acuity, the level of care, interventions and carbapenem usage.

It is usually not feasible, due to a lack of single rooms, to place patients in pre-emptive isolation whilst waiting for the result of their screen (38, 39). When a single room is not available, use standard infection control precautions (SICP) and contact (transmission based) precautions in a multi-occupancy bay setting until screening results available (see Section 4 for detail). Local risk assessment will determine which patients are priority for a single room for example patients transferred from hospitals overseas (see Appendix B).

Active screening for CPE carriage is not usually required in outpatient departments or ambulatory care unless there is evidence of transmission in these settings. However, CPE status should be recorded on the discharge summary and or patient transfer documents if the patient has been screened during their admission.

Figure 2: Algorithm for admission and on-going screening strategies

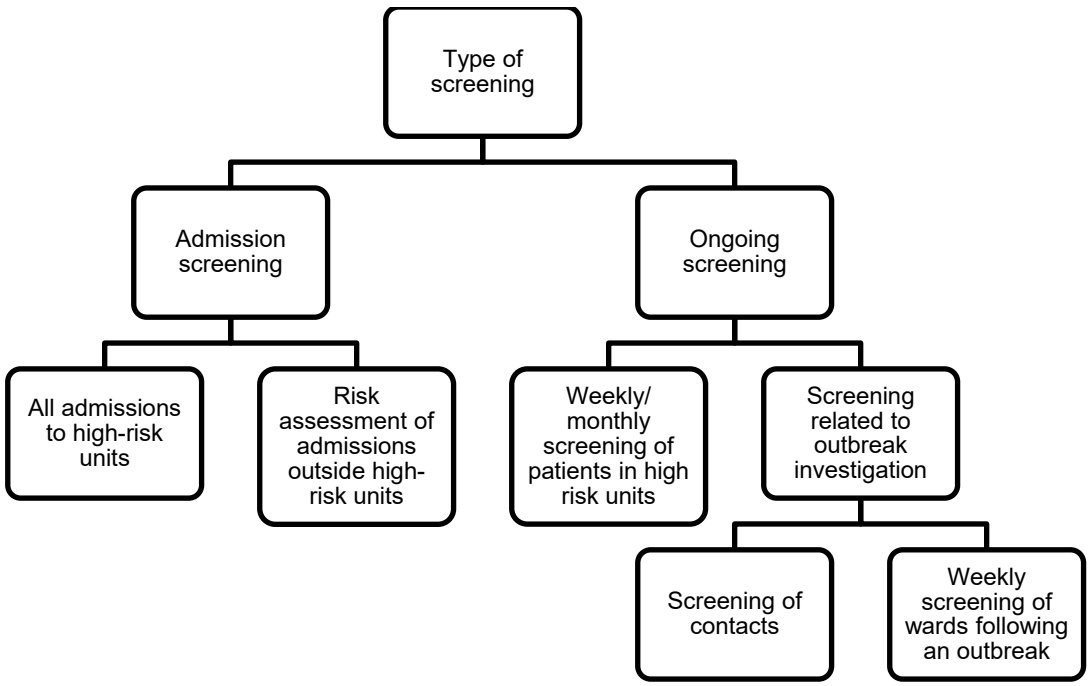


Figure 2: Algorithm for admission and on-going screening strategies – text alternative

Question 1: Type of screening
- Go to question 2 or 3

Question 2: Admission screening
- All admissions to high-risk units
  or
- Risk assessment of admissions outside high-risk units

Question 3: Ongoing screening
- Weekly/ monthly screening of patients in high-risk units
  or
- Go to question 4

Question 4: Screening related to outbreak investigation
- Screening of contacts
  or
- Weekly screening of wards following an outbreak

2.3.2 On-going screening

The evidence base to inform on going screening strategies is limited, however the options listed below may help local decision-making.

There is evidence that serial admission screening (repeat screening separated by specified time points) for CPE does not improve the rate of detection. However, repeat screening of long-stay patients may improve the identification of antibiotic-resistant Gram negative bacteria (13).

Repeated screening of individual patients may detect patients who were previously not recognised as carrying CPE in certain situations such as for long stay patients on augmented care or high risk units, on units where there is high usage of carbapenem antibiotics or in a setting of transmission (26, 40, 41)[5]. Some trusts have implemented repeat screening after 28 days in their high-risk areas. However, implementing repeated screening of individuals based on their length of stay is challenging, therefore some high-risk units undertake weekly or monthly screening to ensure early detection of new cases of CPE. Periodic point prevalence studies of these units are an alternative approach advocated by other guidelines (21, 23).

Once an in-patient is found to be CPE positive, no further screening is necessary during their inpatient stay, as repeated screens of the same patient usually remain positive for CPE over the course of a single hospitalisation (42). CPE carriers should be clearly identified on patient records or electronic systems (case flagging). The patient's GP should also be informed about their colonisation or infection status by the provider of services who took the sample, and this information should also be included on any inter-hospital transfer information or for a future admission to another hospital.

Evidence suggests that colonisation with CPE extends at least through a single hospitalisation and could extend between multiple hospitalisations (42, 43), although a recent paper found that 3 quarters did not have detectable CPE on readmission screening (26).

2.3.3 Definition of a close contact for screening purposes

A CPE contact is defined as a patient who has been in direct (for example person to person contact) or indirect contact (for example contact with contaminated environment or equipment) with another patient who is affected by CPE (infected or colonised) and is therefore at risk of CPE carriage and should be screened.

The definition of a CPE contact will depend on several factors, including:

- the setting
- clinical scenario
- type and length of exposure

[5] For more detailed information on the burden of carbapenem resistance see the English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report

CPE contacts are most commonly defined as having shared the same clinical space (for example bay or less commonly ward) as a known CPE carrier. Outside the hospital environment these could also include a person living in the same house or care home, or sexual partner.

2.3.4 Screening outside of acute care

Outside of the acute care sector, screening strategies should be based on the local epidemiology, patient acuity and level of interventions, such as long-term ventilation and rehabilitation facilities, (see Appendix C). UKHSA Health Protection Teams can assist with local risk assessments. They can also liaise with Local Authority Health Protection Team or community Infection Prevention and Control Team where these exist.

2.4 Outbreak screening strategy

Bay or unit contacts of patients newly identified as CPE positive need to be screened to detect possible transmission as further carriers may be detected. The number of contacts to be screened will be determined by the hospital infection prevention and control team on a case by case basis based on proximity to the index case, duration of exposure, and shared staff. In high risk units, hospitals should strongly consider screening all patients on these wards.

When CPE positive patients are found among screened contacts, the strategy for further screening of patients' needs to be expanded.

An enhanced period of screening is recommended during the outbreak period. As an example, the patients in the affected unit, bay or ward should be screened twice a week for 2 weeks, and weekly for a further 2 weeks. Once no new cases are detected the frequency of screening may be reduced and stopped at an appropriate point in time after no further cases have been detected. While there is no evidence to suggest how long this should be, experience with other resistant bacteria would suggest a pragmatic period of between 4 and 8 weeks.

Screening of patients already discharged from an outbreak ward to their usual home setting is not generally recommended. However, flagging of households can alert patients requiring screening on (readmission to hospital. Information on the patient's potential exposure to CPE should be included on any inter hospital or intra hospital transfer documents and or discharge summary to alert relevant healthcare providers (including GPs).

2.5 Screening swabs

Rectal specimens are most sensitive for detecting the carriage of antibiotic resistant Enterobacterales (14). If a screening sample is required, the ability of the lab to detect the presence of CPE can be optimised by:

- a rectal swab, making sure faecal material and/or discolouration is visible on the swab (a stool specimen if a rectal swab is not feasible or acceptable)
- a wound swab and or a urine sample (if catheterised)

A rectal swab is a specimen taken by gently inserting a swab inside the rectum 3 to 4cms beyond the anal sphincter, rotating gently and removing. Normal saline can be used to moisten the swab prior to insertion. The swab should have visible faecal material to enable organism detection in the laboratory.

A single rectal screening swab is sufficient to determine CPE colonisation status on admission unless patients have been previously identified as CPE positive. Hospitals may wish to treat these patients as persistently colonised regardless of screening, though the evidence base for this is limited and is likely to change as knowledge evolves.

2.6 Staff screening

Staff screening is not recommended. There is no evidence of effectiveness and it is not recommended in international guidelines (44, 45) or by UK experts.

Section 3. Monitoring and surveillance

Box 3: New evidence and recommendations for monitoring and surveillance of CPE
New evidence since publication of previous guidance
• Horizonal transfer of carbapenemases means that surveillance systems need to monitor patients colonised and or infected with different bacteria (46, 47).
Key recommendations
All healthcare providers: • Real-time surveillance systems should be in operation to rapidly detect patients either colonised or infected with CPE. • Surveillance definitions should be clear and based on acquired carbapenemases. • Analyse data regularly (at least monthly) to improve case finding within the organisation. • Maintain a database of known cases and their contacts, that is accessible to those who need to make decisions on isolation and screening within the organisation. Hospital settings: • Flag patients with history of or exposure to CPE so that they can be isolated and or screened as appropriate on readmission. • Track colonised patients and contact movements within organisations to identify common epidemiological links and potential transmission routes. • Employ laboratories that report phenotypically-resistant Gram-negative bacteria AND those identified as acquired carbapenemase producers. • Report acquired carbapenemase producers to UKHSA's national microbiological surveillance system.

3.1 Introduction

Surveillance and monitoring of CPE is important for rapid identification and control. Surveillance is a fundamental aspect of infection prevention and control activities, particularly during outbreaks.

3.2 Surveillance systems

Surveillance systems are needed to rapidly detect patients either colonised or infected with CPE. In addition to active patient screening (section 2.2), systems and processes to continuously monitor, review and analyse data are essential for robust surveillance of

CPE (48). These systems should focus on resistance mechanisms, rather than bacteria, as carbapenemase genes can transfer between genera (46, 47, 49).

Most laboratories and IPC teams will have electronic systems for alert organism surveillance. These systems should be configured to detect potential cases (ideally based on molecular detection of CPE genes, but as a minimum based on carbapenem susceptibility testing) and monitor laboratory confirmed cases.

Automated alerts based on laboratory data should be a key part of such systems to ensure deviations from the norm can be identified for example observed increase in proportion of CPE screens that are positive.

Diagnostic laboratories are well-placed to support local non-acute settings in the rapid identification of clusters or outbreaks in their locations and therefore consideration should be given to how to identify and proactively communicate abnormal findings to these settings.

Your local UKHSA Service Team can advise on data collection approaches.

3.3 Monitoring

Databases of cases (and close contacts) should include patient demographics, specialties, locations, procedures and bed movements, specimen date and date of onset of infection (if applicable). Computerised patient administration systems may facilitate this.

To ensure ongoing monitoring of CPE cases and contacts, patients with history of or exposure to CPE should be flagged on administrative systems so that they can be isolated and or screened as appropriate on readmission. This should involve flagging the address of CPE positive patients to allow rapid identification of close contacts outside acute healthcare settings.

3.4 Reporting of surveillance data to UKHSA

UKHSA monitor the incidence and prevalence of many infectious diseases including CPE to track the threat at national and regional levels. Data for this is obtained from local laboratories.

‘Acquired carbapenemase-producing Gram-negative bacteria’, which includes CPE, has been added to the list of causative agents under Schedule 2 of the Health Protection

(Notifications) Regulations 2020.[6] From 1 October 2020 diagnostic laboratories must ensure that their laboratory information management systems are capable of reporting acquired carbapenemase producers isolated from human samples to UKHSA's national microbiological surveillance system (Second Generation Surveillance System, SGSS). This data is required to monitor and track carbapenemase activity across the country.

Further to this, from 1 October 2020 diagnostic laboratories in England have a duty to report the results of any antimicrobial susceptibility test and any resistance mechanism identified in any of the causative agents listed in Schedule 2 of the Regulations, where this is known to the operator. Again, this information should be reported via SGSS.

[6] The Health Protection (Notification) (Amendment) (No. 2) Regulations 2020

Section 4. Minimising transmission

Box 4: New evidence and recommendations for how to minimise transmission
New evidence since publication of previous guidance
• Infection prevention and control measures including hand hygiene have led to a reduction of CPE in endemic settings (50 to 52) • Transmission to other patients is reduced with the consistent application of standard infection control practices and use of contact precautions where required (24, 28, 53 to 55).[7] • Appropriate use and prioritisation of isolation facilities can help control transmission, especially where used together with dedicated staff to care for patients colonised or infected with CPE (53, 54). • The genes conferring carbapenem resistance are transmitted between bacteria living in patients and the environment (56).
Key recommendations
• In acute care facilities all inpatients screened for or known to be CPE positive should be managed in a single room with en-suite facilities, where possible. • If isolation is not possible, patients with the same carbapenemase enzyme and organism can be cohorted within one ward (or defined area of a ward). • Areas where patients undergo diagnostics and or procedures should place CPE positive patients at the end of the day's list to allow for thorough cleaning and decontamination of the environment. • Decolonisation of CPE positive patients is not recommended. • In a shared care environment, a CPE carrier who is not at high risk of spreading CPE to others does not need to be isolated. • Non-acute settings should not refuse admission or readmission of service users on the grounds that they are colonised with CPE

4.1 Introduction

People who are colonised or infected with CPE act as reservoirs for transmission to others, leading to the possibility of further colonisations, infections or outbreaks. Colonisation pressure is the likelihood of a patient coming into contact with a colonised patient. This can rapidly change dependent on the number of colonised patients on a

[7] The evidence base for individual IPC interventions is lacking because they should be implemented together (World Health Organization. 'Guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, Acinetobacter baumannii and Pseudomonas aeruginosa in health care facilities' World Health Organization Guidelines 2017)

ward or unit; where the number of colonised patients is high, there is a greater chance of nosocomial transmission occurring.

Preventing onward transmission is crucial in containing CPE. This section outlines the interventions required to prevent transmission between patients, and from patients to the environment or equipment. See Section 5 for detailed information on cleaning and decontamination.

4.2 Standard infection control precautions and contact precautions

Standard infection control precautions (SICP) and contact (transmission based) precautions should be used for patients suspected or known to be CPE positive (Boxes 5 and 6).[8] Staff should apply contact (transmission based) precautions in the acute healthcare setting and on a risk assessment basis outside acute settings for patients infected or colonised with CPE, particularly where there is a presence of wound drainage, diarrhoea or faecal incontinence. In these settings, there is increased potential for environmental contamination and subsequent risk of transmission. For patients with profuse diarrhoea, appropriate medical management and enhanced cleaning of lavatory facilities should be undertaken.

Local IPC policies should reflect all relevant Health Technical Memoranda for waste management and linen.

See Appendix D for a flowchart summary of IPC measures.

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[8] The Scottish National Infection Prevention and Control manual is to be adopted across England as set out in the AMR National Action Plan 2019 to 2024 – there are some changes to terminology that differ from previous understanding within national policy that will now mirror those in the NIPCM

Box 5 – Standard infection control precautions[9]

Used by all staff, in all care settings, at all times, for all patients whether infection is known to be present or not to ensure the safety of those being cared for, staff and visitors in the care environment

Hand hygiene[10]

Respiratory and cough hygiene

Personal protective equipment which includes:

- gloves
- aprons
- long sleeved gowns to be worn where any part of the uniform (work wear) is not adequately protected by an apron for example turning patient, or where there is a risk of extensive splashing of blood and or other body fluids for example excessive wound exudate, diarrhoea, faecal incontinence

Safe management of care equipment

Safe management of the care environment

Safe management of linen

Safe management of blood and body fluid spillages

Safe disposal of waste (including sharps)

Occupational safety: prevention and exposure management (including sharps)

[9] Adapted from National Infection Prevention and Control Manual

[10] Standard infection control precautions: national hand hygiene and personal protective equipment policy

Box 6 – Contact precautions[9]
Used to prevent and control infections that spread via direct contact with the patient or indirectly from the patient's immediate care environment (including care equipment). Patient placement assessment for infection risk Safe management of patient care equipment in an isolation room cohort area Safe management of the care environment Personal protective equipment: respiratory protective equipment [not routine for CPE patient care] Infection prevention and control during care of the deceased

4.3 Visitors

Visitors who are not providing any patient care and who are not visiting other patients in the hospital do not need to wear gloves or an apron or gown. However, they should clean their hands on leaving the room. If visitors are taking an active part in the patient's care, SICP should be used. Visitors should not use patient toilet facilities.

4.4 Isolation

In acute care facilities all inpatients who have been screened for or have confirmed CPE should be managed in a single room with en-suite facilities, where possible. If the single room does not have en-suite facilities, a commode or dedicated toilet should be assigned to the patient. Reusable bedpans, commode pots and bedpan holders should be decontaminated in an automatic washer disinfector.

If single rooms are not available for every screened or known CPE-positive patient a risk assessment should be undertaken by the IPC and clinical teams to determine where to care for patients (38, 39). Single rooms should be prioritised based on:

- patient characteristics, particularly those presenting an increased risk of secondary transmission, such as patients who have diarrhoea, or are incontinent, have wounds with uncontrolled drainage, or are colonised in their respiratory tract and who are coughing
- patient's level of self-care and type of stay (pre-operative, day case, admission or intensive care)
- screening results (high risk patients or confirmed positive)

This also applies to outpatient investigations or procedures, including day surgery unit visits and ambulatory care.

See Appendix E for risk assessment where isolation rooms are limited.

4.5 Cohorting

Cohorting for CPE is recommended as a second line if isolation is not feasible. This should be considered as a pragmatic alternative to isolation when there is an increase in the number of patients with CPE in a defined clinical area or speciality, on the advice on infection control specialists.

Patients with same acquired carbapenemase enzyme and organism can be cohorted within one ward (or defined area of a ward) with dedicated bathroom facilities, equipment and staffing. Patients or residents with different mechanisms of resistance should not be cohorted together.

The following need to be assessed when agreeing cohorting arrangements:

- duration of length of stay of patients and clinical need
- enhanced IPC support for staff including education, training and monitoring of compliance with contact precautions
- increased environmental cleaning of the cohort area
- ability to provide a dedicated cohort of nursing staff over 24 hours
- geographical location of cohort area including dedicated toilet or bathroom facilities
- provision of dedicated patient-shared equipment (disposable where possible)
- if the cohort area is part of a ward (rather than the whole ward), consider CPE screening of patients in other parts of the same ward as an indication of onward transmission
- impact on patient flow across the wider organisation

4.5.1 Where cohorting is not an option

Where patient isolation or cohorting is not feasible, management of CPE positive patients may sometimes require the application of SICP and contact (transmission based) precautions in a multi-occupancy bay. Patients should remain under contact precautions for the duration of their inpatient stay. Patients in the same bay should be regarded as CPE contacts, and have CPE screens when moving to other wards or acute care providers.

Close contacts should be risk assessed to determine patient placement whilst awaiting screening results for example faecal incontinence. If they are discharged before screening is performed, close contacts should have their patient records flagged for CPE screening on readmission to acute care hospitals.

Risk assessments should be regularly reviewed for example wards that have a concurrent norovirus outbreak and have a patient colonised with CPE being managed in an open bay will need to revise the appropriateness of this approach.

There may be unique scenarios that warrant specific consideration for example paediatric settings (see Appendix F).

4.5.1 Other settings

In outpatient settings and ambulatory care settings, faecally continent patients with CPE who have no other risk factors, present a very low risk of transmission and therefore isolation or cohorting are not routinely required. However, where feasible their close contacts should have their records flagged for admission CPE screening to acute care hospitals. In contrast, CPE colonised patients with diarrhoea pose a greater risk of transmission and, environmental and equipment decontamination will be required following their visit.

4.6 Patient movement

Should the patient require a diagnostic test or procedure, this should be undertaken in the patient's room if possible. If not, the procedure should be planned at a time when decontamination of equipment and the environment can be undertaken after the patient has vacated the area. It is recommended to remove any equipment not needed for the procedure from the room to aid cleaning.

Areas where patients undergo diagnostics and or procedures, including operating theatres, should aim to place CPE positive patients at the end of the day's list to allow for thorough cleaning. However, patient care should not be compromised. Where possible, CPE positive patients should have separate waiting and recovery areas to reduce any possible environmental contamination and subsequent transmission.

4.7 Decolonisation of patients

Although colonisation with CPE increases the risk of developing infection, decolonisation is not recommended and may increase the risk of inducing antimicrobial resistance (57). Reduced susceptibility to chlorhexidine has been reported in Gram-positive and Gram-negative bacteria; the clinical significance of this reduced susceptibility, which is below in-use concentrations of chlorhexidine, is unclear (58, 59). There currently is insufficient evidence to recommend either skin or gut decolonisation of patients infected or colonised with CPE.

4.8 Non-acute care settings

Non-acute settings should not refuse admission or readmission of service users on the grounds that they are colonised with CPE. Furthermore, discharge should not be delayed until an infection has resolved if the patient is well enough to be discharged. Good communication will prevent unnecessary anxiety, misunderstanding or confusion for the family or healthcare facility receiving the patient.

In a shared care environment, a CPE carrier who is not at high risk of spreading CPE to others does not need to be isolated and should be allowed to use communal facilities. If possible, the individual should be accommodated in a single room with en-suite facilities. If not possible, they should not share a room with an immunocompromised individual or those with other risk factors such as chronic wounds.

Those at high risk of infecting others for example with uncontrolled faecal incontinence should have their care activities undertaken in a single room with en-suite facilities. If an en-suite room is not available, the individual should be placed in a single room with a designated commode with easy access to hand washing facilities.

Where rehabilitation is needed, and faecal incontinence is unable to be resolved for example due to an underlying bowel condition or ~~a~~ long-term discharging anal rectal wound, an individual risk assessment can be undertaken with the support of the IPC team, which should include the:

- ability to perform hand hygiene, before, after and during the activity
- frequency of loose stools
- ability to contain the faecal incontinence and wound discharge
- environment within which the rehabilitation is being undertaken such as, surfaces that are easy to clean
- resident's compliance with IPC precautions
- type of activity being undertaken for example heavy exercise with likely sweat
- equipment being used – can it be easily cleaned?
- susceptibility to infection of other participants – where possible rehabilitation activities should be undertaken on an individual basis rather than group activities

See Appendix C for further information on how to conduct a CPE risk assessment in non-acute settings. In outpatient and ambulatory care settings, faecally continent patients with CPE who have no other risk factors present a very low risk of transmission and therefore isolation or cohorting are not routinely required. In contrast, CPE colonised patients with diarrhoea pose a greater risk of transmission; environmental and equipment decontamination will be required following their visit.

Determining if someone is a high risk of infecting others is based on a risk assessment. The local Health Protection Team can provide advice on this, or Community Infection Prevention and Control specialists if available.

Section 5. Cleaning and decontamination

Box 7: New evidence and recommendations for cleaning and decontamination
New evidence since publication of previous guidance
• Transmission to other patients is reduced through appropriate ward and equipment cleaning and disinfection, appropriate waste disposal, education of staff, audit of processes and feedback (24). • Effective cleaning of high-touch surfaces and management of environmental reservoirs will minimise spread of gut flora and transmission to subsequent room residents (60, 61). • Environmental reservoirs can be difficult to eradicate; such reservoirs include sinks, drains, and other water sources (62 to 65). • An example of an itemised risk and or cleaning assessment log for rehabilitation patients with CPE (106). • National Cleaning Standards
Key recommendations
• Use dedicated single-patient or single-use equipment, for example blood pressure cuffs, pulse oximeters or thermometers. • Implement and audit high standards of cleaning and disinfection. • Decontaminate equipment after use by a colonised or infected patient, especially when the equipment may be shared with other patients. • Enhance cleaning and disinfection (for example increase frequency) in response to an outbreak or cluster of CPE positive patients. • Physical removal of biofilm from a sink or shower waste trap by cleaning is not recommended. • All basins, sinks and showers should be maintained so they drain efficiently. • Hand wash basins should only be used for hand hygiene.

5.1 Introduction

The environment of CPE patients has been found to be significantly contaminated (56, 66, 67). Recontamination of the environment in the presence of a patient colonised or infected with CPE can be rapid despite good standards of cleaning. No cleaning schedule can be expected to eliminate CPE reliably whilst a colonised or infected patient is present. Efforts should be focussed on containment and risk reduction; ideally equipment should be dedicated to that specific patient. If this is not possible, meticulous decontamination of any items before use with other patients is essential.

5.2 Decontamination following patient or resident discharge

Environmental decontamination is critical following the transfer, discharge or death of a colonised or infected patient and requires coordination between cleaning services, ward or unit staff and the IPC Team. Scrupulous cleaning and disinfection of all surfaces is required with particular attention to frequent hand touch surfaces. Some organisations find it helpful to use a post clean checklist before the room is used for a new patient.

Examples of particular importance are:

- mattresses are especially important as sheets are not an effective barrier to passage of contamination patient-to-mattress or mattress-to-patient
- bedframes, handrails and mattress covers should be cleaned then disinfected, and the integrity of the cover assessed; if the mattress cover is damaged, the mattress should be condemned. Pillows should be disposed of if the integrity of the cover is damaged or the pillow itself is soiled
- dynamic mattresses should be disassembled, cleaned and disinfected, usually by specialist external contractors or in specialist facilities within the hospital
- privacy curtains should be removed and laundered or be single-patient use only
- all used or unused single-use items or consumables in the patient's immediate vicinity (that may have become contaminated by hand contact) should be discarded, keeping limited stocks near the patient reduces the need for this
- avoid having extraneous equipment in the individual's room
- tubes of ointment and lubricant should be discarded
- lavatory brushes and their holder should be disposed of as part of the discharge or terminal clean

Disinfection should only be undertaken after cleaning and removal of all visible soiling. Manufacturer's instructions should be followed. Disinfectant wipes can be used for decontaminating equipment between use (68) but can dry out if each wipe is used over too large a surface area (69).

Use a disinfectant that is effective against a Gram-negative bacteria. The choice of disinfection will depend on local considerations such as material compatibility and user acceptability. There is limited evidence on the specific use of non-contact disinfection (hydrogen peroxide dispersal or UV) as the sole intervention. If non-contact disinfection is used, conventional environmental cleaning must occur first to remove surface physical soiling, followed by environmental disinfection.

5.3 Sinks, basins, showers and drains

Many surfaces within drainage systems will be colonised by micro-organisms in a slime layer; this is known as a ‘biofilm’. Antibiotic-resistant bacteria can be long-term residents within these biofilms and studies have demonstrated that hospital sinks and associated drainage systems can harbour antimicrobial resistant bacteria, including CPE (66, 70).

Sink and shower waste traps (the water filled U-bend that prevents foul air from the drain entering the indoor environment) can harbour high numbers of bacteria. Whilst most of these bacteria are firmly fixed within the biofilm matrix, bacteria can also be released into the water covering the biofilm. There is some evidence that CPE in waste traps and or drainage biofilm can transmit to patients (66, 71, 72). Strains recovered from sinks have also been isolated from patients, but the route and or direction of transmission is difficult to determine and is often unclear (66, 70).

This could occur in several ways, such as:

- if the stream of water from the spout of a tap flows directly into the drain hole of the sink below, it could cause dispersal of drain water by splashing, this could contaminate surrounding surfaces and the person using that sink
- if drainage is partially blocked and water builds up in the sink bowl, there is likely to be a pooling of water and reflux from the drain – water flow from the tap will cause splashing and dispersal of contaminated water droplets
- if showers do not drain efficiently, there can be reflux of water from the drain and contact between the shower user’s feet and that contaminated water

Poor penetration and or the inactivation of disinfectants within the biofilm matrix means well established biofilms are highly resistant to disinfection. Whilst a variety of treatments have claimed to reduce biofilm in drainage systems, none have undergone extensive validation in more general use (62, 63).

Physical removal of biofilm from a sink or shower waste trap by cleaning is unlikely to be fully effective and any biofilm killed or removed will soon be replaced by biofilm recolonising from further down the drainage system (64, 65). Attempts at cleaning waste traps are likely to disperse profuse contamination into the clinical area as well as contaminating the equipment used Cleaning of waste traps should only be done whenever drainage is impaired or as planned preventative maintenance as part of a local schedule; surrounding surfaces and the equipment used should be thoroughly disinfected afterwards. Precautions to contain contamination from this should be agreed with infection control teams.

Water from tap spouts should not flow directly into the drain hole; this can still occur even if both conform to the guidance outlined in the Health Building Note (HBN 00-10

part C: Sanitary assemblies, 2013) (73). Sink design and impaired drainage have been implicated in outbreaks of multidrug-resistant bacteria, including CPE (71, 74, 75). Laboratory studies have confirmed that water flowing directly into a sink drain can disrupt established biofilm and or cause dispersal of contaminants present within the waste trap. Allowing back flow of water from the waste trap to accumulate within the basin has been shown to facilitate dispersal of contaminated droplets (75 to 77).

Nutrients such as food waste may both increase bacterial numbers in a biofilm and impede drainage and should not be disposed of via sinks. Hand wash basins should only be used for hand hygiene and not for:

- disposal of body fluids
- disposal of tea, coffee or other nutrient containing beverages
- disposal of IV fluids
- washing any patient equipment
- storage of used equipment awaiting decontamination

It is important to ensure that cleaning of hand wash basins and taps is undertaken in a way that does not allow cross contamination from a bacterial source to the tap.

Taps should be cleaned before the rest of the clinical wash-hand basin. Care should be taken to avoid transferring contamination from wash-hand basin to wash-hand basin (refer to best practice advice appendix 1: Health Technical Memorandum 04-01 Addendum: Pseudomonas aeruginosa – advice for augmented care units (publishing.service.gov.uk and Health Building Note 00-09: Infection control in the built environment (publishing.service.gov.uk)

5.4 Endoscopes

Transmission of multi-resistant Gram-negative bacteria, including CPE, has been observed (78, 79). All flexible endoscopes should be decontaminated in compliance with ‘Management and decontamination of flexible endoscopes (HTM 01-06)’ (80).There are no extra decontamination requirements for endoscopes used on patients who are colonised or infected with CPE, however transmission of CPE has been observed in other countries associated with duodenoscopes (78, 79). These have a more complex structure than other flexible endoscopes and consequent additional decontamination requirements which are set out on HTM 01-06.

Any attached cameras or equipment which cannot be steam sterilised should be protected using a single-use covering and thoroughly cleaned and disinfected between patients once the covering has been removed.

Section 6. Antimicrobial prescribing and stewardship

Box 8: New evidence and recommendations for antimicrobial prescribing and stewardship
New evidence since publication of previous guidance
• Antimicrobial stewardship with particular attention to reducing the use of broad-spectrum antibiotic use is critical in the prevention of antimicrobial resistance (81).
Key recommendations
• Providers of health and social care should implement antimicrobial stewardship interventions to minimise the development of CPE. • Antimicrobial resistance and consumption data should be regularly reviewed, and relevant actions taken based on findings. • Treatment options must involve infection specialists including medical, nursing and pharmacy. • Continuous monitoring of local antimicrobial consumption and resistance trends are critical in order to guide treatment and surgical prophylaxis. • Antimicrobial stewardship committees should review availability of new antimicrobials through horizon scanning.

6.1 Introduction

To minimise the development and impact of resistant Gram-negative bacteria including CPE, commissioners and providers of health and social care should regularly review their antimicrobial stewardship (AMS) programme[11] in accordance with actions outlined in The Health and Social Care Act 2008 Code of Practice on the prevention and control of infections and related guidance criterion 3 (82), WHO Essential Medicines List adaptation (83), and recommendations specified in NICE Guidance NG15 (81) and relevant NICE or UKHSA Antimicrobial prescribing guidelines.

[11] Antimicrobial stewardship is defined as systems and processes for effective antimicrobial medicine use (NICE – NG 15)

6.2 General principles

Providers of health and social care should implement AMS interventions to minimise the development of resistant organisms that follow the Start Smart then Focus (84) (in secondary care) and TARGET Antibiotics resources (85) (in primary care). Antimicrobial resistance (AMR) and consumption data should be reviewed at regular intervals by local antimicrobial stewardship committees (or equivalent) and action taken where there are early signals of increasing AMR or antimicrobial consumption trends, particularly broad-spectrum agents including carbapenems, third-generation cephalosporins and piperacillin and tazobactam.

A whole system approach to AMS is important. AMS committees should consider how to have a combined approach across primary and secondary care and link with IPC committees, Sustainability and Transformation Partnerships and Integrated Care Systems to offer a one system approach. G details further resources.

6.3 Monitoring

A program of audit and quality improvement programmes to address inappropriate broad-spectrum antimicrobial prescribing with feedback to individual prescribers should be considered. Box 9 provides a range of monitoring tools available for acute and non-acute settings.

Providers should consider implementing strategies to reduce overall antimicrobial use, in particular broad-spectrum antibiotics, with efforts made to protect antibiotics in the Restrict and Watch categories (83). These strategies should also minimise use of antimicrobials associated with colonisation with CPE or other significant adverse effects (for example *Clostridioides difficile* infection) such as fluoroquinolones, cephalosporins and antimicrobials where high level resistance has been identified locally.

Box 9: Monitoring tools for assessing antimicrobial usage

- NICE AMS guidance and infection guidelines assessment tools
- Course: TARGET antibiotics toolkit hub
- AMS Peer Review Inspection Tool
- Antibiotic appropriateness assessment instrument
- Point prevalence surveys
- OHID Fingertips (UKHSA AMR local indicators profile)
- ePact
- PresQipp data portals

6.4 Responding to increased antibiotic consumption trends

As part of responding to or identifying increased antibiotic consumption, increased frequency of monitoring is required. These may include:

- increased surveillance of CPE
- more regular review of consumption of antibiotics using the AWaRE categories (83)
- surveillance of antimicrobial resistance mechanisms driving use of carbapenems and other restricted antibiotics for example ESBL or AmpC rates

6.5 Treatment and surgical prophylaxis options

Specific and timely routine monitoring of local antimicrobial consumption and resistance trends are critical in order to guide available treatment and where appropriate surgical prophylaxis options.

Due to the varying resistance profiles and prevalence of CPE, it is not possible or appropriate to make national treatment recommendations. Treatment options must involve infection specialists including medical, nursing and pharmacy as part of the wider AMS team to ensure optimal dosing and monitoring are in place. Organisations should consider reaching out to other centres with experience in such treatment modalities.

Stewardship principles are important during surgical prophylaxis. Specifically, prophylaxis against CPE should be considered when developing local surgical prophylaxis policy:

- for patients undergoing surgery with a current systemic CPE infection or infection localised to site of surgery
- for patients colonised (including history if most recent screen negative) with CPE undergoing high risk surgery
- choice of agent for surgical prophylaxis should be based on local epidemiology or individual sensitivity results if available

6.6 Horizon scanning for new antimicrobials

Antimicrobial stewardship committees should review the positioning and available access of new antimicrobials within the formulary through horizon scanning, particularly for antibiotics that may be required to treat multidrug-resistant Gram-negative infections.

Where new antibiotics with activity against CPE multidrug resistant bacteria are adopted for use within an organisation, a local assessment should account for:

- the impact of its routine or widespread use
- prescribing restrictions
- implementation to ensure appropriate use with monitoring and feedback to the antimicrobial stewardship committee

Section 7. Laboratory methods

Box 10: New evidence and recommendations for laboratory methods to detect CPE
New evidence since publication of previous guidance
• Detecting carbapenemase genes is important to recognise outbreaks as these genes spread horizontally (46, 47). • Identification of acquired carbapenemases can help inform treatment (86 to 89).
Key recommendations
• Laboratories should ensure they have methods in place to detect both CPE colonisation and invasive infections using relevant UKHSA guidance.[12] • Diagnostic laboratories should implement a molecular or immunochromatographic assay for at least the detection of KPC, OXA-48-like, NDM and VIM carbapenemase families. • Diagnostic laboratories should optimise and review their phenotypic laboratory methods for detection of acquired carbapenemase-producing Gram-negative bacteria.

7.1 Introduction

Carbapenemases are intrinsic (found naturally) in a few clinical bacteria; this section focusses on acquired carbapenemases. Local testing for acquired carbapenemases with rapid turnaround, rather than referral to the national reference laboratory, will have maximal impact on patient management to prevent onward transmission and effective clinical treatment. However, there is currently no ‘gold standard’ methodology for detection of all carbapenemases but there are a growing number of methods available.

[12] Detection of acquired carbapenemases: commercial assays

7.2 Detection of CPE in diagnostic laboratories

UKHSA strongly recommends that diagnostic laboratories implement a molecular or immunochromatographic assay for at least the detection of KPC, OXA-48-like, NDM and VIM carbapenemase families, the most commonly reported nationally and globally (90), and refer to AMRHAI all carbapenem resistant isolates with local negative tests for the 'big 4' to detect other rarer carbapenemase families.

A screening algorithm using either a one-step detection via molecular or immunochromatographic test direct from clinical or screening specimens[13], or 2 step detection involving culture followed by molecular or immunochromatographic test should be implemented. Laboratories need to consider their local CPE epidemiology and laboratory capacity (39) when deciding on this algorithm, noting that in endemic settings a one-step approach may be more effective in rapidly detecting colonised patients and reducing transmission (26, 39)

Where possible, specimens that undergo one-step detection should also be cultured; CPE negative isolates may require further characterisation to determine whether referral to AMRHAI is warranted to screen for rarer carbapenemases, whilst CPE positive specimens may require culture for organism identification, typing and determination of the antibiogram, particularly in situations where patient cohorting is being considered.

UKHSA's report 'Commercial assays for the detection of acquired carbapenemases' has been published to enable an informed decision on the choice of commercial carbapenemase detection assay to implement based on their local circumstances (91). Furthermore, laboratories should be referring to the most recently published UK Standards for Microbiological Investigation (SMI) 'Detection of bacteria with carbapenem-hydrolysing β-lactamases (carbapenemases)' (92) to optimise phenotypic laboratory methods for detection of acquired carbapenemase-producing Gram-negative bacteria.

[13] Note: protocols for CPE detection via immunochromatographic test direct from rectal swabs have been published but have not yet been validated by the manufacturers.

Section 8. Managing CPE outbreaks and clusters

Box 11: New evidence and recommendations for preventing and controlling CPE outbreaks
New evidence since publication of previous guidance
• The management of individual patients with CPE and outbreaks of CPE is costly (8).
Key recommendations
• Identify the type of patients and or setting(s) affected. • Adopt a screening strategy appropriate to the situation, with the aim of identifying potential cases. • Optimise staff-to-patient ratios and monitor adherence to IPC guidance. • Risk assess the need for patient isolation and or cohorting. • Investigate environmental reservoirs if this is indicated or appropriate. • Review antimicrobial prescribing practices. • Ensure the multi-disciplinary team responding to the outbreak comprises individuals with experience of outbreak management. • Undertake epidemiological assessment in an attempt to identify the source and or assess the effectiveness of interventions. • Implement a communication plan for both internal and external stakeholders.

8.1 Introduction

Large-scale, costly CPE outbreaks often arise from transmission from patients whose colonisation status are not recognised or swiftly contained. It is vital that any CPE detection is appropriately managed to prevent onward transmission. A robust, multidisciplinary approach is required to investigate and manage such incidents.

Detail on the management of CPE outbreaks in acute healthcare settings has been published (93) and suggested actions are summarised in Appendix H. These aspects should be integrated into relevant organisational outbreak and multidrug resistant organism management policies. Many of the actions may be necessary on the identification of one CPE positive patient to prevent the development of an outbreak.

While some CPE incidents are just one organism strain (clonal), others may not be organism specific, multiple different organisms may be found, harbouring the same resistance mechanism and therefore still be linked. Microbiological expertise will be required to consider if plasmids carrying resistance mechanisms have transmitted between genera for example from *E. coli* to *Klebsiella* spp.

8.2 Risk assessment in non-acute settings

Where suspected transmission occurs in non-acute settings such as rehabilitation units or care homes, contact your local Health Protection Team or Consultant in Public Health Infection (who is located with the local Field Service Team) for help with conducting a risk assessment.

8.3 Ongoing transmission

For ongoing transmission**,** consider obtaining further advice from UKHSA. This could include a peer-review visit, advice or investigation from your local Health Protection Team, with additional support provided by Field Service or the national HCAI and AMR Division. UKHSA HPTs can liaise with Local Authority Health Protection Team or Community Infection Prevention and Control Team where these exist.

Section 9. Organisational responsibilities

Box 12: New evidence and recommendations for ensuring appropriate organisational responsibilities
New evidence since publication of previous guidance
• Communication to patients, within organisations, and between organisations is essential (21, 94 to 96).
Key recommendations
In acute care settings, or others where higher levels of interventional care are provided for example long-term ventilation: • Ensure the appropriate management and governance arrangements (including at board level) are in place, with CPE included in the IPC assurance framework (65). • Develop and implement a CPE prevention and control policy within each organisation and present data to the board at least bi-annually. • Ensure that the Director of Infection Prevention and Control or IPC lead (as outlined in the Code of Practice) has the authority to challenge inappropriate practice and inappropriate prescribing decisions (82). • Communicate patient's CPE status to receiving organisation or team on discharge. In all settings: • Ensure all relevant staff have received appropriate education and training on the organisation's CPE and or multidrug resistant organism policy (33, 97).

9.1 Introduction

Providers of health and social care in England must have appropriate arrangements and resources in place for prevention and control of infections (82). IPC and outbreak response roles and responsibilities need to be formally assigned in all providers of regulated activities (98). These arrangements need to be proportionate to the size and complexity of the organisation, but should be appropriately communicated and adopted in any setting (99).

9.2 Leadership, planning and implementation

Leadership is essential to ensure that IPC policies are developed, communicated, and implemented, with appropriate levels of resourcing. Commitment and coordination, along with robust planning and preparation will ensure all staff are enabled to deliver care in a way that protects patients from the risk of colonisation or infection with CPE (100). Maintaining awareness of CPE amongst staff can be a challenge to implementation, particularly for providers with no or low numbers of CPE cases (1).

9.3 Communication

The provider organisation should discharge its ‘duty of care’ by ensuring that the right people, in the right place, have the right knowledge through planning early communications, and this should include:

- alerting neighbouring trusts, commissioners, providers and the local Health Protection Team about CPE outbreaks
- ensuring discharge letters detail CPE colonisation and or infection status, or potential exposure to CPE in a ward environment – this information should be received by GPs, receiving organisations and relevant healthcare professions, for example district nursing teams, where appropriate (see Appendix I for primary care quick reference guide)
- communicating with the patient, family and carers (see Appendix J and Appendix K) and or the care facility to which the patient is to be discharged, providing an accurate explanation of risk in a non-acute or community setting and IPC advice (101)

9.4 Repatriations from abroad

The receiving hospital should inform their trust IPC team at the time of the request to enable an appropriate risk assessment to be undertaken and relevant control measures implemented on arrival (including isolation and screening).

If a complex multiple patient repatriation across multiple trusts is planned, this should be coordinated through regional or national NHS colleagues and UKHSA’s national team (HCAI.AMRdepartment@ukhsa.gov.uk) in hours or the national public health on-call service (+44 20 8200 4400) out-of-hours (including weekends).

Glossary of terms

acute care setting	A healthcare setting, usually a hospital, that provides short-term treatment or care for an illness, urgent medical condition, injury or surgical procedure.
carbapenemases	Enzymes (such as KPC, OXA-48-like, NDM and VIM) produced by some bacteria which cause destruction of the carbapenem antibiotics, resulting in resistance.
carbapenems	A group of powerful antibiotics used to treat severe infections. They include meropenem, ertapenem and imipenem.
close contact	A person living in the same house; sharing the same sleeping space (room or hospital bay); or a sexual partner.
colonisation	The presence of micro-organisms (such as bacteria) living harmlessly on the skin or within the bowel and causing no signs or symptoms of infection.
decontamination	The processes required to remove infection risk; the elements within it are context dependent. For medical devices in the context of CPE, decontamination will be either cleaning plus disinfection or cleaning, disinfection and sterilization. For the environment in the context of CPE, it would be cleaning and disinfection of items with staff or patient contact.
Enterobacterales	A group of bacteria that usually live harmlessly in the gut of humans (and animals). They include *Escherichia coli* (*E. coli*), *Klebsiella* spp., *Enterobacter* spp.
high-risk for colonisation and or infection with CPE	• patients with a history of an overnight stay in hospital within the last 12 months, including abroad • patients who were previously identified as CPE positive • patients who have multiple hospital admissions or treatments for example are dialysis dependent or have had cancer chemotherapy in last 12 months • epidemiological link to a known carrier of CPE • patients who are admitted into augmented care or high risk units

	• patients with recent exposure to broad-spectrum antibiotic courses, and in particular carbapenems, within their last or current hospital stay
high-touch surfaces	Surfaces that are touched many times throughout the day by various people. High touch surfaces include, but are not limited to: bed rails; bed frames; moveable lamps; tray table; bedside table; handles; IV poles; blood pressure cuff.
infection	The presence of micro-organisms (such as bacteria) in the body causing adverse signs or symptoms.
laboratory confirmed case – for the purposes of this guidance	Recent laboratory confirmation of CPE infection and colonisation during this admission episode or confirmed at a transferring healthcare facility (UK facility only).
non-acute care setting	Usually applies to healthcare settings that provide non-acute care, such as in care homes and mental health trusts, also rehabilitation and palliative care services including hospices.

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References

1. Coope CM and others. ‘An evaluation of a toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae: a cross-sectional survey of NHS acute trusts in England’ Journal of Hospital Infection 2018: volume 99, page 381
2. World Health Organization. ‘Guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in health care facilities’ World Health Organization Guidelines 2017 Geneva, Switzerland
3. Freeman R and others. ‘Epidemiology of carbapenemase-producing Enterobacterales in England, May 2015 to March 2019: national enhanced surveillance findings and approach’ Infection Prevention in Practice 2020. Article in press.
4. Tamma PD and others. ‘Comparing the Outcomes of Patients With Carbapenemase-Producing and Non-Carbapenemase-Producing Carbapenem-Resistant Enterobacteriaceae Bacteremia’ Clinical Infectious Diseases 2017: volume 64, pages 257-64
5. Xu L and others. ‘Systematic review and meta-analysis of mortality of patients infected with carbapenem-resistant *Klebsiella pneumoniae*’. Annals of Clinical Microbiology and Antimicrobials 2017: volume 16, page 18
6. Bartsch SM and others. ‘Potential economic burden of carbapenem-resistant Enterobacteriaceae (CRE) in the United States’ Clinical Microbiology and Infection 2017: volume 23, 48.e9-.e16
7. Birgand G and others. ‘Measures to eradicate multidrug-resistant organism outbreaks: How much do they cost?’ Clinical Microbiology and Infection 2016: volume 22, 162.e1-.e9
8. Otter JA and others. ‘Counting the cost of an outbreak of carbapenemase-producing Enterobacteriaceae: an economic evaluation from a hospital perspective’ Clinical Microbiology and Infection 2017: volume 23, pages 188-96
9. Lapointe-Shaw L and others. ‘Cost-effectiveness analysis of universal screening for carbapenemase-producing Enterobacteriaceae in hospital inpatients’ European Journal of Clinical Microbiology and Infectious Diseases 2017: volume 36, pages 1,047-55
10. Nicolas-Chanoine MH and others. ‘Risk factors for carbapenem-resistant Enterobacteriaceae infections: a French case-control-control study’ European Journal of Clinical Microbiology and Infectious Diseases 2019: volume 38, pages 383-93
11. Palacios-Baena ZR and others. ‘Comprehensive clinical and epidemiological assessment of colonisation and infection due to carbapenemase-producing Enterobacteriaceae in Spain’ Journal of Infection 2016: volume 72, pages 152-60
12. Logan LK, Weinstein RA. ‘The Epidemiology of Carbapenem-Resistant Enterobacteriaceae: The Impact and Evolution of a Global Menace’ Journal of Infectious Diseases 2017: volume 215, S28-S36
13. Mookerjee S and others. ‘Evaluating the benefit of serial screening cultures to detect carbapenemase-producing Enterobacteriaceae (CPE) following hospital admission’ Journal of Hospital Infection 2018
14. Dyakova E and others. ‘Efficacy and acceptability of rectal and perineal sampling for identifying gastrointestinal colonization with extended spectrum beta-lactamase Enterobacteriaceae’ Clinical Microbiology and Infection 2017: volume 23, page 577

15. Jans B and others. ‘Infection due to travel-related carbapenemase-Producing Enterobacteriaceae, a largely underestimated phenomenon in Belgium’ Acta Clinica Belgica 2015: volume 70, pages 181-7
16. Henderson J and others. ‘A point prevalence study to determine the inpatient rate of carbapenemase-producing organisms at a large London NHS Trust’ Journal of Hospital Infection 2019
17. Dall LB and others. ‘Do probiotics prevent colonization with multi-resistant Enterobacteriaceae during travel? A randomized controlled trial’ Travel Medicine and Infectious Disease 2019: volume 27, pages 81-6
18. Reuland EA and others. ‘Travel to Asia and traveller's diarrhoea with antibiotic treatment are independent risk factors for acquiring ciprofloxacin-resistant and extended spectrum beta-lactamase-producing Enterobacteriaceae-a prospective cohort study’ Clinical Microbiology and Infection 2016: volume 22, 731 e1-7
19. Logan LK, Weinstein RA. ‘The Epidemiology of Carbapenem-Resistant Enterobacteriaceae: The Impact and Evolution of a Global Menace’ Journal of Infectious Diseases 2017: volume 215, S28-s36
20. Health Protection Scotland. ‘Toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae in Scottish acute settings’ Glasgow: Health Protection Scotland 2019
21. Australian Commission on Safety and Quality in Health Care. ‘Recommendations for the control of carbapenemase-producing Enterobacteriaceae (CPE) – A guide for acute care health facilities’ Sydney 2017
22. European Centre for Disease Prevention and Control. ‘Carbapenem resistant Enterobacteriaceae – second update’ Stockholm: ECDC 2019
23. Centers for Disease Control and Prevention. ‘Facility Guidance for Control of Carbapenem-resistant Enterobacteriaceae (CRE) – November 2015 Update CRE Toolkit’ Atlanta: CDC 2015
24. Wilson APR and others. ‘Prevention and control of multi-drug-resistant Gram-negative bacteria: Recommendations from a Joint Working Party’ Journal of Hospital Infection 2016: volume 92, S1-S44
25. Magiorakos AP and others. ‘Infection prevention and control measures and tools for the prevention of entry of carbapenem-resistant Enterobacteriaceae into healthcare settings: Guidance from the European Centre for Disease Prevention and Control’ Antimicrobial Resistance and Infection Control 2017: volume 6
26. Tucker A and others. ‘Screening for carbapenemase-producing Enterobacteriaceae in previous carriers readmitted to hospital: evaluation of a change in screening policy’ Journal of Hospital Infection 2019: volume 103, pages 156-9
27. Donker T and others. ‘The relative importance of large problems far away versus small problems closer to home: insights into limiting the spread of antimicrobial resistance in England’ BioMed Central Medicine 2017: volume 15, page 86
28. European Centre for Disease Prevention and Control. ‘Systematic review of the effectiveness of infection control measures to prevent the transmission of carbapenemase-producing Enterobacteriaceae through cross-border transfer of patients’ 2014

29. Carmeli Y and others. ‘Controlling the spread of carbapenemase-producing Gram-negatives: therapeutic approach and infection control’ Clinical Microbiology and Infection 2010: volume 16, pages 102-11
30. Khawaja T and others. ‘Patients hospitalized abroad as importers of multiresistant bacteria-a cross-sectional study’ Clinical Microbiology and Infection 2017: volume 23, 673.e1-.e8
31. Van Loon K and others. ‘A systematic review and meta-analyses of the clinical epidemiology of carbapenem-resistant enterobacteriaceae’ Antimicrobial Agents and Chemotherapy 2018: volume 62, e01730
32. Cronin KM and others. ‘Risk factors for KPC-producing Enterobacteriaceae acquisition and infection in a healthcare setting with possible local transmission: a case-control study’ Journal of Hospital Infection 2017: volume 96, pages 111-5
33. World Health Organization. ‘Guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, Acinetobacter baumannii and Pseudomonas aeruginosa in health care facilities’ 2017 Geneva, Switzerland
34. Richards M and others. ‘Recommendations for the control of carbapenemase-producing Enterobacteriaceae (CPE): A guide for acute care health facilities: Australian Commission on Safety and Quality in Health Care’ Infection, Disease and Health 2017: volume 22, pages 159-86
35. Schwaber MJ and others. ‘Predictors of carbapenem-resistant *Klebsiella pneumoniae* acquisition among hospitalized adults and effect of acquisition on mortality’ Antimicrobial Agents and Chemotherapy 2008: volume 52, pages 1,028-33
36. Donker T and others. ‘The relative importance of large problems far away versus small problems closer to home: insights into limiting the spread of antimicrobial resistance in England’ BioMed Central Medicine 2017: volume 15, pages 1-11
37. Skjot-Arkil H and others. ‘Carrier prevalence and risk factors for colonisation of multiresistant bacteria in Danish emergency departments: a cross-sectional survey’ British Medical Journal Open 2019: volume 9, e029000
38. Vella V and others. ‘Isolation demand from carbapenemase-producing Enterobacteriaceae screening strategies based on a West London hospital network’ Journal of Hospital Infection 2016: volume 94, pages 118-24
39. Knight GM and others. ‘Fast and expensive (PCR) or cheap and slow (culture)? A mathematical modelling study to explore screening for carbapenem resistance in UK hospitals’ BioMed Central Medicine 2018
40. Poole K and others. ‘Active case finding for carbapenemase-producing Enterobacteriaceae in a teaching hospital: prevalence and risk factors for colonization’ Journal of Hospital Infection 2016: volume 94, pages 125-9
41. Gharbi M and others. ‘Forecasting carbapenem resistance from antimicrobial consumption surveillance: Lessons learnt from an OXA-48-producing *Klebsiella pneumoniae* outbreak in a West London renal unit’ International Journal of Antimicrobial Agents 2015: volume 46, pages 150-6
42. Tacconelli E and others. ‘ESCMID-EUCIC clinical guidelines on decolonisation of multidrug-resistant Gram-negative bacteria carriers’ Clinical Microbiology and Infection 2019

43. Zimmerman FS and others. ‘Duration of carriage of carbapenem-resistant Enterobacteriaceae following hospital discharge’ American Journal of Infection Control 2013: volume 41, pages 190-4
44. Otter JA and others. ‘Controversies in guidelines for the control of multidrug-resistant Gram-negative bacteria in EU countries’ Clinical Microbiology and Infection 2015: volume 21, pages 1,057-66
45. Decker BK and others. ‘Healthcare personnel intestinal colonization with multidrug-resistant organisms’ Clinical Microbiology and Infection 2018: volume 24, 82.e1-.e4
46. Ludden C and others. ‘Sharing of carbapenemase-encoding plasmids between Enterobacteriaceae in UK sewage uncovered by MinION sequencing’ Microbial Genomics 2017: volume 3, e000114-e
47. Martin J and others. ‘Covert dissemination of carbapenemase-producing *Klebsiella pneumoniae* (KPC) in a successfully controlled outbreak: long- and short-read whole-genome sequencing demonstrate multiple genetic modes of transmission’ Journal of Antimicrobial Chemotherapy 2017: volume 72, pages 3,025-34
48. World Health Organization. ‘Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level’ 2016: Geneva, Switzerland
49. Lutgring JD, Limbago BM. ‘The Problem of Carbapenemase-Producing-Carbapenem-Resistant-Enterobacteriaceae Detection’ Journal of Clinical Microbiology 2016: volume 54, pages 529-34
50. Stone PW and others. ‘Hospital staffing and health care-associated infections: a systematic review of the literature’ Clinical Infectious Diseases 2008: volume 47, pages 937-44
51. Karampatakis T and others. ‘Impact of active surveillance and infection control measures on carbapenem-resistant Gram-negative bacterial colonization and infections in intensive care’ Journal of Hospital Infection 2018: volume 99, pages 396-404
52. Karampatakis T and others. ‘Effects of an Active Surveillance Program and Enhanced Infection Control Measures on Carbapenem-Resistant Gram-Negative Bacterial Carriage and Infections in Pediatric Intensive Care’ Microbial Drug Resistance 2019: volume 25, pages 1,347-56
53. Twyman A and others. ‘Control of Carbapenem-resistant Enterobacteriaceae, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* in Healthcare Facilities: A Systematic Review and Reanalysis of Quasi-experimental Studies’ Clinical Infectious Diseases 2018: volume 68, pages 873-84
54. French CE and others. ‘Control of carbapenemase-producing Enterobacteriaceae outbreaks in acute settings: an evidence review’ Journal of Hospital Infection 2017: volume 95, pages 3-45
55. Cantey JB and others. ‘Prompt control of an outbreak caused by extended-spectrum beta-lactamase-producing *Klebsiella pneumoniae* in a neonatal intensive care unit’ Journal of Pediatrics 2013: volume 163, pages 672-9
56. Yan Z and others. ‘Prospective investigation of carbapenem-resistant *Klebsiella pneumonia* transmission among the staff, environment and patients in 5 major intensive care units, Beijing’ Journal of Hospital Infection 2019: volume 101, pages 150-7

57. Tacconelli E and others. ‘ESCMID-EUCIC clinical guidelines on decolonization of multidrug-resistant Gram-negative bacteria carriers’ Clinical Microbiology and Infection 2019
58. Wand ME and others. ‘Mechanisms of Increased Resistance to Chlorhexidine and Cross-Resistance to Colistin following Exposure of Klebsiella pneumoniae Clinical Isolates to Chlorhexidine’ Antimicrobial Agents and Chemotherapy 2017: volume 61
59. Zhang Y and others. ‘Chlorhexidine exposure of clinical strains of *Klebsiella pneumoniae* leads to acquired resistance to this disinfectant and colistin’ International Journal of Antimicrobial Agents 2019
60. Nseir S and others. ‘Risk of acquiring multidrug-resistant Gram-negative bacilli from prior room occupants in the intensive care unit’ Clinical Microbiology and Infection 2011: volume 17, pages 1,201-8
61. Ajao AO and others. ‘Risk of acquiring extended-spectrum beta-lactamase-producing *Klebsiella* species and *Escherichia coli* from prior room occupants in the intensive care unit’ Infection Control and Hospital Epidemiology 2013: volume 34, pages 453-8
62. Stjärne Aspelund A and others. ‘Acetic acid as a decontamination method for sink drains in a nosocomial outbreak of metallo-β-lactamase-producing *Pseudomonas aeruginosa*’ Journal of Hospital Infection 2016: volume 94, pages 13-20
63. Deasy EC and others. ‘Minimizing microbial contamination risk simultaneously from multiple hospital washbasins by automated cleaning and disinfection of U-bends with electrochemically activated solutions’ Journal of Hospital Infection 2018: volume 100, e98-e104
64. Carling PC. ‘Wastewater drains: epidemiology and interventions in 23 carbapenem-resistant organism outbreaks’ Infection Control and Hospital Epidemiology 2018: volume 39, pages 972-9
65. Decraene V and others. ‘A large, refractory nosocomial outbreak of *Klebsiella pneumoniae* carbapenemase (KPC)-producing *Escherichia coli* demonstrates carbapenemase gene outbreaks involving sink sites require novel approaches to infection control’ Antimicrobial Agents and Chemotherapy 2018: volume 62
66. De Geyter D and others. ‘The sink as a potential source of transmission of carbapenemase-producing Enterobacteriaceae in the intensive care unit’ Antimicrobial Resistance and Infection Control 2017: volume 6, page 24
67. Lerner A and others. ‘Environmental contamination by carbapenem-resistant Enterobacteriaceae’ Journal of Clinical Microbiology 2013: volume 51, pages 177-81
68. Casini B and others. ‘Improving cleaning and disinfection of high-touch surfaces in intensive care during carbapenem-resistant acinetobacter baumannii endemo-epidemic situations’ International Journal of Environmental Research and Public Health 2018: volume 15
69. Royal College of Nursing. ‘Wipe it out, essential practice for infection prevention and control’ 2012
70. Clarivet B and others. ‘Persisting transmission of carbapenemase-producing *Klebsiella pneumoniae* due to an environmental reservoir in a university hospital, France, 2012 to 2014’ Eurosurveillance 2016: volume 21, 30213
71. Leitner E and others. ‘Contaminated Handwashing Sinks as the Source of a Clonal Outbreak of KPC-2-Producing *Klebsiella oxytoca* on a Hematology Ward’ Antimicrobial Agents and Chemotherapy 2015: volume 59, pages 714-6

72. Regev-Yochay G and others. ‘Sink traps as the source of transmission of OXA-48-producing *Serratia marcescens* in an intensive care unit’ Infection Control and Hospital Epidemiology 2018: volume 39, pages 1,307-15
73. Department of Health and Social Care. ‘HBN 00-10 Part C Sanitary assemblies’ 2013: London, England
74. Hota S HZ and others. ‘Outbreak of multidrug-resistant *Pseudomonas aeruginosa* colonization and infection secondary to imperfect intensive care unit room design’ Infection Control and Hospital Epidemiology 2009: volume 30, pages 25-33
75. Breathnach AS and others. ‘Multidrug-resistant *Pseudomonas aeruginosa* outbreaks in 2 hospitals: association with contaminated hospital waste-water systems’ Journal of Hospital Infection 2012: volume 82, pages 19-24
76. Kotay SM and others. ‘Droplet- Rather than Aerosol-Mediated Dispersion Is the Primary Mechanism of Bacterial Transmission from Contaminated Hand-Washing Sink Traps’ Applied and Environmental Microbiology 2019: volume 85, e01997-18
77. Aranega-Bou P and others. ‘Carbapenem-resistant Enterobacteriaceae dispersal from sinks is linked to drain position and drainage rates in a laboratory model system’ Journal of Hospital Infection 2018
78. Verfaillie CJ and others. ‘Withdrawal of a novel-design duodenoscope ends outbreak of a VIM-2-producing *Pseudomonas aeruginosa’* Endoscopy 2015: volume 47, page 502
79. United States Food and Drug Administration. Infections Associated with Reprocessed Duodenoscopes 2015
80. Department of Health and Social Care. ‘Management and decontamination of flexible endoscopes (HTM 01-06)’ 2016: London, England
81. National Institute for Health and Care Excellence. ‘Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use’ 2015: London, England
82. Department of Health and Social Care. ‘The Health and Social Care Act 2008 Code of Practice of the prevention and control of infections and related guidance’ London, England
83. Budd E and others. ‘Adaptation of the WHO Essential Medicines List for national antibiotic stewardship policy in England: being AWaRe’ Journal of Antimicrobial Chemotherapy 2019: volume 74, pages 3,384-9
84. Public Health England. ‘Start Smart – Then Focus. Antimicrobial Stewardship Toolkit for English Hospitals’ 2015: London, England
85. Royal College of General Practitioners. ‘TARGET Antibiotics Toolkit’ 2018: London, England
86. Wei Q and others. ‘Evaluation of Modified Rapid Carbapenem Inactivation Method (mrCIM) Combined with Rapid EDTA-Modified Carbapenem Inactivation Method (reCIM) to Detect Carbapenemase and Distinguish Metallo-Carbapenemase in Enterobacteriaceae Within 4 Hours’ Infection and Drug Resistance 2020: volume 13, pages 1,919-27
87. Da Cunha RSR and others. ‘Impact of the blue-carba rapid test for carbapenemase detection on turnaround time for an early therapy against *Pseudomonas aeruginosa*’ American Journal of Infection Control 2020
88. Jing X and others. ‘The Rapid Carbapenemase Detection Method (rCDM) for Rapid and Accurate Detection of Carbapenemase-Producing Enterobacteriaceae and *Pseudomonas aeruginosa*’ Frontiers in Cellular and Infection Microbiology 2019: volume 9, page 371

89. Banerjee R, Humphries R. ‘Clinical and laboratory considerations for the rapid detection of carbapenem-resistant Enterobacteriaceae’ Virulence 2017: 8, pages 427-39
90. Public Health England. English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report 2018
91. Public Health England. Commercial assays for the detection of acquired carbapenemases
92. Public Health England. SMI B 60: Detection of bacteria with carbapenem hydrolysing β lactamases (carbapenemases)
93. Puleston R and others. ‘Recommendations for detection and rapid management of carbapenemase-producing Enterobacterales outbreaks’ Infection Prevention in Practice 2020. Article in press.
94. Love N DJ and others. ‘Towards a harmonised approach to Carbapenemase-producing Enterobacteriaceae (CPE) screening and patient management in North East and Cumbria hospitals’ Access Microbiology 2020: volume 2
95. Gorgulho A and others. ‘Carbapenemase-producing Enterobacteriaceae in a Portuguese hospital a 5 year retrospective study’ Germs 2020: volume 10, pages 95-103
96. Schneider A and others. ‘Implementing a toolkit for the prevention, management and control of carbapenemase-producing Enterobacteriaceae in English acute hospitals trusts: a qualitative evaluation’ BioMed Central Health Services Research 2019: volume 19, page 689
97. Michie S and others. ‘The behaviour change wheel: A new method for characterising and designing behaviour change interventions’ Implementation Science 2011: volume 6, pages 2-11
98. Gould DJ and others. ‘Leadership and management for infection prevention and control: what do we have and what do we need?’ Journal of Hospital Infection 2016: volume 94, page 165-8
99. The Health Foundation. ‘Infection prevention and control: Lessons from acute care in England’ 2015: London, England
100. Centers for Disease Control and Prevention. ‘Vital Signs: Estimated Effects of a Coordinated Approach for Action to Reduce Antibiotic-Resistant Infections in Health Care Facilities – United States’ Morbidity and Mortality Weekly Report 2015: volume 64, pages 826-831
101. Poole K and others. ‘Evaluation of patient-held carbapenemase-producing Enterobacteriaceae (CPE) alert card’ Journal of Hospital Infection 2016: volume 92, pages 102-5.
102. British Society of Rehabilitation Medicine (BSRM). Framework for Action to contain carbapenemase-producing Enterobacteriacae (CPE) – application in rehabilitation 2021: Appendix 1, pages 7-8

Appendices – framework of actions to contain carbapenemase-producing Enterobacterales

A. CPE – Think RISK

B. Risk prioritisation of infection prevention and control measures, screening and isolation

C. How to conduct a CPE risk assessment in non-acute settings

D. Acute care – flow chart of infection prevention and control measures to contain CPE

E . Risk assessment tool for isolating CPE-positive patients (when isolation room capacity is limited)

F. Containing CPE in a paediatric setting

G. Antimicrobial stewardship tools and resources

H. Considerations when managing an outbreak of CPE in acute care settings

I. Primary care quick reference guide

J . Frequently asked questions that can be used in local patient information materials

K. CPE patient-held card

Appendix A: CPE – Think RISK

Healthcare providers should consider the risk of CPE carriage when admitting patients. Patients that meet the risk criteria should be screened on admission.

R – Recent exposure to antibiotics	Patients that have received the following antibiotics in the previous month are at increased risk of CPE carriage: • Cephalosporins • Piperacillin and tazobactam • Fluoroquinolones • Carbapenems
I – In the last 12 months	Screen if a patient: • previously been identified as CPE positive • was admitted to any hospital in the UK or overseas • has had multiple hospital treatments for example haemodialysis or receiving cancer chemotherapy

S – Specialty	Patients admitted to the following specialties should be screened:
	• augmented care
	• high risk settings –
	  • immunosuppression
	  • transplant
	  • haematology and oncology
	  • organ support
	  • extensive care needs for example liver
	  • burns unit
	• Long Term Care Facilities where higher levels of interventional care are provided for example long term ventilation

K – Knowledge of local CPE transmission	Screen if patient has been in contact with a known case of CPE

Appendix B: Risk prioritisation of infection prevention and control measures, screening and isolation

It is best practice for any patient receiving care who has a risk factor for colonisation with carbapenemase-producing Enterobacterales to be isolated and managed in line with the CPE framework of actions. However, where risk prioritisation is required (due to competing priorities such as side room availability) the matrix below is intended as a guide to patient placement. This is a prioritisation tool, and while the high and medium risk groups of patients are recommended to be isolated in side rooms, it is recognised this is not always possible.

	Patient characteristic				
Care environment	Known CPE case	Direct transfer from hospital abroad	Epidemiological link	Hospitalisation last 12 months	Care dialysis and chemotherapy
Admission to specialist and augmented unit					
Admission to general acute ward					
Day and ambulatory care	**	**	**	**	**
Outpatient clinic	**	**			
Care and residential homes					

High risk	Isolate immediately in a single room with en-suite facilities (or dedicated commode or WC) and retain in isolation until screening results available
Medium risk	Isolate in single room with en-suite facilities (or dedicated commode or WC) if possible (see increased transmission risks) until screening results available. If not possible to isolate in single room then nurse with strict emphasis on maintaining compliance with contact precautions and optimal environmental cleaning following discussion with IPC team **For outpatients and day cases – provide appointment timed for end of clinic or list; consider caring for day case in single room dependent on degree of contact with body fluids for example endoscopic procedures would pose greater risk of transmission than an ophthalmology patient. Maintain compliance with standard precautions and optimal environmental cleaning. In an outpatient setting, contact precautions should be instigated based on a risk assessment and in discussion with IPC team.
Low risk	No action, other than be alert to change in risk-level in light of any further information relating to patient status. Maintain compliance with standard infection control precautions and optimal environmental cleaning.
The following factors increases the risk of CPE transmission and should be considered when prioritising side rooms. Patients with: • diarrhoea, incontinence (urine or faeces), discharging wounds, medical devices in situ, ventilatory support requirements, high risk of wandering and poor hygiene	

For the purposes of this document, the patient groups in an augmented care or high risk settings include:

a. those patients who are severely immunosuppressed because of disease or treatment: this will include haematology and oncology and transplant patients and similar heavily immunosuppressed patients during high-risk periods in their therapy
b. those cared for in units where organ support is necessary, for example critical care (adult, paediatric and neonatal), renal (including dialysis settings), respiratory or other critical care or intensive care situations
c. those patients who have extensive care needs such as liver units and patients with breaches in their dermal integrity, such as in those units caring for burns

Appendix C: How to conduct a risk CPE assessment in non-acute settings

At all risk levels ensure:

- standard infection control precautions are maintained at all times
- effective environmental hygiene and cleaning – prevention of faecal and environmental contamination is crucial; remain alert to episodes that risk direct transmission to others and or environmental contamination; ensure timely and thorough cleaning
- hygiene advice to individual and family and contacts it is important to inform individuals and those around them to ensure they take appropriate personal hygiene measures to prevent the spread of infection, especially when using the toilet

Risk assessments must include consideration of the care environment, for example nursing care setting, specialist or general-rehabilitation, haemodialysis unit, EMI, dementia care unit, community hospital or hospice, mental health trust, residential care, domiciliary care, or detention centre prison.

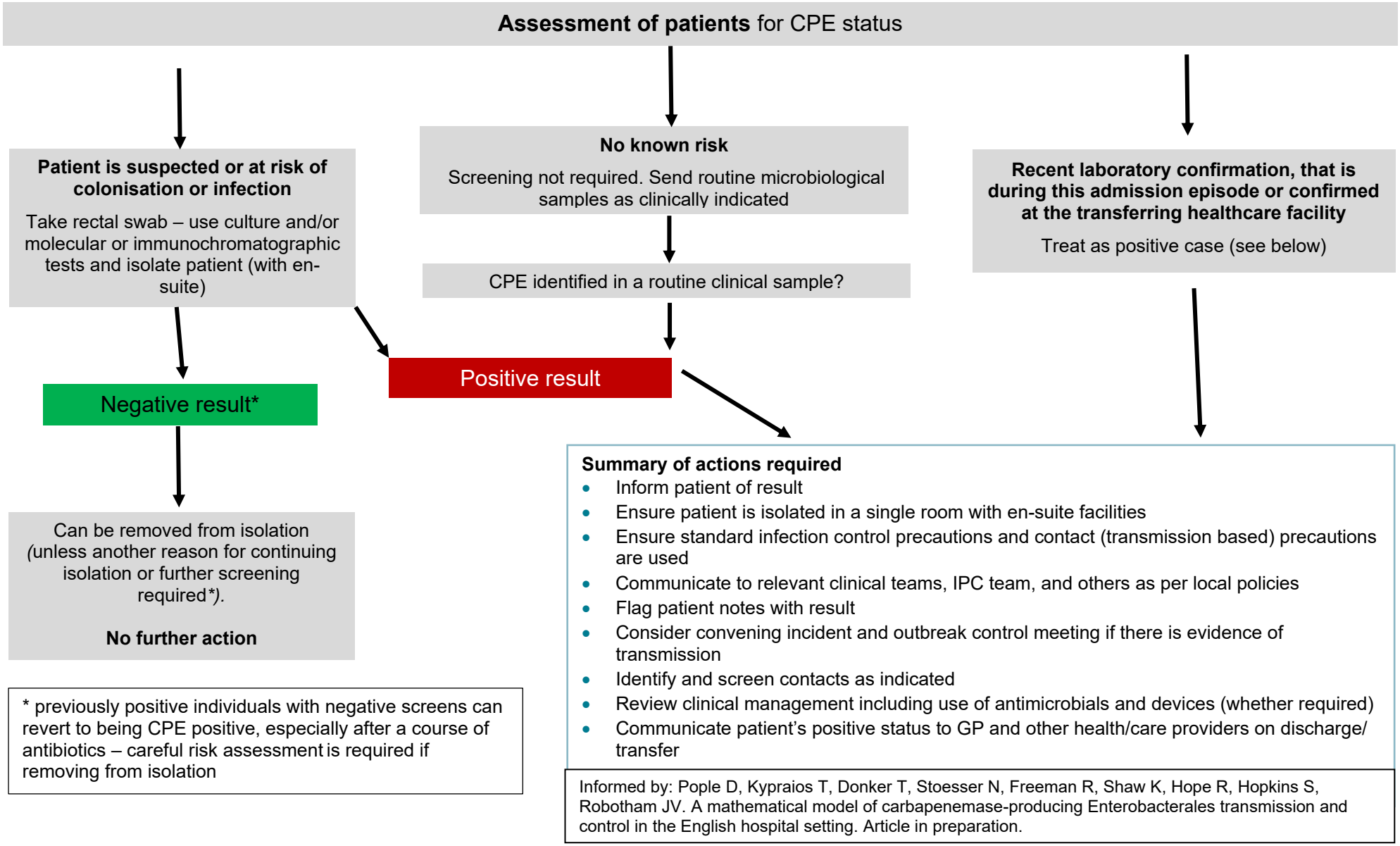
If the individual is colonised (the presence of bacteria on a body surface, such as skin or gut, without causing disease in the person): single room with en-suite facilities including toilet or designated commode is recommended; where a single room is not available, it is recommended that a designated toilet or commode is made available. No curtailment of communal activities is required where standard precautions and effective environmental hygiene are being maintained and there is no risk of transmission to others.

If the individual is infected: conduct a risk assessment with your IPC advisor and or UKHSA contact to discuss possible isolation (with defined end-of-isolation criteria) consider the mental and physical health and wellbeing of the individual when deciding to isolate.

Always communicate the positive status of an individual when transferring the individual between care settings.

Care needs	Guidance for risk assessment
High risk For example, the individual has: • diarrhoea, faecal incontinence, smearing or dirty protests • discharging wound • long term ventilation • confusion and dementia • device(s) in situ • undergoing invasive procedures	Identify if there is an immediate risk of infecting or contaminating others and the shared environment. Discuss management with GP or clinician in charge, IPC nurse. Consider the mental and physical health and wellbeing of the individual and the level of supervision required.
Medium risk For example, the individual requires assistance with hygiene, mobility or physical rehabilitation.	No immediate risk of infecting others identified: • standard infection control precautions are maintained • hygiene advice is provided to individual and family and contacts as appropriate • maintain effective environmental hygiene If unsure, contact your usual IPC advisor or UKHSA via the local Health Protection Team or Consultant in Public Health Infection, or local Community IPC Team where available.
Low risk For example, the individual is independent and self-caring.	

Appendix D: Acute care – flow chart of infection prevention and control measures to contain CPE



* previously positive individuals with negative screens can revert to being CPE positive, especially after a course of antibiotics – careful risk assessment is required if removing from isolation

Informed by: Pople D, Kypraios T, Donker T, Stoesser N, Freeman R, Shaw K, Hope R, Hopkins S, Robotham JV. A mathematical model of carbapenemase-producing Enterobacterales transmission and control in the English hospital setting. Article in preparation.

Acute care: flow chart of infection prevention and control measures to contain CPE – text alternative

Question 1. Assessment of patients for CPE status

- Go to question 2, 3 or 4

Question 2. Patient is suspected or at risk of colonisation or infection. Take rectal swab – use culture and/or molecular or immunochromatographic tests and isolate patient (with en-suite):

- Negative result: Can be removed from isolation *(*unless another reason for continuing isolation or further screening required*).* No further action
- Positive result:

  Summary of actions required
  - Inform patient of result
  - Ensure patient is isolated in a single room with en-suite facilities
  - Ensure standard infection control precautions and contact (transmission based) precautions are used
  - Communicate to relevant clinical teams, IPC team, and others as per local policies
  - Flag patient notes with result
  - Consider convening incident and /outbreak control meeting if there is evidence of transmission
  - Identify and screen contacts as indicated
  - Review clinical management including use of antimicrobials and devices (whether required)
  - Communicate patient's positive status to GP and other health/care providers on discharge/ transfer

(Informed by: Pople D, Kypraios T, Donker T, Stoesser N, Freeman R, Shaw K, Hope R, Hopkins S, Robotham JV. A mathematical model of carbapenemase-producing Enterobacterales transmission and control in the English hospital setting. Article in preparation.)

Question 3. No known risk. Screening not required. Send routine microbiological samples as clinically indicated. CPE identified in a routine clinical sample?

- Positive result

  Summary of actions required:
  - Inform patient of result
  - Ensure patient is isolated in a single room with en-suite facilities
  - Ensure standard infection control precautions and contact (transmission based) precautions are used
  - Communicate to relevant clinical teams, IPC team, and others as per local policies
  - Flag patient notes with result

- Consider convening incident and outbreak control meeting if there is evidence of transmission
- Identify and screen contacts as indicated
- Review clinical management including use of antimicrobials and devices (whether required)
- Communicate patient's positive status to GP and other health/care providers on discharge/ transfer

(Informed by: Pople D, Kypraios T, Donker T, Stoesser N, Freeman R, Shaw K, Hope R, Hopkins S, Robotham JV. A mathematical model of carbapenemase-producing Enterobacterales transmission and control in the English hospital setting. Article in preparation.)

Question 4. Recent laboratory confirmation, that is during this admission episode or confirmed at the transferring healthcare facility. Treat as positive case

- Positive result:
  Summary of actions required:
  - Inform patient of result
  - Ensure patient is isolated in a single room with en-suite facilities
  - Ensure standard infection control precautions and contact (transmission based) precautions are used
  - Communicate to relevant clinical teams, IPC team, and others as per local policies
  - Flag patient notes with result
  - Consider convening incident and /outbreak control meeting if there is evidence of transmission
  - Identify and screen contacts as indicated
  - Review clinical management including use of antimicrobials and devices (whether required)
  - Communicate patient's positive status to GP and other health/care providers on discharge/ transfer

(Informed by: Pople D, Kypraios T, Donker T, Stoesser N, Freeman R, Shaw K, Hope R, Hopkins S, Robotham JV. A mathematical model of carbapenemase-producing Enterobacterales transmission and control in the English hospital setting. Article in preparation.)

* previously positive individuals with negative screens can revert to being CPE positive, especially after a course of antibiotics – careful risk assessment is required if removing from isolation

Appendix E: Risk assessment tool for isolating CPE-positive patients (when isolation room capacity is limited)

	Yes	No
Does the patient have diarrhoea? (Type 6 or 7 on Bristol Stool Chart)	Nurse in a side room on a general ward	See questions below
Is the patient…	**Yes**	**No**
Continent of urine and faeces?	✓	
Alert and orientated?	✓	
Independently mobile?	✓	
➔ Consider caring for the patient in a bay on a general ward		
Is the patient…	**Yes**	**No**
Continent of urine and faeces?		✘
Alert and orientated?	✓	
Independently mobile?	✓	
➔ Patient to be nursed in a side room on general ward (refer to Continence Nurse for additional advice regarding the management of continence, if available)		
Is the patient…	**Yes**	**No**
Continent of urine and faeces?	✓	
Alert and orientated?		✘
Independently mobile?	✓	
➔ Take into account clinical environment and risk; consider moving patient to an alternative area if confused and unable to comply with isolation in a side room		
Is the patient…	**Yes**	**No**
Continent of urine and faeces?	✓	
Alert and orientated?	✓	
Independently mobile?		✘
➔ Patient can be nursed in a bay on a general ward with a dedicated commode		

Appendix F: Containing CPE in a paediatric setting

Advice from Infection Prevention and Control (IPC) team

Seek advice from your IPC team, to assist with conducting a risk assessment appropriate for your environment or hospital.

There are several considerations. the key one being that the parent(s) are also likely to be colonised with a CPE and therefore, ensure the baby (with resident mother) is placed in a room with an en-suite for the mother, and their visitors to use. If an en-suite is not available, consider a dedicated toilet.

Food management

Food brought in from home is also a potential source of cross contamination of shared fridges. Food brought in by the family should be in wipeable containers, this need to be wiped clean prior to placing in or back into the fridge. Containers or food that has come into the patient's environment should not be returned to the communal fridge.

Equipment management

The family are not to take any equipment or hospital items nappies, milk bottles, trays and so on out of the room. Equipment is only to be taken out of the room by a member of staff who will then clean according to the trust agreed protocol for this situation.

Used nappies

These should not be taken out of the room – if weighing is required, weigh in the room. If this is not possible, they should be taken out in a nappy sack or container, by a member of the unit staff (not the parent or carer) to the sluice room and weighed, then disposed of. Cleaning of the scales plus any surfaces that the nappy, or staff member has been in contact with should then be undertaken.

Breast pumps

It is preferable for a mother to use her own pump. This can stay in the room with the mother, the expressing kit will need decontaminating, this should be carried out by a HCW if coming out of the room. If the mother does not have her own pump, a dedicated breast pump is preferable to be used for her for the length of the baby's admission.

Management of expressed milk

Bottles should be cleaned by a HCW prior to storage in a communal fridge.

Feeding bottles and equipment are disposed of in the room.

Follow the local procedure for cleaning and decontamination of expressed kits, ensuring that surfaces are not left contaminated.

The mother and baby's clothing should be taken home to launder and the family given advice on washing clothes at a high temperature.

The family should be able to use communal areas with advice on maintaining hand hygiene after handling nappies and care of the baby.

If the baby has or develops loose or diarrhoea stool or has a stoma

If the family are involved with nappy care or with this aspect of care, then they should wear an apron to protect their clothing from contamination to prevent possible spread to communal areas. They should be reminded of the importance of hand hygiene to reduce cross transmission

Education and follow up

The family and visitors must be educated in hand hygiene, fridge management; equipment management, as necessary and follow up to ensure compliance.

Management of food trays

Food trays and crockery, cutlery and water jugs are only to be removed from the room by the ward staff. If possible clean the underside of the tray or item prior to leaving the room. In the kitchen ensure that the crockery cutlery and tray are placed directly in the dishwasher. The surface in the kitchen should be cleaned after contact.

Toys and play

Toys should be dedicated for the child with CPE for the duration of their stay. Those that are not cleanable should either go home with the child or be discarded.

School age children having teaching

This should occur in the child's room. Items that cannot be easily cleaned should not be used and should not be brought into the room.

Education staff need to wear the same PPE as unit staff.

Laptops and similar items can be wiped clean by the education team after use.

Sibling visitors are not to use the playroom or school areas or communal play areas in the trust. Minimise visitors.

Appendix G: Antimicrobial stewardship tools and resources

Please click on underlined text for link.

NICE. Antimicrobial Stewardship. All NICE products on antimicrobial stewardship. Includes guidance, advice, NICE Pathways and quality standards

Health Education England. Training resources on antimicrobial resistance and stewardship

UKHSA. Antimicrobial Stewardship: Organisational Peer-to-Peer Review Tool to Improve Service Provision in Line with National Guidance

Viale P and others. Considerations About Antimicrobial Stewardship in Settings with Epidemic Extended-Spectrum beta-Lactamase-Producing or Carbapenem-Resistant Enterobacteriaceae. Infectious Diseases and Therapy 2015: volume 4, supplement 1, pages 65-83

Hawkey PM and others. Treatment of infections caused by multidrug-resistant Gram-negative bacteria: report of the British Society for Antimicrobial Chemotherapy/Healthcare Infection Society/British Infection Association Joint Working Party Journal of Antimicrobial Chemotherapy 2018: volume 73**,** supplement 3, pages iii2-iii78

Antimicrobial consumption

UK Health Security Agency (UKHSA). ‘AMR local indicators’ London

UKHSA. ‘English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Yearly Report’ London, UKHSA 2021

Nathwani D, Sneddon J. ‘Practical Guide to Antimicrobial Stewardship in Hospitals’ London, British Society for Antimicrobial Chemotherapy 2013

Carbapenem sparing strategies

Wilson APR. Sparing carbapenem usage. Journal of Antimicrobial Chemotherapy 2017: volume 72 issue 9, pages 2,410-2,417

Appendix H: Considerations when managing an outbreak of CPE in acute care settings

Confirm type of patients and rapidity of detection
• Assess if high-risk setting or patient [see Appendix B] • Check for any delays in identification and isolation of cases • Identify contacts and monitor their distribution across the healthcare facilities (including non-acute settings)
Adopt appropriate screening strategy
• Consider what screening strategy is appropriate (including frequency) to identify the exposed pool of contacts
Optimise staff-patient ratios
• Optimise staff-patient ratios to allow good adherence with infection prevention and control activities • Minimise transfer of staff from affected unit to unaffected units
Monitor adherence to infection prevention and control guidelines and cleaning standards
• Observe and highlight deficiencies in current IPC practice, and audit implementation • Implement enhanced cleaning and disinfection approaches to mitigate the outbreak and ensure these are implemented rigorously and consistently
Consider isolation and cohorting strategy
• Consider what isolation strategy is needed and implement [see Appendix D and Appendix E] • Cohorting may be appropriate where there are insufficient single rooms for individual isolation (ensure advice is sought from microbiologist) • Cohorting should not be undertaken where patients have different carbapenemases or different organisms • There is some indirect evidence that nurse cohorting prevents further CPE transmission (28)
Ensure appropriate use of shared patient equipment (for example blood pressure monitors, commodes)
• Ensure single use patient equipment is being used • Where equipment must be reused ensure appropriate disinfection
Consider environmental reservoirs
• Consider environmental risk factors, shared equipment and reservoirs for example sink drains, and the inappropriate use of hand wash basins • Environmental microbiological sampling guided by microbiological advice on suitable sites and sampling methods may be considered

• Review need for enhanced frequency of cleaning and or the introduction of a disinfectant
Assess current antibiotic pressures
• Consider whether prescribing formulary changes are required to minimise patient or environmental exposure to broad spectrum antibiotics, in particular carbapenems
Ensure involvement of staff with relevant expertise
• Ensure multi-disciplinary team includes IPC staff and staff experienced in outbreak management • Agree incident action plan including communications to key staff and stakeholders and update regularly • Consider closing the unit or ward to admissions to minimise potential for transmission to other patients and minimise patient transfers from affected unit
Undertake appropriate epidemiological assessment
• Develop definitions for cases and contacts • Describe outbreak data to determine epidemiological links and potential sources • Implement effective interventions as soon as possible
Implement communication plan
• Implement internal and external outbreak communications plan including patients and families, staff awareness and media • Implement regular brief reminders to staff to promote strict adherence to the outbreak and incident plan, particularly around adherence to IPC policies

Appendix I: Primary care quick reference guide

Carbapenemase-producing Enterobacterales

Enterobacterales are Gram-negative bacteria (including *Escherichia coli*, *Klebsiella* spp. and *Enterobacter* spp.) of which a subgroup, the Enterobacteriaceae, naturally colonise the gut of humans and animals.

They commonly cause opportunistic urinary tract, intra-abdominal and bloodstream infections.

Carbapenemases are enzymes for example KPC, OXA-48, NDM and VIM, that destroy carbapenem antibiotics, thereby conferring resistance.

Carbapenem antibiotics, include meropenem, ertapenem and imipenem, which are normally reserved for serious infections caused by drug-resistant Gram-negative bacteria.

Colonisation with carbapenemase-producing Enterobacterales is more common than infection; the duration of colonisation is unclear.

High-risk groups, that are at increased risk of being colonised or infected

In the last 12 months has the individual:

- been an inpatient in any hospital, UK or abroad?
- had multiple hospital treatments, for example are dialysis-dependant or have had cancer chemotherapy?
- been previously identified as CPE-positive (includes household and care home contacts of known cases)?
- been admitted to an augmented care or high-risk unit?

Based on local epidemiology:

- immunosuppression
- previous exposure to broad spectrum antibiotic courses, particularly carbapenems in last month
- resident in Long Term Care Facilities, particularly where higher levels of interventional care are provided for example long term ventilation

What is required from primary care

On receipt of a positive result, inform and advise the patient (and or family as appropriate) and care setting.

Where the patient is in residential care, or hospital admission or repeat visits are likely, prompt your local infection prevention and control teams and UKHSA Centre or Health Protection Team to undertake risk assessment in relation to the patient and prevention of transmission if required.

Code in notes as significant and indefinite or 1 year as Extended spectrum beta lactamase and carbapenemase producing bacteria (organism) SCTID: 762987008
Seek advice from a local medical microbiologist for the management of infection (see below if colonised only); refer to secondary care for the management of severe infections.

Communicate status to any receiving health and social care providers.

Screening and early detection (only if requested)

Not routinely used in community. If required, rectal swab ensuring visible faecal material on swab (stool sample second choice); swabs from wounds and device related sites may provide additional information if requested.

Decolonisation

Neither skin nor gut decolonisation are recommended. There is no effective equivalent of the topical suppression used to reduce shedding of MRSA in the healthcare environment. Attempts at eradication of MDR Gram negative organisms from the gastrointestinal tract have not been successful.

Treatment of infection

If an infection is due to carbapenemase-producing Enterobacterales, discuss treatment with a microbiologist. If a patient with previous carbapenemase-producing Enterobacterales colonisation or infection presents with a suspected infection that is likely to be caused by a Gram negative organism and requires empirical antibiotics, a microbiologist should be contacted for advice on antibiotic choice.

Infection prevention and control

In your surgery, standard infection prevention and control practices will minimise the spread of this organism. Standard precautions should be rigorously implemented at all times. Seek advice from your local IPC team or UKHSA centre or Health Protection Team if needed; where infection exists refer to risk assessment guidance and IPC guidelines for recommended measures to prevent the spread of infection.

Communication

Include patient carbapenemase-producing Enterobacterales status in all communications and within the patient record. It is crucial to communicate patient carbapenemase-producing Enterobacterales status during referrals.

Appendix J: Frequently asked questions that can be used in local patient information materials

General

What are ‘carbapenemase-producing Enterobacterales’?

Enterobacterales are bacteria that usually live harmlessly in the gut of humans. This is called colonisation (a person is said to be a carrier). However, if the bacteria get into the wrong place, such as the bladder or bloodstream they can cause infection.

Carbapenemase-producing Enterobacterales (abbreviated to CPE) are a type of bacteria which have become resistant to carbapenems, a group of powerful antibiotics. This resistance is helped by enzymes called carbapenemases, which are made by some strains of the bacteria and allows them to destroy carbapenem antibiotics. This means the bacteria can cause infections which are resistant to carbapenem antibiotics and many other antibiotics.

Why does carbapenem resistance matter?

Doctors rely on carbapenem antibiotics to successfully treat certain complicated infections when other antibiotics have failed. The spread of these resistant bacteria can cause problems to vulnerable patients in hospitals or other settings because there are so few antibiotics available to treat the infections they cause.

CPE positive patient

How did I get this infection and what are the symptoms?

This bacteria can be found, living harmlessly, in the gut of humans and so it can be difficult to say when or where you picked it up. However, there is an increased chance of picking up these bacteria if you have been a patient in a hospital abroad or in the UK that has had patients carrying the bacteria, or if you have been in contact with a carrier elsewhere.

How will I be cared for while in hospital?

You may stay in a single room with toilet facilities or in a specific ward whilst in hospital. You may be asked to provide a number of samples, depending on your length of stay, to check if you are infected with or carrying the bacteria. The samples might include a number of swabs from certain areas, such as where the tube for your drip (if you have one) enters the skin, a rectal swab (a sample taken by inserting a swab briefly inside your bottom), and/or a stool sample.

How can the spread of CPE be prevented?

Being in a single room or specific area helps to prevent spread of the bacteria. Healthcare workers will use gloves and aprons when caring for you and should wash their hands regularly. The most important measure for you to take is to wash your hands well with soap and water, especially after going to the toilet. You should avoid touching medical devices (if you have any) such as your urinary catheter tube and your intravenous drip, particularly at the point where it is inserted into your body or skin. Visitors will be asked to wash their hands on entering and leaving the room and may be asked to wear an apron.

What about when I go home?

You may still be a carrier of CPE when you go home and quite often this will go away with time. No special measures or treatment are required at home. You should carry on as normal, maintaining good hand hygiene. If you have any concerns you may wish to contact your GP for advice.

Before you leave hospital, ask the doctor or nurse to give you a letter or card advising that you have had an infection and may still be a carrier of CPE. This will be useful for the future and it is important that you make healthcare staff aware of it. Should you or a member of your household be admitted to hospital, you should let the hospital staff know that you are, or have been a carrier of CPE and show them the letter or card.

How long does a person carry the bacteria?

There is no definitive answer to how long a person may carry the bacteria. The length of time could be anything from a few days to indefinitely. Treatment with certain antibiotics (for any infection) may also affect length of carriage. Effective hygiene practices and the use of standard precautions for all individuals receiving care will minimise the transmission of carbapenemase-producing *Enterobacterales*.

Where can I find more information?

If you would like any further information please speak to a member of your care staff, who may also contact the Infection Prevention and Control Team for you. The UKHSA website is another source of information.

Non-acute settings

What is the risk to those being cared for in the community?

Most people will be unaware that they are a carrier and, in general, the chance of developing an infection with the bacteria is low. However, immunocompromised individuals, and those receiving complex care in the community with frequent hospital admissions will be more vulnerable. These individuals are at greater risk of colonisation

and potentially suffering more serious consequences should they develop an infection. Colonised individuals with devices in situ may be at greater risk of developing an infection.

While the level of risk for infected or colonised individuals is lower than in acute settings, if the levels of hygiene in the care setting are inadequate, resistant bacteria may spread among individuals who congregate together for example in a care home. This may increase the risk of the spread of infection within the care setting.

For managing carbapenemase-producing Enterobacterales why do you advise different approach for the community than you do for acute trusts?

Patients in an acute care setting often have multiple intensive interventions which restrict daily life and are concentrated together with many other vulnerable patients. In contrast, most individuals in the community are in their own home or another community setting. Generally, but not always, they are more likely to be more mobile and undergo fewer procedures or interventions.

Risk of spread in the community setting is low. To maintain a low level of risk, effective hygiene practices should be maintained by all, service users and staff; particularly for staff when assisting positive individuals with toileting, undertaking dressings, managing or changing urinary catheters and other devices. It is crucial that the affected individual is encouraged or assisted to practice good hand hygiene after visiting the toilet and that good infection prevention and control standards are followed in the management of diarrhoea and leaking wounds.

Why is screening of individuals suspected of being a carrier recommended for acute trusts but not for other care settings?

There is a higher risk of spread between patients in an acute setting. To manage patients effectively, acute trusts need to have a full understanding of the patient's positive or carrier status, achieved through screening. This will allow them to plan the care for that individual and those around them in a safe and effective manner.

Are staff at risk of taking this home to their families? I have a vulnerable relative at home. If I care for this individual will I put my relative at risk?

Like any other bacteria that staff come into contact with routinely, effective hand hygiene and adherence to standard precautions, are the most effective way to prevent indirect spread to others, including family members. Staff should carry on as normal at home without any changes to their activities of daily living.

In order to alleviate their concerns, organisations should ensure that all staff have appropriate education, training and knowledge about carbapenemase–producing *Enterobacterales* and measures aimed at preventing their spread.

Should staff caring for individuals colonised or infected with carbapenemase-producing Enterobacterales be screened to see if they have become a carrier themselves?

Currently, there is no evidence to support screening of staff as part of routine infection prevention and control measures. Adherence to standard precautions in the workplace and effective hand hygiene at all times are the key measures to prevent spread.

What happens if the individual needs to go into hospital or to another care home?

When transferring an affected individual to another care setting, senior staff should ensure that the destination hospital or setting has been supplied with a completed copy of the Inter care transfer form notification of an individual carrying or infected with a carbapenemase producing *Enterobacterales* or other multidrug resistant organism to inform the receiving facility of the individual's positive status.

Direct verbal communication of the individual's status to the receiving staff and the IPC team may be helpful in assisting them to make an appropriate risk assessment (as long as confidentiality requirements can be maintained). A patient held card (Appendix K) may be useful for the individual to present to staff if they attend another health or social care setting.

What about family members or visitors who are pregnant?

The placenta is an effective barrier in preventing bacteria such as carbapenemase-producing *Enterobacterales* from crossing from the mother to the baby, therefore the unborn baby is not at risk in the womb. The affected individual should practice effective hand hygiene, especially after visiting the toilet (as these bacteria are mainly carried in the gut) to minimise transmission of carbapenemase-producing *Enterobacterales*. Similarly, effective hygienic practices by those who live with and care for the individual, including adherence to standard precautions by carers are important.

The affected individual wants to know if it is safe for them to share a bed with their partner?

There is a chance that the bacteria could be passed onto the partner, particularly if the affected individual has a discharging infected wound. This would need to be contained within an impermeable dressing and regular laundering of bedding encouraged. Advice can be sought about individual cases from your usual IPC advisor, the individual's GP or local UKHSA centre.

When ambulance staff transport a patient, are any extra precautions required?

In a similar way to transporting any patient, standard precautions should be adopted and routine cleaning of trolleys and equipment between patients undertaken. If there is any contamination from a leaking wound or faecal contamination, terminal cleaning of the vehicle will be required.

What about affected individuals who have companion animals?

Companion animals, for example cats, dogs and horses can become colonised or infected with carbapenemase-producing *Enterobacterales*. There is some evidence to suggest the transmission of carbapenemase-producing *Enterobacterales* from affected humans to companion animals, and rare evidence of transmission between companion animals in veterinary hospitals. Further research is required to understand the risk that colonised companion animals pose to human health. Effective hand hygiene using soap and water when handling companion animal faeces, before handling food for companion animals and maintaining a clean environment can minimise the risk of transmission.

Where can we get further advice?

If the advice is not relevant to your situation, please seek further advice from your usual advisor or community or CCG IPC team or nurse, medical microbiologist, the individual's general practitioner (according to which service is appropriate and available). Alternatively, you may obtain further advice and signposting, particularly in relation to making a risk assessment, through your local UKHSA Centre. The UKHSA website is another source of information.

Appendix K: CPE patient-held card

Some trusts may provide CPE carriers with cards such as found below. This card can be cut out and folded in half to fit in a standard wallet or printed double sided at credit card size.

An evaluation on the use of these cards has been published.[14]

UK Health Security Agency

NHS

Important information about carbapenemase-producing Enterobacterales (CPE)

Please show this card to health and social care staff if you need to attend a health or social care setting

For the attention of health and social care staff

This patient is known to be colonised with CPE. Please follow your local infection control guidelines.

For further advice please contact your local infection prevention and control team.

Issued: ___________

UK Health Security Agency

NHS

Important information about carbapenemase-producing Enterobacterales (CPE)

Please show this card to health and social care staff if you need to attend a health or social care setting

For the attention of health and social care staff

This patient is known to be colonised with CPE. Please follow your local infection control guidelines.

For further advice please contact your local infection prevention and control team.

Issued: ___________

UK Health Security Agency

NHS

Important information about carbapenemase-producing Enterobacterales (CPE)

Please show this card to health and social care staff if you need to attend a health or social care setting

For the attention of health and social care staff

This patient is known to be colonised with CPE. Please follow your local infection control guidelines.

For further advice please contact your local infection prevention and control team.

Issued: ___________

[14] Poole K and others. 'Evaluation of patient-held carbapenemase-producing Enterobacteriaceae (CPE) alert card' Journal of Hospital Infection 2016: volume 92, pages 102-5

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

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