Public Health England

Protecting and improving the nation's health

Framework of actions to contain carbapenemase-producing Enterobacterales

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Executive summary

This framework focuses on **carbapenemase-producing Enterobacterales (CPE)** because these organisms spread rapidly in healthcare settings and leading 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, learning 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 to minimise spread, with appropriate surveillance systems to capture this
- prompt recognition of outbreaks and clusters to enable effective management
- consistent implementation of infection prevention and control practices
- 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 bacteria
- organisational ownership to support the implementation of this framework.

This document recognises that the evidence base for some recommendations is limited and that local risk assessment is important for building a local CPE policy 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 eight areas with core recommendations that all settings should introduce or further develop:

Framework of actions to contain CPE	
*Patient screening**	• Active screening for CPE is recommended to minimise transmission from CPE positive patients, to minimise the risk that colonised patients will develop clinical infection and to minimise environmental contamination and the development of potential reservoirs. • Patient screening, the scope of which should be guided by number of acquisitions and ward environment, must accompany infection prevention and control (IPC) interventions.
Surveillance	• Surveillance systems and appropriate microbiological testing are needed to rapidly detect and monitor patients either colonised or infected with CPE to inform infection prevention and control activities, particularly during outbreaks.
Infection prevention and control	• Consistent implementation of a combination of infection prevention and control interventions including patient isolation, has been shown to reduce the spread of CPE. This includes the application of standard infection control precautions and contact (transmission based) precautions.
Cleaning and decontamination	• Thorough cleaning processes are required when CPE positive patients are detected as the environment of these patients has been found to be significantly contaminated and this poses a transmission risk to other patients. Thorough must be undertaken before disinfection.
Outbreaks and clusters	• Detection of CPE in a patient or resident setting must be investigated promptly to enable effective IPC interventions and prevent

	onward transmission. This will minimise the occurrence of clusters or outbreaks. • Environmental samples should only be taken when epidemiologically indicated.
Antimicrobial stewardship (AMS)	• AMS audit data should be reviewed at regular intervals by local antimicrobial stewardship committees (or equivalent) and specific action taken where there are early signals of increasing antimicrobial resistance (AMR) or antimicrobial consumption trends, particularly broad-spectrum agents including carbapenems
*Laboratory methods**	• Implementation of molecular or immunochromatographic assay in frontline diagnostic laboratories for the detection of KPC, OXA-48-like, NDM and VIM carbapenemases. Refer to AMRHAI carbapenem resistant isolates with local negative tests to detect IMPs.
Organisational responsibilities	• Organisational leadership to support the infection prevention and control programme aimed at preventing the spread of CPE by providing materials and, organisational and administrative support including monitoring, audit and feedback.

**not applicable outside of acute providers of care*

Section 1. Context & background

1.1 Rationale for the update and objectives

This document is an update of the Acute trust toolkit for the early detection, management and control of Carbapenemase-producing Enterobacteriaceae and the Carbapenemase-producing Enterobacteriaceae: non-acute toolkit. Stakeholders had requested one document to replace the two 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 (and those working in other settings where interventions may also be important), to develop their own guidance and tools for the early recognition of CPE, to prevent transmission and contain 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 Public Health England (PHE)

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 document has been developed to provide a framework of recommended practice to aid the detection of CPE early, prevent transmission and contain their spread within health and social care settings. This framework provides 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 CPE spread.

This document refers to CPE alone, although some interventions may be common to other carbapenem resistant species/organisms such as carbapenem-resistant *Pseudomonas* spp. and *Acinetobacter* spp., the latter are not included within the document given the differences in epidemiology, microbiology, transmission, and environmental persistence. In 2017, the World Health Organisation has produced detailed guidance [11] 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 these relate solely to a specific sector this will be clarified.

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 all 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. Almost everyone carries antibiotic susceptible strains of these bacteria in their gut.

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

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 carbapenemase-producing Enterobacterales (CPE). KPC, OXA-48, NDM, VIM, and IMP enzymes are the most common types. Increasing gut colonisation with these resistant bacteria will inevitably lead to an increase in difficult to treat infections.

1.4 Importance of controlling CPE

Unless action is taken and learning from experiences elsewhere in the world (see Appendix A for guideline comparison), 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, lead to poor clinical outcomes because of limited therapeutic options, and have significant cost and operational implications for healthcare organisations.

Previous 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. This guidance is intended to assist with rapid identification and control of CPE, limiting their spread and preventing endemicity.

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,
- individualised risk assessments of areas where transmissions is most likely to occur.

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

In this framework, we refer to CPE surveillance and control that relate to one organism strain (clonal), and across multiple different organisms where the same resistance mechanism is identified.

1.5 New evidence over past 5 years since previous guidelines[1]

In summary, there is increasing evidence that:

1. Patients are colonised with CPE prior to developing an invasive infection.
2. CPE screening can be cost effective.
3. Invasive infections with CPE increases both patient length of stay, as a consequence of morbidity, and mortality, compared to bacteria not carrying resistance markers.
4. The management of individual patients with CPE and outbreaks of CPE is costly.
5. Almost all acute care 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.

[1] The evidence behind these statements is referenced in relevant sections of the Framework

6. The aim of active screening is to prevent transmissions and therefore prevent an increase in the numbers of colonised patients who are at risk of invasive infection.[2] Therefore acute care providers should screen patients at risk of colonisation.
7. Identifying patients colonised with CPE is optimised by taking rectal swabs
8. Laboratories should ensure they have methods in place to detect both CPE colonisation and invasive infections using relevant PHE guidance. Detecting carbapenemase genes is important to recognise outbreaks as these genes spread horizontally (between strains of bacteria) and potentially inform new options for treatment.
9. Transmission to other patients is reduced with the consistent application of infection control practices including hand hygiene, patient placement, appropriate ward and equipment cleaning and disinfection, appropriate waste disposal, education of staff, audit of processes and feedback.
10. 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.
11. The genes conferring carbapenem resistance are transmitted between bacteria living in patients and the environment.
12. Environmental reservoirs can be difficult to eradicate, but effective cleaning of high hand touch surfaces will minimise spread of gut flora and transmission to subsequent room residents. Such reservoirs include sinks, drains, and other water sources.
13. Antimicrobial stewardship with particular attention to reducing the use of broad-spectrum antibiotic use is critical.
14. Communication to patients, within organisations, and between organisations is essential.

1.6 Costs of CPE outbreaks and incidents

The operational challenges of implementing this framework cannot be underestimated. It will require board and senior management level commitment and support to ensure sustained capital and recurrent funding needed 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

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

managing a single case to be between $22,484 to $66,031 for hospitals (2). 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 (3).

One UK study estimated the cost of a CPE outbreak where 40 patients identified as infected or colonised over 10 months in 2014-15 in five hospitals in London as £1 million (4). 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 at a lower prevalence than currently reported in Canada (and 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 (5). More generally, it is expected that suitable selection criteria would enhance the cost-efficiency of screening.

While there are no prospective studies determining the optimal measures to implement to prevent and control CPE, managing one or more CPE outbreaks carry considerable costs – financial, logistical, and reputational.

1.7 Discharge or transfer of patients to non-acute settings

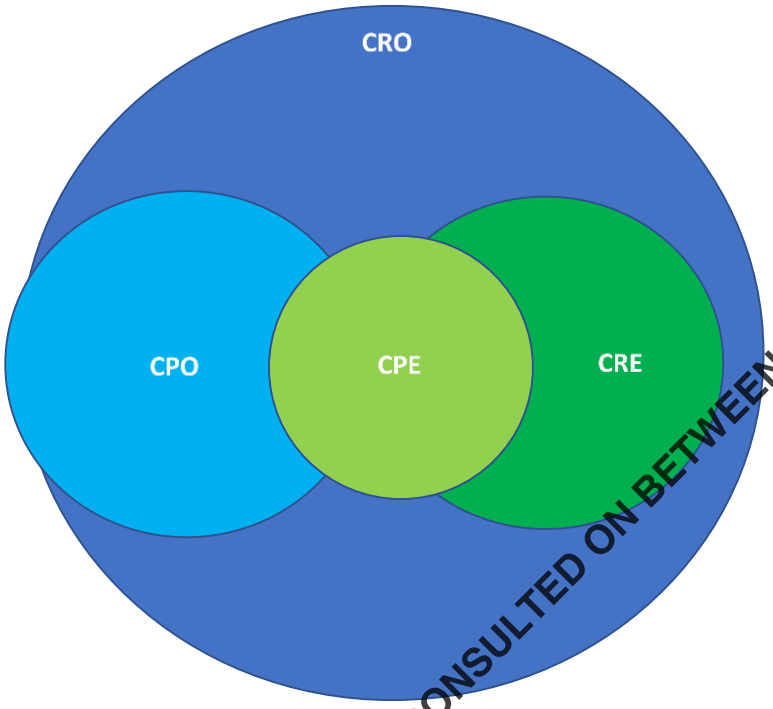
Note: Non-acute settings should not refuse admission or readmission of service users on the grounds that they are colonised with CPE, or discharge to be delayed once an infection has been resolved. Good communication will prevent unnecessary anxiety, misunderstanding or confusion for the family or healthcare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

Figure 1 – explanation of different terminology for various carbapenem resistances and nomenclature

CRO are Gram negative bacteria which are resistant to carbapenems. They can be naturally resistant such as *Stenotrophomonas maltophilia* OR

They can acquire genes (carbapenemases) which confers carbapenem resistance. These are called **CPO**.

CRE refers to Enterobacterales, a particular type of Gram negative organism which is resistant to carbapenems. These are part of the CRO group. Resistance can be caused by carbapenemases which would make them a **CPE**, a carbapenemase producing Enterobacterales



Examples

CRO:

- *Stenotrophomonas maltophilia*
- *Elizabethkingia* species

CPO:

- *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* containing a NDM carbapenemase.
- *Klebsiella pneumoniae* producing KPC carbapenemase

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

*Replicated 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*'*

CRP = Carbapenem resistant organisms. CRE = Carbapanem-resistant *Enterobacterales.* CPE = Carbapenemase-producing *Enterobacterales.*
KPC = *Klebsiella pneumoniae* carbapenemase. OXA-48 = *bla*OXA carbapenemase genes.
NDM = New Delhi Metallo-beta-lactamase. VIM = Verona Integron-Mediated Metallo-β-lactamase.

Section 2. Who to screen and why

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 and cross infection (6-9).

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 (10). Active screening for CPE is recommended to:

- minimise transmission from CPE positive patients
- minimise the risk that colonised patients will develop clinical infections e.g. from invasive devices recognising that colonisation precedes infection or appropriate surgical prophylaxis (see section 7.3), and prescribe early appropriate antibiotic therapy if clinical infection develops
- minimise environmental contamination and the development of potential reservoirs.

The evidence to inform CPE screening strategies is limited and the recommendations included in this framework are consistent with international guidelines (10-14) and UK expert consensus.

2.1 Key risk factors for CPE colonisation or infection

2.1.1 Admission screening to acute care providers

Acute trusts will need to make own risk assessment based on regional prevalence, patient mix, and linkages with other care providers. We do not recommend any routine screening for primary care settings or on admission to a care or residential home.

The following patients should be strongly considered for screening on admission if they are likely to stay in hospital overnight (13, 15), if:

- in the last 12 months, they have:

  - been previously identified as CPE positive (16-18)[3]
  - been an inpatient in any hospital, both in the UK or abroad (16, 19-22)
  - had multiple hospital treatments e.g. are dialysis dependant (21) or have had cancer chemotherapy (16, 23)
  - had known epidemiological link to a known carrier of CPE (includes household and care home contacts of known cases) (16, 24)
- they are admitted into augmented care or high risk units (11, 21, 26-27) (see box 1).

Box 1 - Definition augmented care/high risk settings (adapted from DH MRSA 2014 and Water systems - Health Technical Memorandum 04-01)

For the purposes of this document, the patient groups in an augmented care/high risk settings 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 (28).

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 (21),
- with exposure to broad-spectrum antibiotic courses (such as cephalosporins, glycopeptides, and piperacillin/tazobactam) (23, 26),

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

and in particular carbapenems (21) within the past one month (29), not covered in other risk groups e.g. those receiving OPAT

- admitted from Long Term Care Facilities where higher levels of interventional care are provided e.g. long term ventilation (15, 21).

Appendix B (think RISK) provides a reminder acronym for admission screening.

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 (6, 29, 30), including the United Kingdom (31), particularly from the Asian subcontinent (32, 33). However, this does not form part of taking a routine patient history outside of an infectious disease settings, and will not be captured or recorded in current electronic patient records. Therefore, we have not recommended including this category for screening due to limitations in data availability rather than lack of evidence for better ascertainment.

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 (34, 35). 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 e.g. patients transferred from hospitals overseas (see Appendix C).

A single rectal screening swab is sufficient to determine CPE colonisation status on admission (see Section 2.3 Screening swabs, and Section 8. Laboratory methods) 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.

Outbreaks have also occurred in specialist wards beyond augmented care/high risk area such as vascular and endocrine wards.

Active screening for CPE carriage is not usually required in outpatient departments or ambulatory care unless there is evidence of transmission in these settings.

2.1.2 Screening outside of acute care

Outside of the acute 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 D). PHE Health Protection Teams can assist with local risk assessments. They can also liaise with Local Authority Health Protection Team/Community Infection Prevention and Control Team where these exist.

2.1.3 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 (17). Some trusts have implemented repeat screening after 28 admission in their high-risk areas.

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/high risk units, on units where there is high usage of carbapenem antibiotics or in the setting of transmission (18, 36, 37)[4].

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 (12, 14).

[4] For more detailed information on the burden of carbapenem resistance see the English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report https://www.gov.uk/government/publications/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur-report

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 (38). 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 (38, 39), although a recent paper found that three quarters did not have detectable CPE on readmission screening (18).

2.1.4 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

CPE contacts are most commonly defined as having shared the same clinical space (e.g. 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.

2.2 Outbreak/cluster 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 number of patients to be screened needs to be expanded using the 'stone in the pond' (concentric-ring approach to contact tracing) principle (40).

An enhanced period of screening is recommended during the outbreak or cluster period. As an example, the patients in the affected unit/bay/ward should be screened twice a week for two weeks, and weekly for a further two 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, case flagging of epidemiologically linked patients should occur and these patients should be screened on re-admission to hospital. Refer to your local duty of candour policies regarding whether the patient's GP should be informed about patients with CPE contacts while in hospital. Information on the patient's potential exposure should be included on any inter-hospital transfer information or for a future admission to another hospital.

2.3 Screening swabs

Rectal specimens are most sensitive for detecting the carriage of antibiotic resistant-Enterobacterales (41). If a screening sample is required, the following optimise the ability of the lab to detect the presence of CPE:

A rectal swab, making sure faecal material and/or discolouration is visible on the swab

Or

A stool specimen (if a rectal swab is not feasible or acceptable)

And

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 3-4cms 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.

2.4 Staff screening

Staff screening is not recommended. This is no evidence of effectiveness and it is not recommended in international guidelines (42, 43) or by UK experts.

Section 3. Monitoring/surveillance

The surveillance of healthcare associated infections is important for the identification and control of these infections and for informing infection prevention and control activities, particularly during outbreaks.

Surveillance systems are needed to rapidly detect patients either colonised or infected with CPE. In addition to patient screening (section 3.1), systems and processes to continuously monitor, review and analyse data are essential for robust surveillance of CPE (44). These systems should focus on resistance mechanisms as carbapenemase genes are not specific to particular Gram-negative bacteria and can transfer between species (45, 46).

3.1 Recommendations

All healthcare providers should:

- have real time surveillance systems in place
- develop clear case definitions for bacteria and carbapanemase enzymes under surveillance
- 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
- analyse the data regularly (at least monthly) and use this to improve case finding within the organisation

Those within hospital settings should also:

- flag patient records with clear documentation of CPE cases and contacts 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, either locally or by the national reference laboratory, to PHE's national microbiological surveillance system (Second Generation Surveillance System, SGSS).

3.2 Monitoring

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 carabapenem susceptibility testing) and monitor laboratory confirmed cases (45, 46).
Databases (which can generate line lists) of cases should include patient demographics, specialties, locations, procedures and bed movements, date of onset of positive screen or clinical isolate. Computerised patient administration systems may facilitate this.

Automated alerts based on laboratory data should be a key part of such systems to ensure deviations from the norm can be identified e.g. increases in proportion of CPE screens that are positive, or alert thresholds of CPE bacteraemias.

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 Public Health England Field Service Team can advise on data collection approaches.

3.3 Reporting of surveillance data to Public Health England

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

At the time of writing it is likely that acquired carbapenemase-producing Gram-negative bacteria will be added to the list of causative agents requiring statutory notification under the Health Protection (Notification) Regulations. Laboratories must therefore ensure that their laboratory information management systems are capable of reporting acquired carbapenemase producers to SGSS. These data are required to monitor and track carbapenemase activity across the country.

Section 4. How to reduce/minimise transmission

Consistently implemented infection prevention and control programmes have been shown to reduce the spread of CPE. Active surveillance and infection prevention and control measures including hand hygiene have led to reduction of CPE in endemic settings such as Greece and Israel (47-49).

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 ward or unit and with it the likelihood of transmission events occurring (see Appendix E). Where the number of colonised patients is high, there is a greater chance of nosocomial transmission occurring.

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. Preventing onward transmission is crucial in containing CPE. This section outlines the interventions required to prevent transmission between patients, the environment or equipment.

Standard infection control precautions (SICP) **and** contact (transmission based) precautions should be used for patients suspected or known to be CPE positive[5] (boxes 2 and 3). 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.

The evidence base for individual IPC interventions is lacking because they should be implemented together (11). There is evidence that using such a 'bundle' approach is effective in prevention of transmission of multi-drug

[5] The Scottish National Infection Prevention and Control manual (www.nipcm.hps.scot.nhs.uk) is to be adopted across England as set out in the AMR National Action Plan 2019 – 2024 - there are some changes to terminology that differ from previous understanding within national policy that will now mirror those in the NIPCM https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/784894/UK_AMR_5_year_national_action_plan.pdf

resistant Gram-negative bacteria including CPE (15, 20, 50-52), as well as other nosocomial pathogens such as , MRSA and *Clostridioides difficile* (54). The most frequently implemented IPC measures to prevent and control transmission were contact precautions, active surveillance, monitoring, audit and feedback of compliance with prevention measures, patient isolation or cohorting, hand hygiene, environmental cleaning, and care during invasive procedures with a high risk of infection (50, 51).

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

Box 2 - Standard infection control precautions[6]

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[7]

Respiratory and cough hygiene

Personal protective equipment[7] which includes:

- gloves
- aprons
- long sleeved gowns to be worn when there is a risk of extensive splashing of blood and/or other body fluids, e.g.: 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)

[6] www.nipcm.hps.scot.nhs.uk

[7] Standard infection control precautions: national hand hygiene and personal protective equipment policy (2019). https://improvement.nhs.uk/documents/4957/National_policy_on_hand_hygiene_and_PPE_2.pdf

Box 3 - Contact precautions[6]

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

Infection prevention and control during care of the deceased

4.1 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/gown. However, they should clean their hands on leaving the room. If visitors are taking an active part in the patient's care, standard infection control precautions should be used. Visitors should not use patient en-suite toilet facilities.

4.2 Isolation

In acute care facilities, outside of intensive care, all inpatients with screened or confirmed CPE should be managed in a single room with en-suite facilities. If the single room does not have en-suite facilities, a commode or dedicated WC should be assigned to the patient. If reusable bedpans are used, they should be decontaminated in an automatic washer disinfector.

If single rooms are not available for every screened or known CPE-positive patient (especially in a healthcare facility where CPE is endemic) a risk assessment should be undertaken by the IPC team to determine where to care for patients (34, 35). 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/intensive care)

- screening results (‘high-risk’ patients or confirmed positive).

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

4.3 Cohorting

Cohorting refers to the management of patients with same CPE carbapenemase enzyme only within one ward or defined area of a ward with dedicated bathroom facilities, equipment and staffing. 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/speciality, on the advice on infection control specialists. There should be no cohort mixing of patients colonised with CPE with different resistance mechanisms.

The following need to be assessed when agreeing cohorting arrangments:

- 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/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.

4.3.1 Where no single rooms are available

Due to the lack of single rooms available in some provider organisations, isolation for CPE 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 this bay should be regarded as CPE contacts, and have CPE screens when moving to other wards or acute care providers.

4.3.2 Other scenarios

CPE close contacts who are currently inpatients in an acute setting do not need to be routinely isolated but should be risk assessed to determine patient placement whilst awaiting screening results e.g. faecal incontinence. If they are discharged before screening is performed, close contacts should have their patient records flagged for admission CPE screening on readmission to acute care hospitals.

Risk assessment should be dynamic e.g. 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.

In outpatient 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 be 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. Section 4.4 also applies to outpatient investigations or procedures.

There may be unique scenarios that warrant specific consideration e.g. paediatric settings (see Appendix G).

4.4 Patient movement

Should the patient require a diagnostic test or procedure, this should be undertaken in the patient's room if feasible. 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. It is key that appropriate cleaning is performed – for many settings the most practical solution is to place the patient at the end of the day's list. However, patient care should NOT be compromised.

4.5 Decolonisation of patients

Although colonisation with CPE increases the risk of infections, the evidence for or against antimicrobial decolonisation is unclear and decolonisation may increase the risk of inducing antimicrobial resistance (55). 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 (56, 57). There is currently insufficient evidence to recommend either skin or gut decolonisation of patients infected or colonised with CPE.

4.6 Non-acute care settings

In a shared care environment, a CPE carrier who is not at high risk of infecting 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.

Those at high risk of infecting others e.g. with uncontrolled faecal incontinence should be placed 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.

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.

Routine screening is not recommended in primary care settings or care home or other residential settings unless transmission is suspected, however these organisations must have protocols in place to determine how to access appropriate treatment advice for patients colonised with CPE.

CPE contacts do not need to be routinely isolated in non-acute settings.

Advice can be sought from PHE via local health protection teams or Consultants in Public Health Infection, or local Community Infection Prevention and Control Teams where available.

Section 5. Cleaning and decontamination

The environment of CPE patients has been found to be significantly contaminated (58-60). 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.

5.1 Recommendations

Providers should:

- use dedicated single-patient or single-use equipment, for example blood pressure cuffs, pulse oximeters or thermometers
- implement and audit high standards of cleaning
- decontaminate equipment after use by a colonised or infected patient, especially when the equipment may be shared with other patients
- enhance cleaning and disinfection (e.g. increasing the frequency of cleaning and/or introducing a disinfectant) in response to an outbreak or sustained period of increased incidence.

5.2 Decontamination advice following discharged patients/resident

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

The following points are of particular importance:

- 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 may also need to be replaced
- 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/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 (61) but can dry out if each wipe is used over too large a surface area (62).

CPE have no inherent resistance to disinfectants - the manner in which the disinfectant(s) of choice are used is more important than choice of disinfectant. Local considerations will include 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 conventional 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". In this context, biofilms will be mixed microbial populations with no fixed composition at any one place or at

any one time. Bacteria can migrate around different areas within a biofilm and between biofilms. Antibiotic-resistant bacteria indistinguishable from clinical strains can be long-term residents within these biofilms. Studies have demonstrated that hospital sinks and associated drainage systems can harbour antimicrobial resistant bacteria, including CPE (58, 63).

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 will 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 (58, 64, 65). 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 (58, 63).

This could occur in several ways:

- 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 (66, 67).

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 (68, 69). 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 when strictly necessary

to ensure efficient drainage; surrounding surfaces and the equipment used should be thoroughly disinfected afterwards.

Sampling of drains is a poor predictor of the absence of colonisation with CPE as different microbial components of a biofilm will change over time as they can migrate through drainage system biofilms. A negative sample at any one time does not provide evidence that CPE will remain absent.

Water from tap spouts should not flow directly into the drain hole. Here the combination of tap and basin are important; 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) (70). Sink design (tap positioning; basin depth) and impaired drainage have been implicated in outbreaks of infection (64, 71, 72). 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 backflow of water from the waste trap to accumulate within the basin has been shown to facilitate dispersal of contaminated droplets (72-74).

All basins, sinks and showers should be maintained so they drain efficiently. 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.

5.4 Endoscopes

All flexible endoscopes should be decontaminated in compliance with Health Technical Memorandum 01-06, Management and decontamination of flexible endoscopes (75) and there are no extra decontamination requirements for endoscopes used on patients who are colonised or infected with CPE. Any attached cameras/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.

Transmission of multi-resistant Gram negatives including CPE has been observed in other countries to occur via duodenoscopes (76, 77), which have a more complex structure than other flexible endoscopes and consequent additional decontamination requirements which are set out on HTM 01-06. Ensure that:

- the distal cap is removable to allow cleaning of the distal components of the endoscope
- the elevator wire channel is amenable to irrigation
- any endoscope washer-disinfector used for duodenoscopes has been validated to irrigate their elevator wire channel
- any endoscope drying cabinet used for duodenoscopes has been validated to dry their elevator wire channel.

Section 6. Outbreaks/clusters of CPE

6.1 New case, cluster and outbreak management

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.

This section provides information for providers on detecting and managing a situation where there has been:

- a newly diagnosed case in an area not previously affected
- a cluster of cases where transmission may have occurred
- a period of increased incidence in endemic settings
- an outbreak situation where transmission to others has been proven

These recommendations should be utilised alongside relevant organisational outbreak and multidrug resistant organism management policies.

6.2 Recognition of a transmission occurrence

Providers should have in place an appropriate system (alert organism surveillance) for capturing and tracking data on colonised and infected patients and review their data regularly. Action is required on detection of a single case of colonisation or infection. If the patient was not identified as being at high risk and was not isolated on admission, this may indicate acquisition (transmission) in the healthcare facility. A robust multidisciplinary approach is required to investigate and manage such incidents.

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 organism species e.g. from *E. coli* to *Klebsiella* spp.

For any CPE detection, it is important to **recognise** that transmission may already have occurred and that organisations must **act fast** to investigate and implement interventions to minimise any further transmission.

All providers must undertake a rapid risk and epidemiological assessment of the suspected outbreak to inform the following actions. 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 Epidemiology Services Team) for help with conducting a risk assessment.

Risk assessment	Actions
Type of patients and rapidity of detection	• Assess if augmented care/high risk settings or individual patient clinical risk factors • Check for any delays in identification and isolation of cases that have led to the occurrence of a pool of exposed contacts, and carefully record details of their distribution across the health care facility with inter-hospital transfers/ repatriation/care and nursing home transfers
Number of colonised or infected patients on the ward or unit	• Consider what screening strategy is appropriate (including frequency) to identify the exposed pool of contacts, implement and then undertake mitigation to minimise further transmissions
Staff-patient ratios	• Optimise staff-patient ratios to allow good adherence with infection prevention and control activities and minimise transfer of staff from affected unit to other unaffected units
Current adherence to infection prevention and control guidelines and cleaning standards	• Observe and highlight deficiencies in current IPC practice, and audit implementation • Implement what enhanced cleaning/disinfection approaches are needed to mitigate the outbreak and ensure these are implemented rigorously and consistently
Isolation capacity on the ward/unit	• Consider what isolation strategy is needed and implement. In some instances, cohorting may be appropriate where there are insufficient single rooms for individual isolation, however expert microbiological advice is required in implementing this

	(see Section 4. How to reduce/minimise transmission). • Cohorting should NOT be undertaken where patients have differing mechanisms of carbapenem resistance as there is a risk of plasmids carrying resistance mechanisms being transmitted between organisms • There is some indirect evidence that nurse cohorting prevents further CPE transmission (20); the decision to implement nurse cohorting must be led by local risk assessment
Shared patient equipment (e.g. blood pressure monitors, bed pan frames, commodes)	• Ensure single use patient equipment is being used - where equipment must be reused ensure appropriate disinfection
Environmental considerations (e.g. contamination of sinks/waste water drains)	• Consider environmental risk factors, shared equipment and reservoirs e.g. sink drains, and the inappropriate use of hand wash basins • Review need for enhanced frequency of cleaning and / or the introduction of a disinfectant
Assess current antibiotic pressures - particularly carbapenem usage	• Consider whether prescribing formulary changes are required to minimise patient/environmental exposure to broad spectrum antibiotics, in particular carbapenems
The availability of expertise – infection prevention and control staff and staff experienced in cluster/outbreak management	• Agree incident action plan including communications to key staff and stakeholders – and update regularly • Consider closing the unit/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

Consider level of necessary communications	• 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/incident plan – particularly around adherence to IPC policies

6.3 Ongoing transmission

For ongoing transmission despite the application of the recommendations in this document**,** consider obtaining further advice from Public Health England. This could include a peer review visit, advice or investigation from your local Health Protection Team, with additional support provided by Field Services or the national HCAI & AMR Division. PHE HPTs can liaise with the Local Authority Health Protection Team/Community Infection Prevention and Control Team where these exist.

Section 7. Antimicrobial prescribing and stewardship

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 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 (78), WHO Essential Medicines List adaptation (79), and recommendations specified in NICE Guidance NG15 (80) and relevant NICE/PHE Antimicrobial prescribing guidelines.

7.1 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 (81) (in secondary care) and TARGET Antibiotics resources (82) (in primary care). The data from these interventions (including AMR and consumption) should be reviewed at regular intervals by local antimicrobial stewardship committees (or equivalent) and specific action taken where there are early signals of increasing AMR or antimicrobial consumption trends, particularly broad-spectrum agents including carbapenems.

To facilitate identifying weaknesses and strengths within antimicrobial stewardship programmes a peer review can be considered using AMS Peer Review Tool[8] in secondary care. In primary care, there are audit and action planning tools available as part of the TARGET toolkit.

7.2 Responding to increased AMR/Outbreaks or increased antibiotic consumption trends

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. As part of responding to or

[8] PHE. Antimicrobial Stewardship (AMS) Peer Review Inspection Tool. Available in: ESPAUR Report 2019. PHE; London, 2019. - https://www.gov.uk/government/publications/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur-report

identifying increased AMR/outbreaks or increased antibiotic consumption, increased frequency of monitoring is required. These may include:

- increased surveillance of CPE organisms
- more regular review of consumption of antibiotics using the AWaRE categories (5)
- antimicrobial resistance mechanisms driving use of carbapenems and other restricted antibiotics e.g. ESBL/AmpC rates

7.3 Treatment and surgical prophylaxis options

Due to the variation of resistance profiles of CPE, it is not possible or appropriate to make national treatment recommendations. Treatment options should involve infection specialists including medical, nursing and pharmacy as part of the wider AMS team to ensure optimal dosing and monitoring are in place.

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 surveillance or individual sensitivity results if available

7.4 Access to and availability of new antimicrobials to formulary

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 multi-drug 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.

7.5 Monitoring and Data for Action

A program of audit and quality improvement programmes (QIP) to address inappropriate broad spectrum antimicrobial prescribing with feedback to individual prescribers should be considered.

These audits and QIPs would include those listed above as well as:

- total duration of antibiotic prescribing
- outcomes of patients treated for all Gram negative bacteraemias
- diagnostic investigation and appropriate sampling for culture and sensitivity testing
- IV to oral switch
- duration of IV antibiotic prescriptions compared to oral antibiotics

Consider implementing strategies to reduce overall antimicrobial use, in particular broad-spectrum antibiotics. Such strategies may consist of:

- processes to protect antibiotics in the Restrict and Watch categories (79)
- consideration to minimise use of antimicrobials associated with colonisation with CPE or other significant adverse effects (e.g. *Clostridioides difficile* infection) such as fluoroquinolones, cephalosporins and antimicrobials identified locally where high level resistance has been demonstrated in analysis of CPE surveillance

Monitoring Tools

- NICE AMS guidance and infection guidelines assessment tools
- TARGET Toolkit audits and action planning resources on respiratory tract infections and UTI
- AMS Peer review tool
- Antibiotic appropriateness assessment instrument
- Point prevalence survey
- PHE Fingertips
- ePact
- PresQipp data portals

7.6 Whole system approach to AMS

A whole system approach to AMS is important (4). 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. Appendix H details further resources.

Section 8. Laboratory methods

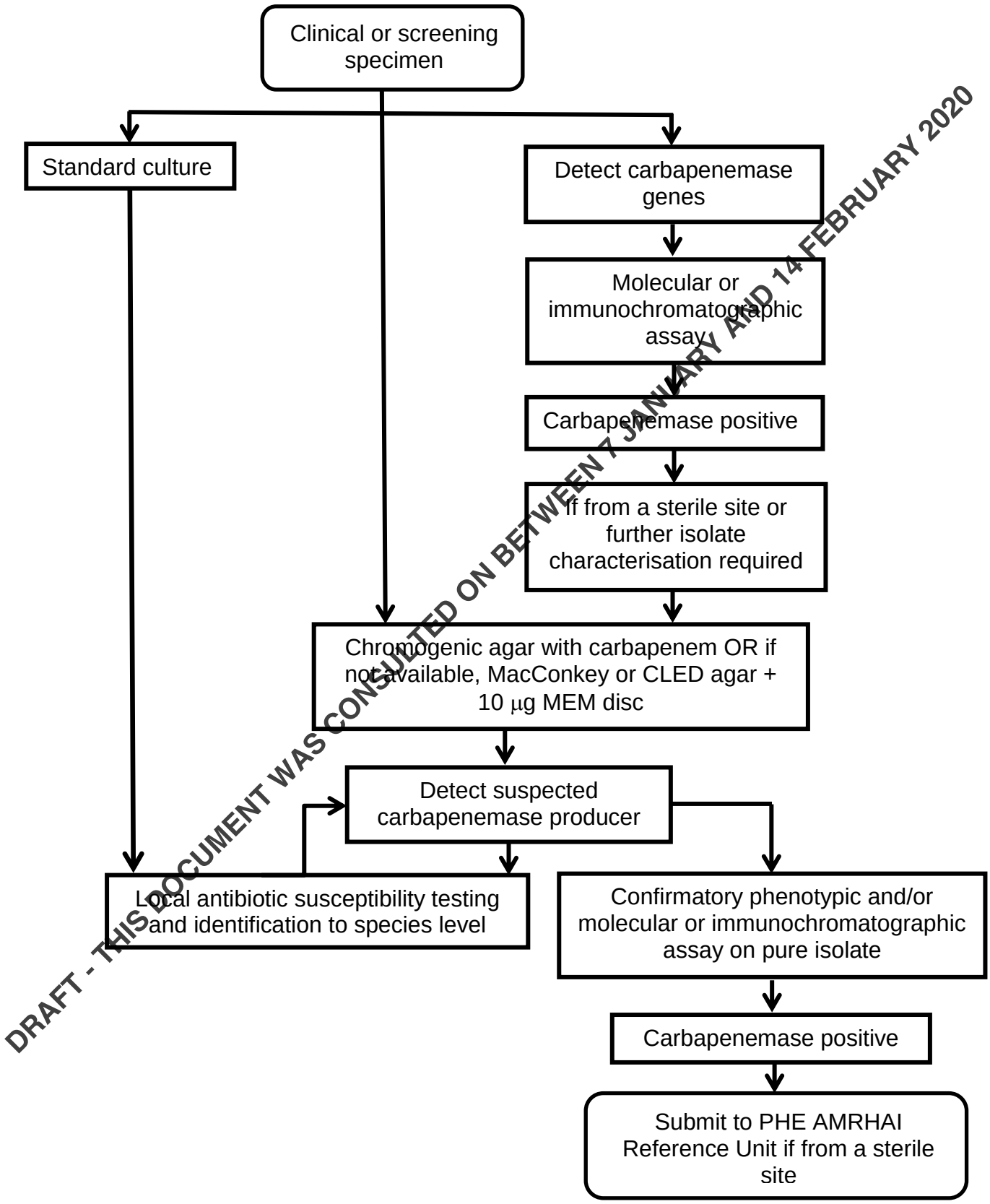
Carbapenemases are intrinsic (found naturally) in a few clinical bacteria; this section focusses on acquired carbapenemases. Local testing for acquired carbapenemases with rapid turnaround, rather than referral to the national reference laboratory, will have maximal impact on patient management to prevent 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. The UK Standards for Microbiological Investigation (SMI) '*Detection of bacteria with carbapenem-hydrolysing β-lactamases (carbapenemases)'* (83) and the PHE guidance document '*Commercial assays for the detection of acquired carbapenemases*' (84) provide an overview of methods currently available for screening and confirmation of carbapenemase production.

8.1 Recommendations

PHE strongly recommends that diagnostic laboratories should:

- 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 (85), and refer to AMRHAI all carbapenem resistant isolates with local negative tests for the 'big 4' to detect IMPs
- determine a screening algorithm using either a one-step detection via molecular or immunochromatographic test direct from clinical or screening specimens, or two-step detection involving culture followed by molecular or immunochromatographic test (see flowchart figure 1)
- consider their local CPE epidemiology and laboratory capacity (35) 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 (18, 35)
- review the PHE report *'Commercial assays for the detection of acquired carbapenemases'* to enable an informed decision on the choice of commercial carbapenemase detection assay to implement based on their local circumstances (84)
- optimise and review their phenotypic laboratory methods for detection of acquired carbapenemase-producing organisms according to the UK Standards for Microbiological Investigation (SMI) '*Detection of bacteria with carbapenem-hydrolysing β-lactamases (carbapenemases)'* (83)

Figure 2. Flowchart summarising workflow for screening and detection of carbapenemases (modified from UK SMI B60) (83)



Section 9. Organisational responsibilities

9.1 Leadership, planning and implementation

Providers of health and social care in England must have appropriate arrangements and resources in place for prevention and control of infections (78). Leadership is essential to ensure that IPC policies are developed, communicated, and implemented, with appropriate levels of resourcing. IPC and outbreak response roles and responsibilities need to be formally assigned in all providers of regulated activities (86). These arrangements need to be proportionate to the size and complexity of the organisation, but should be appropriately communicated and adopted in any setting (87).

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 (88). Maintaining awareness of CPE amongst staff can be a challenge to implementation, particularly for providers with no or low numbers of CPE cases (1).

Control of resistant organisms is a national problem and requires that facilities that share patients work together to prevent transmission.

9.2 Recommendations

In acute care settings, or others where higher levels of interventional care are provided e.g. 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 (69).
- 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 (78).

In all settings:

- Ensure all relevant staff have received appropriate education and training on the organisation's CPE and/or multi-drug resistant organism policy, including any risk assessment required to detect patients at risk of colonisation with CPE, the precautions required to contain the spread, and access to relevant information for patients, carers and staff (11, 89).

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 the following:

- alerting neighbouring trusts, commissioners, providers and the local Health Protection Team about CPE outbreaks
- ensuring discharge letter to GPs and medical (inter-healthcare) transfer documentation to receiving organisations should detail CPE colonisation and infection status, or potential exposure to CPE in a ward environment e.g. if they are a bay contact of a CPE colonised patient, including outstanding screening information.
- communication with primary care providers and GPs (see Appendix I) is very important, as patients may access multiple local healthcare facilities for their care (including providing advice to GPs on actions that are needed e.g. coding as active problem)
- communication of information on positive patients prior to patient transfer or discharge to all relevant healthcare professionals along the patient pathway e.g. district nursing teams
- communicating with family/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/community setting and IPC advice (90).

9.4 Repatriations from abroad

The UK 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 the PHE national team in the HCAI & AMR Division - in hours HCAI.AMRdepartment@phe.gov.uk or through the duty doctor out-of-hours and weekends to Colindale Duty Doctor (+44208 200 4400).

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, NDM and VIM) produced by some bacteria which cause destruction of the carbapenem antibiotics, resulting in resistance – health professionals sometimes use this enzyme abbreviation only
carbapenems	Carbapenems are a group of powerful antibiotics, used to treat severe infections. They include meropenem, ertapenem, doripenem 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 (germs) living harmlessly on the skin or within the bowel and causing no signs or symptoms of infection
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.
decontamination	Decontamination refers to 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, it would be cleaning and disinfection of items with staff or patient contact
infection	The presence of micro-organisms (germs) in the body causing adverse signs or symptoms
laboratory confirmed case- *for the purposes of this guidance*	Recent laboratory confirmation of carbapenemase-producing Enterobacterales infection/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
suspected case- *for the purposes of this guidance*	• 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 eg: are dialysis dependant or have had cancer chemotherapy in last 12 months • epidemiological link to a known carrier of CPE • patients who are admitted into augmented care/high risk units • patients with recent exposure to broad-spectrum antibiotic courses, and in particular carbapenems, within their last or current hospital stay.

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Appendices - Framework of actions to contain carbapenemase-producing Enterobacterales

A. International guidance comparison
B. RISK – admission checklist
C. IPC risk prioritisation matrix
D. How to complete a risk assessment outside the acute care setting
E. Acute care – example of patient admission flow chart
F. Single patient risk assessment form – limited isolation room availability
G. Containing CPE in a paediatric setting
H. Antimicrobial stewardship tools and resources
I. Frequently asked questions
J. CPE Primary Care Quick Reference
K. CPE-Patient held card

Appendix A: National & international guidelines comparison

The following schematic[9] highlights key interventions recommended across other national and international guidelines:

	Hand hygiene		Contact precautions		Single room		Cleaning / disinfection		Environmental screening		Antimicrobial stewardship		Active surveillance cultures		Note flagging / alert code		Cohort patients		Cohort staff		HCW screening		Patient skin decolonisation		Patient intestinal decolonisation	
	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak	All	Outbreak
PHE (England) 2013	■	■	■	■	■	■	■	■					■	■	■	■		■		■	■	■	■	■	■	■
ESCMID 2014*	■	■	■	■	■	■	■	■		■	■	■		■	■	■		■		■				■		
Irish MDRO 2014	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■
CDC 2015	■	■	■	■	■	■	■	■			■	■	■	■	■	■		■		■				■		
HPS (Scotland) 2016	■	■	■	■	■	■							■	■	■	■					■	■	■	■	■	■
UK Working Party 2016	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
ECDC 2017	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■				■		
WHO 2017	■	■	■	■	■	■	■	■					■	■	■	■		■								
ACSQH 2017	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■			■	■	■	■

*ESCMID guidelines did not include CPE specifically, but did include recommendation for MDR *K. pneumoniae*, which are included here as a proxy for CPE because the guidelines also included separate recommendations for ESBL-E.
Blue square = recommended; Orange square = not recommended; Blank = not mentioned or no recommendation.

[9] Updated from Otter JA et al. Controversies in guidelines for the control of multidrug-resistant Gram-negative bacteria in EU countries. *Clin Microbiol Infect* 2015;21(12):1057-66.

Appendix B: CPE – think RISK

Hospitals 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/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 e.g. haemodialysis or receiving cancer chemotherapy
S – Specialty	Patients admitted to the following specialties should be screened: • Augmented care • High-risk settings - *immunosuppression transplant haematology/oncology organ support extensive care needs e.g. liver burns unit* • Long Term Care Facilities where higher levels of interventional care are provided e.g. long term ventilation
K – Knowledge of local CPE transmission	Screen if patient has been in contact with a known case of CPE

Appendix C: Risk prioritisation of infection prevention and control (IP&C) measures, screening and isolation

It is best practice for any patient receiving care who has a risk factor for colonisation with carbapenemase-producing Enterobacteriales 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.

	Patient characteristic				
Care environment	Known CPE case	Direct transfer from hospital abroad	Hospitalisation last 12 months	Epi link	Care Dialysis/Chemo
Admission to specialist/augmented unit[10]					
Admission to general acute ward					
Day/ambulatory care	**	**	**	**	**
Outpatient clinic	**	**			
Care /Residential homes					

High risk	Isolate immediately in a single room with en-suite facilities (or dedicated commode o0r 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 e.g. 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	

[10] For the purposes of this document, the patient groups in an augmented care/high risk settings include:

a. 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;
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 D: How to apply a risk assessment in the non-acute setting for a positive laboratory result for carbapenemase-producing Enterobacterales

At all risk levels ensure the following:

- **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/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, e.g. 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.

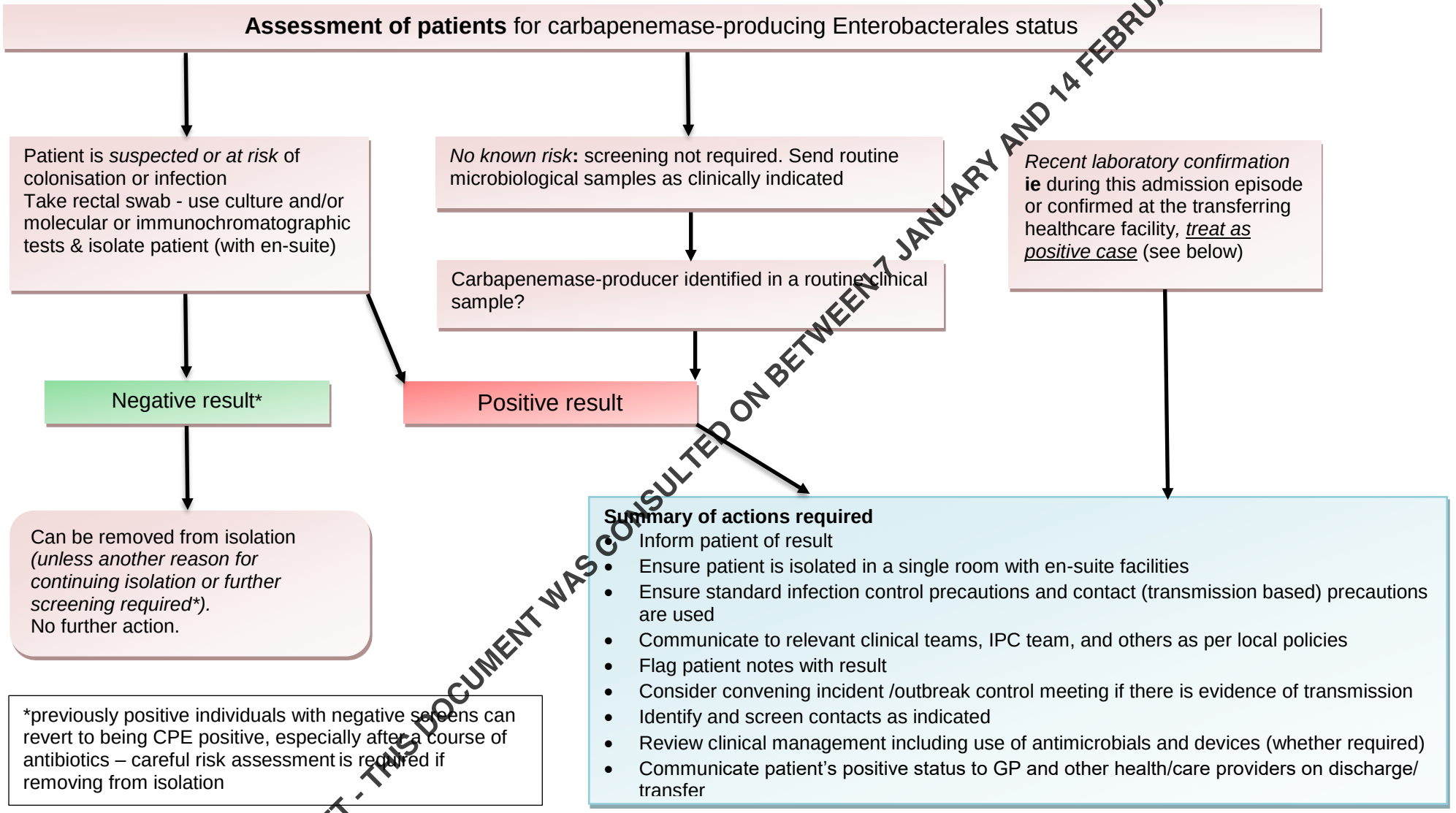
If the individual is colonised: single room with en-suite facilities including toilet or designated commode is recommended; where a single room is not available, it is recommended that a designated toilet or commode is made available. No curtailment of communal activities is required where standard precautions 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 PHE 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, smearing or 'dirty protests' discharging wound, long term ventilation, confusion/dementia, device(s) in situ, undergoing invasive procedures	• Identify if there is an immediate risk of infecting/contaminating others and the shared environment. • Discuss management with GP/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/contacts as appropriate • Maintain effective environmental hygiene If unsure, contact your usual IPC advisor or PHE via the local health protection team of Consultant in Public Health Infection, or local Community IPC Team where available
LOW RISK For example, the individual is independent and self-caring	

Appendix E: Acute care – example of flow chart for infection prevention and control (IPC) measures to contain carbapenemase-producing Enterobacterales



Appendix F: Example of Patient Risk Assessment tool for CPE positive colonisation or infection: when to isolate in acute setting when isolation rooms limited

	Yes	No
Does the patient have diarrhoea? (Type 6/7 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)		
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 G: Containing CPE in a paediatric setting

Advice from Infection Prevention and Control team
Seek advice from your IPC team, to assist with conducting a risk assessment appropriate for your environment/ hospital.

There are several considerations – the key one being that the mother/father 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 wipe-able containers, this need to be wiped clean prior to placing in/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/hospital items nappies, milk bottles, trays etc. 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 to 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/container, by a member of the unit staff (not the parent/ 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 & 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/ 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 are only to be removed from the room by the ward staff. If possible clean the underside of the tray 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.
- Lap tops etc. can be wiped clean by the Education team after use.
- Sibling visitors are not to use the play room or school areas or communal play areas in the trust. Minimise visitors.

Appendix H: Antimicrobial Stewardship Tools and resources

Antimicrobial Stewardship

NICE Guidelines. Antimicrobial stewardship: systems and processes for effective antimicrobial use. London: NICE, 2015.

Viale P, et al. Considerations About Antimicrobial Stewardship in Settings with Epidemic Extended-Spectrum beta-Lactamase-Producing or Carbapenem-Resistant Enterobacteriaceae. *Infect Dis Ther* 2015;4(suppl_1):65–83.

East of England Pharmacy Infection Network. Antimicrobial Stewardship (AMS) Peer Review Inspection Tool. 2016.

Hawkey P, et al. 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. *J Antimicrob Chemother* 2018;73(suppl_3):iii2-iii78.

Antimicrobial consumption

PHE. AMR local indicators. London: PHE, 2019.

PHE. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2018-2019. London: PHE, 2019

Nathwani D & Sneddon J. Practical Guide to Antimicrobial Stewardship in Hospitals. London: BSAC, 2013.

Carbapenem sparing strategies

Wilson APR. Sparing carbapenem usage. *J Antimicrob Chemother* 2017;72(9):2410-2417.

Appendix I: 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 whilst 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/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 Public Health England 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 e.g. 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 PHE 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 - community or CCG IPC team/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 PHE Centre. The Public Health England website is another source of information.

Appendix J – Primary care quick reference guide.

What are 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 e.g. KPC, OXA-48, NDM and VIM, that destroy carbapenem antibiotics, thereby conferring resistance • Carbapenem antibiotics, include meropenem, ertapenem, imipenem and doripenem, 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 i.e. 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 e.g. are dialysis dependant or have had cancer chemotherapy
	  ○ had been previously identified as CPE positive (includes household and care home contacts of known cases)
	  ○ any patient admitted to an augmented care or high risk units
	• 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 e.g. 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 PHE Centre / 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/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 PHE centre / 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.

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3. 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.
4. World Health Organization. Guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, Acinetobacter baumannii and Pseudomonas aeruginosa in health care facilities. 2017.
5. Richards M, Cruickshank M, Cheng A, Gandossi S, Quayle C, Stuart R, et al. 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;22(4):159-86.
6. Schwaber MJ, Klarfeld-Lidji S, Navon-Venezia S, Schwartz D, Leavitt A, Carmeli Y. Predictors of carbapenem-resistant Klebsiella pneumoniae acquisition among hospitalized adults and effect of acquisition on mortality. Antimicrob Agents Chemother. 2008;52(3):1028-33.

Appendix K: Patient Card

Some trusts may provide Carbapenemase-producing Enterobacterales 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.

A small evaluation has been published: Poole K, et al. Evaluation of patient-held carbapenemase-producing Enterobacteriaceae (CPE) alert card. *J Hosp Infect* 2016;92(1):102-5.

Public Health England

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: _____

Public Health England

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

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Issued: _____