Carbapenem-Resistant Organisms

Key Info	**Public health should investigate all CRO that test positive for carbapenemase**. Public health investigation is not required for carbapenemase-negative CRO except for suspected outbreaks.
Signs and Symptoms	CRO have no defining clinical symptoms. Common infections caused by these organisms include wound, urine, and blood, but CRO can colonize and cause no symptoms.
Incubation	CRO may colonize the intestines, skin, and other body sites without causing infection, therefore the incubation period is not well defined.
Case classification	**Clinical criteria**: None
	Confirmed: Patient with a clinical or surveillance test yielding Enterobacterales, *Pseudomonas aeruginosa* or *Acinetobacter baumannii* positive for known carbapenemase gene or positive on phenotypic test for carbapenemase. (See Appendix I for details.)
	CRO isolates tested at PHL and not confirmed as CPO should be classified as "ruled out." CRO isolates that are not submitted for testing should be classified as suspect. (See Section 3.C)
Treatment	Antibiotic treatments for carbapenem-resistant Enterobacterales (CRE) and CRO infections are limited and often associated with side effects; recommend infectious disease (ID) consultation for treatment decisions. Colonization should not be treated except in rare situations and under supervision of ID specialist. PHL offers expanded antimicrobial susceptibility testing (ExAST) for hard-to-treat infections due to CRE.
Duration	CRO can silently colonize intestines, skin, and other body sites. Persistence is associated with healthcare and antibiotic exposure. Colonization may lead to endogenous infection and can spread to others.

Exposure	• Healthcare, particularly high acuity healthcare settings and indwelling devices.
	• Direct contact with colonized or infected skin or body fluids.
	• Indirect contact
	  ○ CRO survives on inanimate surfaces for long periods, including shared/mobile medical equipment, and contaminated surfaces such as bedrails, etc.
	  ○ Healthcare workers' hands.
	• Travel or healthcare in certain parts of the world (including the US)

Laboratory testing	• Isolate genus and species identification, carbapenemase testing, antibiotic susceptibility testing (AST) • Screening for colonization by PCR or culture-based test • Use Antibiotic Resistance Lab Network (ARLN) Requisition Form for isolate submission. For screening, submit Use Electronic Test Ordering and Results (ETOR) entry. • Ship isolates on Choc, HIA, BHI slant (plate ok if submitted via courier), ambient, category B. • Screening rectal swab provided in PHL-approved collection kit, ambient, category B. • Expanded antimicrobial susceptibility testing (ExAST) is available on CRE. Pre-approval required from AR Lab Network (ARLN@doh.wa.gov)
Public health actions	Local health jurisdictions: notifiable to Washington State Department of Health (DOH) Office of Communicable Disease Epidemiology (CDE) within 7 days of completing the investigation or 21 days of receipt of case or lab report. **Only carbapenemase positive cases or healthcare outbreaks must be investigated by public health.** *Infection Control:* • Place cases on appropriate transmission-based precautions, and in a private room if feasible (see Appendix II for details). • Reinforce hand hygiene, proper PPE use, and environmental cleaning. • See What to do if you identify a targeted multidrug resistant organism in your facility

Carbapenem-Resistant Enterobacterales (CRE) and other Carbapenem-Resistant Organisms

1. DISEASE REPORTING

A. Purpose of Reporting and Surveillance

1. To increase awareness of carbapenem-resistant Enterobacterales (CRE) and other carbapenem-resistant organisms (CRO) by public health and healthcare professionals.
2. To promote appropriate infection control interventions to prevent transmission of CRE and other CRO within and between healthcare facilities, and between healthcare facilities and the community.
3. To rapidly identify carbapenemase-producing CRE (CP-CRE) and other carbapenemase-producing-organisms (CPO) and prevent or eliminate sources or sites of ongoing transmission within Washington.
4. To characterize the epidemiology of these infections in Washington to guide response.

B. Required Reporting

1. Health care providers and health care facilities: notifiable to **local health jurisdiction** (LHJ) within 3 business days.
   - Per WAC 246-101-101, CRE infections limited to those due to *Enterobacter* species, *E. coli* and *Klebsiella* species.
   - Per WAC 246-101-015, by Secretary of Health request of provisional reporting for CPOs, all confirmed CPO cases. See Appendix I, Table 2 for confirmatory carbapenemase tests.
2. Laboratories: notifiable to **local health jurisdiction** within 2 business days; submission required – isolate or, if no isolate, submit specimen associated with positive result, within 2 business days
   - Per WAC 246-101-201, *Enterobacter* species, *E. coli*, and *Klebsiella* species,
     a. Positive for known carbapenemase resistance gene (including but not limited to KPC, NDM, VIM, IMP, or OXA-48-like) demonstrated by nucleic acid detection (NAT or NAAT) or whole genome sequencing;
     b. Positive on a phenotypic test for carbapenemase production including but not limited to Metallo-B-lactamase test, modified Hodge test (MHT) (for *E. coli* and *Klebsiella* species only), CarbaNP, Carbapenem Inactivation Method (CIM) or modified CIM (mCIM); See Appendix I, Table 2 for confirmatory carbapenemase tests.
     c. Resistant to any carbapenem including but not limited to doripenem, ertapenem, imipenem or meropenem (minimum inhibitory concentrations of

≥ 4 mcg/ml for meropenem, imipenem, and doripenem or ≥ 2 mcg/ml for ertapenem).

- Per WAC 246-101-015, by Secretary of Health request of provisional reporting for CPOs,
    a. Carbapenem resistant isolates of Enterobacterales, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii* for which the species is not intrinsically resistant. See Appendix I, Table 1 for antimicrobial susceptibility criteria.
    b. Isolates with preliminary or confirmed positive carbapenemase. See Appendix I, Table 2 for confirmatory carbapenemase tests.

Isolates should be accompanied by a Public Health Laboratories (PHL) Antibiotic Resistance Lab Network (ARLN) Requisition Form and clinical lab antimicrobial susceptibility test result. See ARLN Test Menu and Specimen Collection and Submission Instructions for details on isolate submission.

3. Local health jurisdictions: notifiable to Washington State Department of Health (DOH) Office of Communicable Disease Epidemiology (CDE) within 7 days of case investigation completion or summary information required within 21 days
    - Per WAC 246-101-505 and WAC 246-101-015,
        a. Confirmed carbapenemase producing organism cases. See Appendix I, Table 2 for confirmatory carbapenemase tests.

C. Local Health Jurisdiction (LHJ) Investigation Responsibilities

1. LHJs should investigate and report all carbapenemase producing organisms (CPO) in order to identify the source and whether transmission has occurred. Enter the case into the Washington Disease Reporting System (WDRS) under Highly Antibiotic Resistant Organism (HARO). Consult with OCDE for cases with mCIM positive test but negative for a named carbapenemase. See section 3.C for details on case classification.

   LHJs should be notified by laboratories of CRO, and by healthcare providers and facilities of confirmed CPO isolates or cases and should ensure that CRO isolates are submitted to PHL. LHJs may choose to perform a preliminary investigation on carbapenem resistant organisms cases while phenotypic or mechanistic testing for carbapenemase production is performed at PHL or may wait for results before starting the investigation.

2. Any outbreak or suspected outbreak in a healthcare facility, including of CROs, is mandated to be reported immediately to LHJs and should be investigated.

3. Because of the potential for transmission of CRO to vulnerable patients in healthcare settings, providers, infection preventionists, and facilities should institute appropriate infection control precautions when CRO are identified. These actions are described in national expert guidance; see Section 5B and Appendix II for detailed recommendations about infection prevention in healthcare settings. The LHJ may reinforce appropriate infection preventions messaging but implementation and communication of CRO status to the patient or home caregivers, including how to prevent transmission, is the responsibility of healthcare providers, infection preventionists, and facilities.

2. THE DISEASE AND ITS EPIDEMIOLOGY

A. Etiologic Agent

Enterobacterales constitute a large order of Gram-negative bacilli, many of which are normal inhabitants of the intestinal tract in humans, other mammals, and birds. Enterobacterales most commonly encountered in healthcare settings include the taxonomic families, Enterobacteriaceae, Morganellaceae, and Yersiniaceae (see NCBI Taxonomy Browser for more details), including the genera *Citrobacter*, *Enterobacter, Escherichia, Klebsiella, Morganella, Proteus, Providencia,* and *Serratia.* These bacteria may be harmless or can cause serious infections in humans, particularly those with healthcare exposure and who are debilitated due to serious illness, old age, invasive procedures, or indwelling catheters.

Acinetobacter and *Pseudomonas* are also Gram-negative bacilli (not in the order, Enterobacterales). They are common inhabitants of soil and water, may colonize human skin (both) and intestines (*Pseudomonas*), frequently contaminate the hospital environment, and may cause opportunistic infections in debilitated hosts.

Carbapenem antibiotics (doripenem, ertapenem, imipenem, and meropenem) are broad spectrum (active against many different groups of bacteria) and usually reserved for severe life-threatening infections. Certain Gram-negative bacilli, including the order, Enterobacterales, and genera, *Pseudomonas* and *Acinetobacter*, have developed carbapenem resistance which limits options for treating infections due to these organisms. The mechanism of resistance can be varied; most concerning are carbapenemases, enzymes produced by bacteria that inactivate carbapenems directly. Carbapenemase genes transmitted on plasmids are primarily responsible for the worldwide spread of CP-CRE. Plasmids are mobile pieces of genetic material that can be passed between bacterial species, otherwise known as horizontal inheritance. This type of inheritance can rapidly and greatly increase the prevalence of the trait in a population, particularly where there is high risk of transmission such as in a healthcare environment.

Carbapenemases of global importance include *Klebsiella pneumoniae* carbapenemase (KPC), New Delhi metallo-β-lactamase-type 1 (NDM-1), Verona integron encoded metallo-β-lactamase (VIM), imipenemase metallo-β-lactamase (IMP), and oxacillinase-48 (OXA-48).

Non-carbapenemase carbapenem resistance in the Enterobacterales and other Gram-negative bacteria, such as *Pseudomonas* and *Acinetobacter*, occurs via a combination of mechanisms, typically production of an extended-spectrum β-lactamase or extended-spectrum cephalosporinase (also called ESBL or AmpC) plus decreased permeability of the bacterial cell wall (e.g., porin mutations) to influx of carbapenem antibiotics. Although also multidrug resistant, these organisms are currently thought to have local rather than global importance; unlike carbapenemases which have increased significantly over the past 10-15 years, the frequency of non-carbapenemase carbapenem resistance has increased gradually over time. CP-CRE, CP-*Pseudomonas* and CP-*Acinetobacter* are becoming more common in Washington and require the most aggressive infection control measures and coordinated response between healthcare facilities and public health in order to prevent them from becoming endemic.

C. Description of Illness

Infections due to carbapenem resistant (CR) Enterobacterales and other CR-*Pseudomonas* and CR-*Acinetobacter* are associated with high rates of morbidity and mortality and occur most frequently among persons with prolonged hospitalization, such as those who are chronically or critically ill and have invasive devices such as ventilators, urinary catheters, or central venous catheters. These infections may manifest as urinary tract, blood stream, surgical site, and lung infections. Colonization with these bacteria can also occur and *does not require treatment,* though similar infection control precautions should be used for colonized persons in healthcare settings in order to prevent transmission to other patients. Colonized patients are at risk for invasive infection from their own endogenous colonization and this risk increases when indwelling devices are present.

D. CRE in Washington State

In Washington, CRE and other CRO are routinely detected by commercial laboratories, but CP-CRE and other CPO are less common. Before systematic reporting began in 2012, 8 CP-CRE had been identified in Washington.

As of 2023, KPC is the most common carbapenemase in Enterobacterales in the United States; in Washington, NDM are slightly more numerous than KPC. DOH has received reports of 10 different carbapenemases in CRE, *Acinetobacter*, and *Pseudomonas*: KPC, NDM, VIM, IMP and OXA-48-like, OXA-23-like, OXA 24/40-like, OXA-235-like, OXA-58-like and IMI/NMC. The DOH MDRO Dashboard provides a summary of CRO and CPO surveillance in Washington since 2012. Inpatient healthcare remains the most likely reported source of acquisition for carbapenemases.

D. Reservoirs

Enterobacterales are normally carried in the intestines of many mammals and birds. *Acinetobacter* and *Pseudomonas* exist in water and soil. Carbapenem-resistant infections in the United States are generally associated with healthcare exposures and occur most commonly in debilitated persons with chronic illness. These Gram-negative organisms can survive on inanimate objects for many months, including in sinks and drains. Humans can be colonized in wounds, catheter exit sites, stool, urine, and sputum and may transmit in the healthcare environment. Colonized persons are at risk for infection from endogenous carriage.

E. Modes of Transmission

Transmission of CRE and other CRO may occur through direct contact with bodily fluids or by skin contact. In healthcare settings, CRE and CRO can be spread via the hands of healthcare workers, on inanimate objects such as medical equipment, bed rails, computer keyboards, in cleaning supplies, and from colonized sink drains. Transmission has occurred in healthcare settings even when contact precautions were in place, although infection control lapses cannot be ruled out. The attack rate for household contacts of cases has not been defined but is thought to be very low. Persons who are infected or colonized may be a source of transmission to others.

F. Incubation Period

Because CRE and other CRO can colonize the intestines and other sites without causing infection, the incubation period is not well defined.

G. Period of Communicability

Persons can potentially transmit CRE and other CRO to others as long as the organisms are present in bodily fluids or on the body. Patients can be intermittently positive on serial surveillance cultures and may be colonized for long periods of time. Persons at highest risk for transmitting and contracting CRE and CRO are those who require intensive care, assistance with activities of daily living, or have wounds or indwelling devices. Epidemiologically linked patients within the healthcare environment (roommates, those who shared healthcare staff or equipment) are thought to be at highest risk for contracting the organism.

H. Treatment

The antibiotic agents for treating CRE and CRO infections are extremely limited and are often associated with adverse reactions. In general, colonization should not be treated except in extremely rare situations such as planned bone marrow transplant. Infectious disease consultation is recommended for treatment decisions and especially when decolonization is being considered.

3. CASE AND CONTACT DEFINITIONS

A. Clinical Criteria for Diagnosis of Cases

There are no specific clinical criteria for diagnosis. Carbapenem-resistant (CR) and carbapenemase-producing (CP) Enterobacterales, *Pseudomonas* and *Acinetobacter* may cause a variety of clinical syndromes including urinary tract, blood stream, surgical site, pulmonary and intra-abdominal infections similar to other invasive bacterial infections. Persons who are colonized may appear healthy and have no symptoms but still require infection control precautions when in healthcare settings to prevent spread to vulnerable patients.

B. Laboratory Criteria for Diagnosis of Cases

CP-CRE and other carbapenemase producing organisms (CPO): A confirmed carbapenemase-producing CRE (CP-CRE) or CPO case is a patient with a clinical or surveillance culture

1. Positive for known carbapenemase gene demonstrated by molecular test (e.g., Xpert Carba-R, VERIGENE, Streck ARM-D, Cepheid, or validated laboratory-developed nucleic acid amplification test (NAAT)) or by whole genome sequencing; OR
2. Positive on a phenotypic test for carbapenemase production (e.g., Metallo-B-lactamase test (MBL), modified Hodge test (MHT), CarbaNP, Carbapenem Inactivation Method (CIM), modified CIM (mCIM), EDTA-modified carbapenem inactivation method (eCIM), or Immunochromatography tests (ICT), OR
3. Positive by other culture independent diagnostic test (CIDT)

For public health surveillance, each unique genus/species/carbapenemase combination in a clinical culture should be counted as a new case once. Clinical cases should be counted

only once, no subsequent surveillance cases should be counted. Surveillance screening cases may be counted once as a surveillance case and once subsequently as a clinical case. See the Council of State and Territorial Epidemiologist Position Statement, 22-ID-04 for more details about surveillance case counting.

C. Case Classification

Confirmed: CP-CRE or CPO as described in section 3B above.

Rule out: CR-isolates that complete testing and are negative for carbapenemase gene

Suspect: CR isolates reported to public health but not submitted to PHL for carbapenemase testing

Not reportable: Isolates that do not meet criteria for submission. (See antibiotic susceptibility criteria for submission in Appendix I, Table 1.)

Note: Isolates that are mCIM positive with SME or hyper-ampC phenotype reported by PHL should be classified as "ruled out". These resistance mechanisms do not warrant public health response. For other uncommon test results, please consult the HAI MDRO team at MDRO-AR@doh.wa.gov.

4. DIAGNOSIS AND LABORATORY SERVICES

A. Diagnosis

CRE are most commonly diagnosed by bacterial isolation with antibiotic susceptibility testing (AST). See Appendix I for AST criteria for CRE and CRO and confirmatory carbapenemase tests. Most clinical laboratories use automated susceptibility testing methods (Vitek 2, Trek, Microscan, Phoenix). Traditional methods for determining resistance include broth dilution, disk diffusion or E test. Resistance should be determined using the most up-to-date resistance breakpoints as set by Clinical Laboratory Standards Institute (CLSI) M100-Ed32 (described in Appendix I). Phenotypic and molecular tests or whole genome sequencing are used to confirm carbapenemase production. Consult the HAI MDRO team at MDRO-AR@doh.wa.gov.for questions about determining whether a case meets the definition for CRE, CRO, CP-CRE, or CPO, or for submission to PHL for confirmatory testing.

B. Services Available at the Washington State Public Health Laboratories (PHL)

At PHL, all isolates undergo species identification and PCR for carbapenemase production. Modified carbapenemase inactivation method (mCIM) phenotypic testing is also performed on all CR-Enterobacterales and CR-*Pseudomonas* isolates. PHL also performs antimicrobial susceptibility testing (AST).

Specimens submitted from patients for carbapenemase screening undergo RT-PCR performed to identify carbapenemase production. Culture-based screening is sometimes performed if the target is not identified by PCR. PHL provides free screening supplies

and instructions for collection. **Pre-approval is required for carbapenemase screening** through the HAI MDRO team at MDRO-AR@doh.wa.gov.

For clinical purposes, PHL also offers expanded antimicrobial susceptibility testing (ExAST) for hard-to-treat infections. Isolates eligible for submission include Enterobacterales not susceptible to all β-lactams tested, including either ceftazidime/avibactam or meropenem/vaborbactam OR possess at least one MBL gene (blaNDM, blaVIM, or blaIMP) confirmed by a molecular test. Preapproval is required by emailing ARLN@doh.wa.gov. See details at Expanded Antimicrobial Susceptibility Testing.

When submitting specimens to PHL, include the Antibiotic Resistance Lab Network (ARLN) Requisition Form. Note that PHL requires all clinical and screening specimens to have two unique patient identifiers, a name **and** a second identifier (e.g., date of birth), on both the specimen label and the submission form. **These patient identifiers must match exactly.** Due to laboratory accreditation standards, specimens will be rejected for testing if not properly identified. Also include specimen source and collection date.

5. CASE INVESTIGATION

Review laboratory results to confirm genus and species and antimicrobial susceptibility testing to ensure the isolate meets the CRE, CRO, CP-CRE or CPO surveillance case definition, see Appendix I and section 3B for details.

The guidance, What to do if you identify a targeted multidrug resistant organism in your facility, provides response actions for LHJs and healthcare facility infection preventionists in order to quickly collect data for CPO investigations and to prevent transmission to others. DOH HAI MDRO staff are available to assist and can be reached at 206-418-5500.

A. Case Management

Consult an infectious disease specialist for treatment recommendations. In almost all cases, decolonization is not recommended but may be considered prior to immune-modulating therapy such as chemotherapy or bone marrow transplant. For cases with very limited treatment options, the PHL can perform expanded antimicrobial susceptibility testing; pre-approval is required. See Section 4 above.

B. Case Follow Up

Conduct a public health investigation for all confirmed CP-CRE and CPO cases. Case isolates that test negative for carbapenemase do not require public health investigation unless there is suspicion of an outbreak. The DOH HAI MDRO staff are available to lead investigations if requested by the LHJ. Review clinical history, medical records and laboratory records and interview the case, parent/guardian, power of attorney, close family members, or others who may be able to provide pertinent information, as needed to collect necessary information. Complete a WDRS case report under “Highly antibiotic resistant organism” (HARO) and complete the HARO wizard question package including the “Clinical and Laboratory” tab.

B. Ensure Infection Control

Because of the potential for transmission of CRE and other CRO to vulnerable patients in healthcare settings, healthcare providers, infection preventionists and facilities should apply appropriate transmission-based precautions when these resistant organisms are identified by a clinical lab. Providers should also communicate infection or colonization status to patients and family members and educate them about how to prevent transmission in the home using a CRO Patient Notification form, and to receiving facilities and providers when patients transfer care using an inter-facility infection control transfer form.

For patients with CRE and CRO, intensity of infection control measures should be based on mechanism of carbapenem resistance, healthcare setting, and patient's clinical status. More intensive infection prevention should be implemented for CPO, acute care, and for patients with indwelling devices, wounds, diarrhea, uncontained drainage or incontinence, or who require assistance with activities of daily living that involve close contact between patient and caregiver (e.g., dressing, bathing, toileting, transferring).

In general, in acute care settings such as hospitals and long-term acute care hospitals, carbapenemase positive patients should be cared for in private rooms with indefinite application of contact precautions, and carbapenemase negative patients for a minimum of 1 year since most recent detection. Cohorting patients with the same organism and resistance mechanisms may be used if private rooms are unavailable.

For nursing home residents infected or colonized with CRE or CRO, Enhanced Barrier Precautions should be used for all carbapenemase positive cases, and should be *strongly considered* for carbapenemase negative cases for a minimum of 1 year since most recent detection. CP should be used if

- The resident has wounds, secretions, or excretions that are unable to be covered or contained;
- There is ongoing transmission of the MDRO on the unit or in the facility despite attempts to control the spread;
- The resident has another condition or infection for which CP are indicated, such as *C. difficile infection,* norovirus, or scabies. (4)

See the Appendix II for more detailed infection prevention guidance and refer to national expert guidance:

- Management of Multidrug-Resistant Organisms in Healthcare Settings, 2006 https://www.cdc.gov/infectioncontrol/pdf/guidelines/mdro-guidelines.pdf
- Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines.pdf
- CDC Facility Guidance for Control of Carbapenem-resistant Enterobacteriaceae https://www.cdc.gov/HAIAR/pdfs/cre/CRE-guidance-508.pdf
- Interim Guidance for a Health Response to Contain Novel or Targeted MDROs https://www.cdc.gov/hai/pdfs/mdro-guides/Health-Response-Contain-MDRO-508.pdf

- Duration of Contact Precautions for Acute-Care Settings https://www.cambridge.org/core/journals/infection-control-and-hospital-epidemiology/article/duration-of-contact-precautions-for-acutecare-settings/94E38FDCE6E1823BD613ABE4E8CB5E56

C. Identify Potential Sources of Infection or Colonization

Public health should investigate all CP-CRE and CPO cases to identify the source, evaluate for lapses in infection control in healthcare settings, detect potential transmission to other patients, ensure the patient is educated and appropriate communication of CP-CRE or CPO status occurs to healthcare providers and facilities where the patient receives care. Identify current and past healthcare and underlying conditions, including any hospital or long-term care admissions, surgeries, dialysis, indwelling catheters, or international healthcare or travel, focusing particularly on the 12 months prior to diagnosis. If the index case has had many healthcare encounters and public health resources are limited, focus the investigation on the 1 month prior to diagnosis. The guidance What to do if you identify a targeted multidrug resistant organism in your facility will help LHJs and facilities quickly perform the investigation.

6. CONTROLLING FURTHER SPREAD

A. Infection Control Recommendations

See section 5B above and Appendix II for healthcare setting-specific infection prevention recommendations.

Providers should communicate information about patients' carriage of CRE and CRO to receiving facilities, as is done for *C. difficile*, methicillin-resistant *Staphylococcus aureus* (MRSA) and other epidemiologically important organisms, both verbally and in writing using an inter-facility infection control transfer form or other standardized method. Patients, their power of attorney, and their home caregivers should also be informed of multidrug resistant organism (MDRO) carriage and instructed in infection prevention, particularly stressing hand hygiene. A CRO Patient Notification form is available to educate patients and families.

Patients with CRE or CRO who return to a home setting should be instructed by their health care providers in good hand hygiene, especially after touching the infected area, both contaminated dressings, and after using the bathroom. People providing care at home for patients with CRE and CRO should be careful about washing their hands, especially after contact with wounds, dressings and other contaminated objects or surfaces or helping the CRE or CRO patient with toileting. Gloves should be used when anticipating contact with body fluids or blood. This is particularly important if the caregiver is caring for more than one ill person. Healthy people usually don't become infected with CRE or CRO but can become colonized. When discharging a patient to home, health care providers should communicate CRE or CRO status to the patient's primary care team to and other healthcare providers in outpatient settings, particularly those where invasive procedures are performed (i.e., urology) to avoid spread.

C. Contact Management

Epidemiologically linked contacts (defined in section 5D) of a CP-CRE or CPO case who

have symptoms or signs compatible with infection (fever, pneumonia, sepsis, draining wound, dysuria) should be placed in transmission-based precautions and evaluated promptly by a healthcare provider.

Since the SARS-CoV-2 pandemic, there have been many reported instances of CPO transmission in intensive care units despite the use of transmission-based precautions. When there is potential for spread to others in a healthcare setting, consider screening those at risk, according to these recommendations:

- **Roommates and those who shared a bathroom with the case should always be screened, even if they have been discharged from the facility.**
- In most situations, screening should also include at least one of the following:
  1. Patients/residents currently on the hallway, wing or unit (Point Prevalence Survey [PPS]) -- **preferred option**, OR
  2. Patients/residents currently on the unit with risk for MDRO acquisition (e.g., bedbound, high levels of care, indwelling device, wound, or mechanical ventilation), OR
  3. Patients/residents still in the facility who were on the unit at the same time as the case with an overlap of at least 72 hours, OR
  4. Patients/residents still in the facility with risk for MDRO acquisition and who were on the unit with an overlap of at least 72 hours as the case.

*If screening will take more than 72 hours to complete, Public Health recommends option 1 above. Options 1 and 2 result in **more patients** being screened but require **fewer resources** and less time to identify those to be screened. Options 3 and 4 frequently delay screening and often result in few to no epi-linked patients being available for screening.

- In certain situations, patients/residents who are currently in the room or bed space where the case was previously inpatient.
- In some situations, all patients/residents in the facility should be screened.

Screening cultures of healthcare personnel and healthy household contacts is not recommended unless implicated in transmission or in other unique situations.

For further guidance on surveillance screening, see

- CDC Containment Strategy Guidelines for Novel or Targeted MDROs

Please note CDC Containment and Prevention Strategy classifies targeted MDROs into tiers 1, 2 and 3. Washington classifies all carbapenemases, including KPC and OXA, and *Candida auris* as Tier 2. Surveillance screening testing can be performed free of charge at PHL. Consult with the HAI MDRO team at MDRO-AR@doh.wa.gov for guidance on screening recommendations, instructions, and proper collection materials.

D. Environmental Evaluation

In healthcare settings, ensure that environmental cleaning procedures adhere to CDC

and HICPAC Guidelines for Environmental Infection Control in Health-Care Facilities.

Since environmental cleaning is such a vital component of infection prevention, the identification of CRE and CRO in a facility should prompt communication to environmental services staff reinforcing their important role in protecting patients, an audit of cleaning practices, ensuring use of EPA-approved disinfectants, adherence to proper contact time, and completeness of cleaning. Consideration should be given to providing disinfectant wipes so that bedside staff can clean and disinfect high touch surfaces such as—bedside table, remote control, call button, bedside rails, doorknobs, faucet and toilet handles, and light switches—at least once a shift. Ensure that reusable medical equipment is properly cleaned and disinfected between use, and there is a clear procedure for identifying whether equipment is clean and ready for use.

7. ROUTINE PREVENTION

A. Routine Prevention

Prevention of CRE and CRO transmission requires collaboration and coordination between public health agencies and healthcare facilities. Controlling transmission necessitates knowing local and regional prevalence of these organisms through surveillance, rapid identification of colonized and infected patients in healthcare settings and implementing facility-specific and regional interventions to prevent transmission.

Core measures that facilities should follow include hand hygiene, appropriate use of personal protective equipment, ensuring environmental cleaning and disinfection, education of healthcare personnel, minimizing device use, cohorting staff and patients, laboratory notification, antimicrobial stewardship, and screening for CRE or CRO when indicated.

B. Prevention Recommendations

All persons can adhere to good health hygiene to stop the spread of pathogens by washing hands frequently, especially

- Before preparing or eating food
- After using the bathroom or helping another person with toileting or diapers
- After blowing the nose, coughing or sneezing
- After touching used tissues or handkerchiefs
- Before and after changing wound dressings or bandages

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UPDATES

March 2014: Updates include submission and reporting requirements for CRE surveillance and local health responsibilities for investigation and infection control; updates are interspersed throughout but affected mainly

sections 1B and C, 2A and C, 3B, 4B, and 5B and C.

April 2015: Updates include a change in CRE surveillance case definition, and submission and reporting requirements; updates are interspersed throughout but affected mainly sections 1B, 3B, and 4B.

November 2016: Updates include changes in case definitions, and added detail about infection control recommendations for different healthcare settings in section 5B and Appendix B. Other updates are interspersed throughout but affected mainly sections 1B, 3B and 5B.

May 2018: Updates include case definitions in section 3B, reporting requirements in section 1B, and new infection prevention guidance resources in section 5B. We have updated the guidance to be applicable to both CRE and other CRO.

June 2021: Updates include changing the taxonomic family name, Enterobacteriaceae, to the more inclusive order name, Enterobacterales, removing Appendix B, table of genera included under Enterobacteriaceae; making the document applicable to other carbapenem resistant organism, and providing links to new guidance materials, including "What to do if you identify a targeted multidrug resistant organism in your facility."

August 2021: Added Table 1 that defines resistance criteria of bacterial isolates for submission to PHL for carbapenemase testing; clarified that any carbapenemase-producing Enterobacterales, *Acinetobacter* or *Pseudomonas* isolates should be classified as "confirmed" and those testing negative as "not reportable."

November 2021: Reorganized sections 5 and 6 to remove repetition. Updated infection control recommendations in the appendix to better align with national guidance.

December 2022: For 2023 WAC revision combined provider and facility reporting requirement, updated laboratory submission (Section 1B); updated to reflect addition of provisional reporting of all CR-Enterobacterales, *Pseudomonas*, and *Acinetobacter*; removed Table 1 and replaced it with Appendix I showing AST criteria for reporting and submission of CRE, CR-*Pseudomonas* and CR-*Acinetobacter*.

March 2023: Updated link to Interim Guidance for a Health Response to Contain Novel or Targeted MDROs.

June 2023: Added table on confirmatory carbapenemase tests to Appendix I. Added information about infection prevention in community-based settings such as adult family homes to Appendix II.

January 2024: Updated Section 1.B, Required Reporting, Section 3.C, Case Classification, and Appendix I, Table 1 to be clearer.

Appendix I: Reporting and submission criteria for carbapenem resistant Enterobacterales, *Acinetobacter baumannii* and *Pseudomonas aeruginosa*

AI, Table 1: Antimicrobial susceptibility test criteria for laboratories to report and submit carbapenem resistant *Enterobacterales*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa*

Bacterial Order, Family or Genus	**Antibiotic Resistance Criteria**
Carbapenem-resistant Enterobacterales[1] (excluding *Morganella*, *Proteus*, and *Providencia* spp.)	Resistant to ≥ 1 carbapenem: Minimum inhibitory concentrations (MIC) ≥4 µg/ml for meropenem, imipenem, or doripenem, or ≥ 2 µg/ml for ertapenem **OR** Kirby-Bauer zone of inhibition diameter (ZID) ≤ 19 mm for meropenem, imipenem, and doripenem, or ≤ 18 mm for ertapenem
Carbapenem-resistant *Morganella, Proteus* and *Providencia* spp.	Resistant to ≥ 1 carbapenem **excluding imipenem**: MIC ≥ 4 µg/ml for meropenem or doripenem, or ≥ 2µg/ml for ertapenem **OR** Kirby-Bauer ZID ≤ 19 mm for meropenem or doripenem, or ≤ 18 mm for ertapenem
Carbapenem-resistant *Acinetobacter baumanii*	Resistant to ≥1 carbapenem **excluding ertapenem**: MIC ≥8 µg/mL for meropenem, imipenem, or doripenem, **OR** Kirby-Bauer ZID ≤ 14 mm for doripenem or meropenem, and ≤ 18 mm for imipenem
Carbapenem-resistant *Pseudomonas aeruginosa* (non-mucoid)	Resistant to ≥1 carbapenem, **excluding ertapenem**: MIC ≥ 8 µg/mL for meropenem, imipenem, or doripenem, **AND** MIC ≥ 16 µg/mL for ceftazidime or cefepime **OR** Kirby-Bauer ZID ≤ 15 mm for meropenem, imipenem, or doripenem, **AND** Kirby Bauer ZID ≤ 17 mm for ceftazidime or cefepime

[1]Refer to National Center for Biotechnology Information Taxonomy Browser for a list of bacterial families, genera and species in the taxonomic order, Enterobacterales https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=91347.

AI, Table 2: Confirmatory carbapenemase tests for laboratories, facilities and healthcare providers to report for carbapenem resistant *Enterobacterales*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa*

Category of Test	**Examples**
Phenotypic Test[1]	• Metallo-β-lactamase (MBL) test • RAPIDEC Carba NP • Modified carbapenem inactivation method (mCIM) • EDTA-modified carbapenem inactivation method (eCIM) • Hardy NG Carba-5 Immunochromatography test (ICT)
Molecular Test[1]	• Cepheid Xpert Carba-R • Luminex VERIGENE • Streck ARM-D β-lactamase • Validated laboratory-developed nucleic acid amplification test (NAAT)
Next Generation Sequencing (NGS)	• Detection of a carbapenemase gene
Culture Independent Diagnostic Test	• Other culture independent diagnostic test (CIDT)

[1]Isolates that are phenotypically positive for carbapenemase production but negative for a carbapenemase gene via a molecular test should be reported and submitted.

Appendix II:

Highly antibiotic resistant organisms, and particularly carbapenemases, are more common among people who have had many healthcare exposures, invasive procedures, and antibiotics. Often, these risk factors are chronic and ongoing, therefore once a patient is colonized with a carbapenem-resistant organism (CRO), long-term carriage may occur. This information should be factored into decisions about duration of transmission-based precautions (TBP).

Carbapenemases have been identified in Enterobacterales and in *Pseudomonas* and *Acinetobacter* species. Though all three groups may colonize the intestines, Enterobacterales are most likely to maintain colonization in the intestines whereas *Pseudomonas* species are more likely to colonize the respiratory tract, and *Acinetobacter* species to colonize wounds or skin. Therefore, risk of transmission from a colonized patient may vary based on site of colonization and type of care the patient requires. These factors should be considered when assessing the need for TBP.

Acute Care Hospitals

In hospitals, patients colonized or infected with

- **carbapenemase positive CRE or CRO** should be placed on Contact Precautions (CP) indefinitely.
- **carbapenemase negative CRE or CRO** should have CP maintained for the duration of the index hospitalization and upon readmission, facilities should consider continuing for a minimum of 1 year following the most recent detection (1).

See Appendix II, Table 1.

Nursing Homes

In nursing homes, residents infected or colonized with

- **carbapenemase positive CRE or CRO** should be placed on Enhanced Barrier Precautions (EBP) for the duration of their admission and on subsequent admissions, unless CP are more appropriate. (2,3)
- **carbapenemase negative CRE or CRO** should be *strongly considered* for EBP for a minimum of 1 year following most recent detection.

EBP means using gown and gloves for care involving close physical contact (e.g., dressing, bathing, toileting, changing linens, device and wound care). (2)

CP should be used instead of EBP for residents infected or colonized with MDROs in the following situations:

- When a resident has wounds, secretions, or excretions that are unable to be covered or contained;
- On units or in facilities where, despite attempts to control the spread of the MDRO, ongoing transmission is occurring.

- The resident has another condition or infection for which CP are indicated, such as *C. difficile infection,* norovirus, or scabies (4)

See Appendix II, Table 2.

Discontinuation of EBP for carbapenemase positive residents in nursing homes
For nursing home residents with a history of a carbapenemase positive CRE or CRO, there are rare situations when facilities might consider discontinuing EBP. These criteria include:

- The resident has recovered from their acute illness, and
- The resident does not have indwelling devices, wounds or incontinence, and
- The resident has no significant need for assistance with activities of daily living, and
- At least 1 year has elapsed since the most recent positive culture (either screening or clinical),
- The resident is not currently being treated with antibiotics, and
- Two or more consecutive rectal screening sample swabs collected at least a week apart are negative.

Hospitals and nursing homes should discuss with their local health jurisdiction before discontinuing TBP for patients with carbapenemase-positive CRE or CRO.

Group Homes
In Adult Family Homes and other group home where physical care is provided to residents, risk of CPO transmission is thought to be directly related to care needs of the affected resident and of other residents--higher care needs increase risk of acquisition and transmission. Before transferring a person with a CPO to an adult family home or other similar care setting, public health should ensure that caregivers have completed training in infection prevention including careful and consistent use of Standard Precautions, hand hygiene, and environmental cleaning; evaluate underlying conditions and care needs of the resident and others in the home; and provide consultation on resident placement. See Appendix II, Table 3.

References

1. Banach DB, et al. Duration of Contact Precautions for Acute-Care Settings. Infect Control Hosp Epidemiol.2018 Feb;39(2):127-144.).
2. CDC, Implementation of Personal Protective Equipment in Nursing Homes to Prevent Spread of Novel or Targeted Multidrug resistant Organisms (MDROs). Available at: https://www.cdc.gov/HAIAR/containment/PPE-Nursing-Homes.html.
3. Centers for Medicare and Medicaid Services. CMS State Operations Manual, Appendix PP-Guidance to Surveyors for Long Term Care Facilities. Rev.211, February 3, 2023. https://www.cms.gov/medicare/provider-enrollment-and-certification/guidanceforlawsandregulations/downloads/appendix-pp-state-operations-manual.pdf
4. Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines.pdf

Appendix II (continued)

AII, Table 1. Infection prevention recommendations for CRE and CRO cases in acute care settings

Acute Care		
Infection Prevention Measure	**Carbapenemase positive CRE/CRO**	**Carbapenemase negative CRE/CRO**
	Infected or Colonized	**Infected or Colonized**
Standard Precautions	Yes	Yes
Contact Precautions	Yes, indefinitely	Yes, recommended for minimum 1 year following most recent detection
Private Room	Yes	Yes, if feasible
Door signage	Yes	Yes, while precautions are in place
Dedicated or disposable medical equipment	Yes, if feasible	Yes, if feasible
Visitor Recommendations		
Perform hand hygiene often, and always after leaving resident's room.	Yes	Yes
Wear gown/gloves if contact with body fluids is anticipated.	Yes	Yes
Wear gown/gloves if no contact with body fluids is anticipated.	No	No

AII, Table 2. Infection prevention recommendations for CRE and CRO cases in nursing homes

Nursing Homes		
Infection Prevention Measures	**Carbapenemase positive CRE/CRO**	**Carbapenemase negative CRE/CRO**
	Infected or Colonized	**Infected or Colonized**
Standard Precautions	Yes	Yes
Contact Precautions	No, unless resident has wounds, uncontained drainage, or another condition for which CP are indicated; OR there is ongoing MDRO transmission.	No, unless resident has wounds, uncontained drainage, or another condition for which CP are indicated; OR there is ongoing MDRO transmission.
Enhanced Barrier Precautions	EBP indefinitely	Strongly consider EBP for minimum 1 year since most recent detection
Private Room or Cohort	Yes	Yes, if feasible, for duration of EBP
Restricted to Room	No, unless unable to maintain clean hands, clothes, equipment.	No, unless unable to maintain clean hands, clothes, equipment.
Door signage	Yes	Yes, for duration of EBP
Dedicated or disposable medical equipment	Yes	Yes, if feasible, for duration of EBP
Visitor Recommendations		
Perform hand hygiene often, and always after leaving resident's room.	Yes	Yes
Wear gown/gloves if contact with body fluids is anticipated	Yes	Yes
Wear gown/gloves if no contact with body fluids is anticipated	No	No

AII, Table 3. Infection prevention recommendations for CRE and CRO cases in Adult Family Homes

Adult Family Home		
Infection Prevention Measures	**Carbapenemase positive CRE/CRO**	**Carbapenemase negative CRE/CRO**
	Infected or Colonized	**Infected or Colonized**
Standard Precautions	Yes	Yes
Contact Precautions	No, unless there is another reason for CP	No
Private Room or Cohort	Yes, if feasible	No
Dedicated Bathroom	Yes, if feasible	No
Restricted to Room	No, unless unable to maintain clean hands, clothes, equipment.	No, unless unable to maintain clean hands, clothes, equipment.
Door signage	No	No
Dedicated or disposable medical equipment	Yes, if feasible	No
Visitor Recommendations		
Perform hand hygiene often, and always after leaving resident's room.	Yes	Yes
Wear gown/gloves if contact with body fluids is anticipated	Yes	Yes
Wear gown/gloves if no contact with body fluids is anticipated	No	No