Utah Department of Health & Human Services

Carbapenemase-producing organism (CPO)

Carbapenemase-producing organisms may include:

Carbapenem-resistant Enterobacterales (CRE) (including but not limited to *Enterobacter spp.*, *Klebsiella spp.*, or *Escherichia coli*)
Carbapenem-resistant *Acinetobacter* species (CRA)
Carbapenem-resistant *Pseudomonas aeruginosa* (CRPA)

Disease plan

Quick links

Last updated: April 3, 2025 by Chrissy Radloff, Ashley Young, Angela Weil, and Charisse Schenk.

Questions about this disease plan?

Contact the Utah Department of Health and Human Services Office of Communicable Diseases: 801-538-6191.

Quick reference table

About the disease

Signs and symptoms

Infections caused by carbapenemase-producing organisms (CPOs) can cause many different signs and symptoms. The symptoms are usually the same as other bacterial infections, such as:

- bloodstream infections
- pneumonia
- urinary tract infections
- wound infections

Colonization is when bacteria are present, but the patient does not have symptoms or signs of illness. Patients who are colonized with a CPO can still spread the illness to other patients and contaminate the environment. Patients who are colonized with a CPO are at higher risk of developing a CPO infection than patients who are not colonized.[1,2]

Period of communicability

How long is someone contagious?

People who are colonized or infected with a CPO from any part of the body can spread these organisms for long periods of time. People who are colonized or infected with CPO should be placed on transmission-based precautions the entire time they stay in a healthcare facility.

Incubation period

How long does it take to have signs and symptoms after being exposed?

- There is no predictable time frame for signs and symptoms to develop after an exposure. Some people may never have symptoms.

Mode of transmission

How do CPOs spread?

- Direct contact with patients infected or colonized with a CPO
- Indirect contact with surfaces contaminated with a CPO

How do CPOs usually spread in healthcare settings?

- through the hands and clothing of healthcare workers
- shared equipment
- surfaces that have been contaminated

CPOs can grow and thrive in sink drains and toilets. Splashes of water from sink drains and toilets can contaminate a patient or resident's care items or surfaces in their environment with CPOs.[1,2]

Laboratory testing

Type of lab test

To find out whether a patient is infected/colonized with a CPO, they can be tested with:

- Culture and antimicrobial susceptibility test (AST)
    - Test results include
        - minimum inhibitory concentrations (MICs)

        - MIC interpretations
        - Suppressed results
- Carbapenemase phenotypic and genotypic testing
- Matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF)

Type of specimens to collect

- Specimens can be from any body site and can be clinical or screening specimens.
- Typical specimens include, but are not limited to:
    - Sputum
    - Urine
    - Abscesses
    - Wounds
    - Blood
    - Stool
    - Rectal swabs
    - Axillary/groin swabs
    - Perirectal swabs

Treatment recommendations

When should someone be treated for a CPO?

- Patients with a CPO-related infection may be treated with antibiotics.
- Patients who are colonized with a CPO and do not have symptoms should **not** be treated with antibiotics.
- Do **not** use antibiotics for prophylaxis (to prevent infection or colonization).

How to select the proper treatment for patients with a CPO infection

- See the culture and antimicrobial susceptibility test (AST) results.
    - The AST results will list the antibiotics to which the organism is susceptible or resistant.
- If a wound or abscess is infected, it can be cut and drained.
- You can consult with an infectious disease (ID) provider when you treat a patient who has a CPO-positive culture.

Management of cases

Isolation of case and precautions

- Acute care settings (acute care hospitals, long-term acute care hospitals, dialysis centers):
    - Contact precautions: Patients who are colonized or infected with a CPO should be isolated (kept away from others) and placed on contact precautions in addition to standard precautions.
- Long-term care settings (skilled nursing facilities (SNF), nursing homes):
    - Contact precautions: Patients should be isolated (kept away from others) and placed on contact precautions in addition to standard precautions if:
        - They are colonized or infected with a CPO **and**
            - have acute diarrhea without using laxatives, or

        - have secretions or excretions that cannot be contained by incontinence briefs, wound dressings, or other means.
    - Enhanced barrier precautions: Patients may be placed on enhanced barrier precautions in addition to standard precautions if:
        - They are colonized or infected with a CPO **and**
            - **do not** have acute diarrhea
            - **do not** have secretions or excretions that cannot be contained by incontinence briefs, wound dressings, or other means.

      Patients on enhanced barrier precautions **do not** need to be isolated or in a private room.

Quarantine

Patients at high risk for CPO colonization will be tested for CPOs when they are admitted to the healthcare facility. You can prevent the spread of CPOs if you place the patient in a private room and use contact precautions or enhanced barrier precautions (depending on the criteria above) while you wait for their test results.[2]

Infection control and prevention

- Identify patients with CPOs correctly and quickly.
- Wash your hands often or clean them with an alcohol-based hand sanitizer. Make sure patients, residents, and visitors do the same.
- Wear personal protective equipment (PPE) when you care for patients with a CPO.
- Clean and disinfect the patient's environment and medical equipment.
- Keep water droplets from sinks, toilets, or other wastewater plumbing from contaminating the patient's belongings or surfaces in their environment.
- Practice antimicrobial stewardship (AS).
- Let the next healthcare provider know whether a patient is positive for a CPO.

Resources

- Reportable diseases in Utah
- Interfacility infection control transfer form
    - This form should be sent with the patient or resident when they are transferred. It is **not** meant to be used to determine whether the patient can be admitted (admission criteria). It should only be used to provide consistent and coordinated care once the patient has been admitted.
- Interim guidance for a public health response to contain novel or targeted multidrug-resistant organisms
- Considerations for reducing risk: Water in healthcare facilities
- CRE carbapenem-resistant enterobacterales handout
- CRPA carbapenem-resistant pseudomonas aeruginosa handout
- CRAB carbapenem-resistant acinetobacter baumannii handout

What are Carbapenemase-producing organisms (CPOs)?

Antimicrobial resistance happens when bacteria and fungi change to become strong enough to survive the antibiotics that were created to kill them. Infections with antimicrobial-resistant organisms can be difficult and sometimes impossible to treat.[3] Antimicrobial resistance is a growing threat to health worldwide.

In the U.S., there are more than 2.8 million infections and 35,000 deaths from antimicrobial-resistant organisms each year.[4,5] Infections caused by multidrug-resistant organisms are estimated to cost more than $4.6 billion each year in the U.S.[6]

Efforts to prevent and control infections can reduce deaths from antimicrobial resistant organisms by as much as 30%.[4,5] However, this progress was hurt by the COVID-19 pandemic which put extra pressure on healthcare facilities and public health systems.[7,8]

One type of antimicrobial-resistant bacteria is called carbapenem-resistant organisms (CROs). These bacteria are resistant to 1 or more of the carbapenem antibiotics, such as doripenem, imipenem, meropenem, and ertapenem. Carbapenem antibiotics are often used as a last resort when other treatments don't work.

One subset of carbapenem-resistant organisms are carbapenemase-producing organisms (CPOs). These bacteria are a major reason why carbapenem resistance is spreading quickly in U.S. healthcare settings. Carbapenemase-producing organisms are bacteria that make enzymes called carbapenemases. Carbapenemases break down carbapenem and other beta-lactam antibiotics, making them useless. CPOs can share genetic code, like plasmids, with other bacteria. The code contains instructions on how to produce carbapenemase. When other bacteria learn to produce carbapenemase it allows carbapenem resistance to spread quickly.[1,2]

Pan-resistant and pan-not susceptible organisms are other threats to health. Pan-resistant organisms are resistant to all known antibiotics. Pan-not susceptible organisms may have intermediate susceptibilities to some antibiotics, but are not fully susceptible to any known treatment.[9,10] A bacteria's sensitivity to an antibiotic is usually described in one of 3 categories: "susceptible (S)," "intermediate (I)," or "resistant (R)" based on a measured value like the minimum inhibitory concentration (MIC). The MIC shows the lowest concentration of an antibiotic needed to stop the growth of the bacteria. Intermediate susceptibility results may require a higher dose of an antibiotic or dual therapy. Experts assume pan-not susceptible organisms (including pan-resistant organisms) produce carbapenemase and are therefore CPOs.

CPO infections are associated with high mortality (death) rates because they do not respond to common antibiotics, and some are resistant to all available treatments.[1,2] Patients who are colonized or infected with a CPO can spread these organisms to other people, especially in healthcare or long-term care facilities. Utah DHHS works with all local health departments and healthcare facilities to track and stop CPO outbreaks. This is done through surveillance (monitoring), outbreak investigations, education, better infection control, and improved communication between facilities.

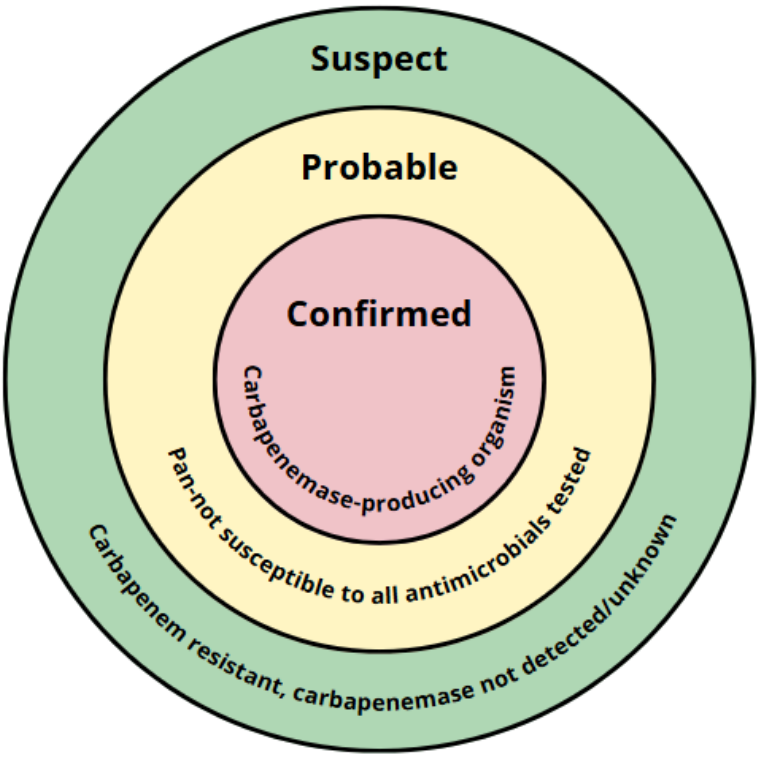
Disease and epidemiology

Clinical description (Signs and symptoms)

CPOs can cause infections in any body site including bloodstream infections, pneumonia, urinary tract infections, and wound infections.

Patients can be colonized with CPOs and not have any signs or symptoms of infection. Patients who are colonized with a CPO can still spread the bacteria to other patients and contaminate surfaces. Patients who are colonized with a CPO are at higher risk of developing CPO infection than patients who are not colonized.[1,2]

Figure 1. Case status cheat sheet



Causative agents

CPOs are gram negative bacteria (Enterobacterales, *Acinetobacter*, and *Pseudomonas aeruginosa*) that have become resistant to 1 or more carbapenem antibiotics. Carbapenems are strong antibiotics that are normally only used for infections that are resistant to most other antibiotics. Three groups of carbapenem-resistant bacteria are currently reportable in the state of Utah:

- CRE (**carbapenem-resistant *Enterobacteriaceae***) include, but are not limited to, *Enterobacter* species, *Klebsiella* species, or *Escherichia coli*, from any specimen source, that are resistant to 1 or more of the commonly-used carbapenems: doripenem, imipenem, meropenem, or ertapenem.
- CRA* (**carbapenem-resistant *Acinetobacter* species**) are *Acinetobacter* species,

from any specimen source, that are resistant to doripenem, imipenem, or meropenem.

- CRPA* (**carbapenem-resistant *Pseudomonas aeruginosa***) is caused by *Pseudomonas aeruginosa*, from any specimen source, that are resistant to doripenem, imipenem, or meropenem.

*Only Enterobacterales are tested for susceptibility to ertapenem. *Acinetobacter* species and *Pseudomonas aeruginosa* are naturally resistant to ertapenem and should not be tested against ertapenem. If *Acinetobacter* species and *Pseudomonas aeruginosa* have resistance to only ertapenem then they do not count as CRA or CRPA.[11] *Providencia*, *Proteus*, and *Morganella* species are all resistant to imipenem and should not be tested against imipenem. If *Providencia Proteus*, and *Morganella* species have resistance to imipenem only then they do not count as a case of CRE.

Laboratory identification

General issues with identifying CPOs in a laboratory

Utah law requires that certain diseases and conditions, called reportable diseases, must be reported to the Utah Department of Health and Human Services (DHHS). The laboratory plays a key role in reporting these diseases and creating alerts for cases of disease that need to be investigated by the health department. This is why laboratory personnel need to be familiar with which diseases should be reported and how to report these diseases as quickly as possible. Review the Utah reportable diseases for the list of diseases that must be reported to Utah DHHS within either 24 hours or 3 days from the time they are diagnosed.

Most laboratories can identify the genus and species from bacteria isolates. A bacterial isolate is when a strain of bacteria is separated from a mixed population of living microbes. Testing includes a culture to find out the type of bacteria and antibiotic susceptibility testing (AST) to find out which antibiotics will work against the bacteria. Most identification and antibiotic susceptibility testing performed today is done with automated stand-alone/walk away instruments that don't need a person to control them.

The Utah Public Health Laboratory (UPHL) can perform AST and carbapenemase testing on CPO isolates. **The Utah communicable disease rule requires laboratories to submit all isolates of organisms that are resistant to carbapenemase (CROs) to UPHL for confirmation and further testing. Bacteria that should be tested for carbapenemase production include:**

- **CRE resistant to any carbapenem.**
- **CRA resistant to any carbapenem (excluding ertapenem).**
- **CRPA resistant to any carbapenem (excluding ertapenem) that is also not susceptible to:**
  - **ceftolozane/tazobactam, or**
  - **cefepime or ceftazidime when ceftolozane/tazobactam resistance is unknown.**

Note: UPHL generally will not repeat carbapenemase testing for the same person within a 12-month period unless:

- it is on a different organism
- AST results have changed, or
- there are other important epidemiologic factors such as:
    - an exposure to a different CP gene (for example if a case of KPC-Klebsiella was also exposed to a NDM-Klebsiella case within the 12-month time frame) or
    - other unique situations where case investigations may need it—determined on a case-by-case basis.

Note: Even if a laboratory submits clinical material to UPHL, Utah Communicable Disease Rule 386-702-5 still requires the laboratory to report the event (electronic laboratory reporting to UPHL of the positive test result and the AST) to Utah DHHS.

The guidelines used to determine whether bacteria are resistant to antibiotics (called clinical and laboratory standards [CLSI] breakpoints) change over time. Because of this, the Council of State and Territorial Epidemiologists (CSTE) recommend that laboratories report the actual test results—either MIC (minimum inhibitory concentration) values or Kirby-Bauer zone sizes—along with interpretations to DHHS. Doing this makes sure reports and investigations of CPOs are accurate and important data about resistance trends is not lost.

Recommendation: Use the most current CLSI guidelines for MIC breakpoints.

Laboratory identification of carbapenem resistance in CRE, CRA, and CRPA

Although most laboratories can identify carbapenem resistance in potential CRE, CRA, and CRPA isolates, only a few laboratories have the capability or capacity to identify whether carbapenem resistance is caused by a carbapenemase-producing mechanism. This means isolates need to be submitted to UPHL for more specialized phenotypic and genotypic testing to determine whether carbapenemase production (CP) is present. The primary carbapenemase genes are:

- *bla*$_{KPC}$ (*Klebsiella* pneumoniae carbapenemase—this resistance mechanism can exist in organisms other than *Klebsiella pneumoniae*)—considered most common in the U.S.
- *bla*$_{IMP}$ (imipenemase metallo-beta-lactamase).
- *bla*$_{NDM}$ (New Delhi metallo-beta-lactamase)—very common in the Indian subcontinent.
- *bla*$_{VIM}$ (Verona integron-encoded metallo-beta-lactamase).
- *bla*$_{OXA-48}$ (oxacillin-48-like carbapenemase).
- *bla*$_{OXA}$ (oxacillin carbapenemase).
- *bla*$_{SIM}$ (Seoul imipenemase).
- *bla*$_{GES}$ (Guiana extended spectrum).
- *bla*$_{GIM}$ (German imipenemase).

- *bla*$_{SPM}$ (Sao Paulo metallo-β-lactamase).

Carbapenemase genes are usually found on mobile genetic elements such as plasmids, which are small pieces of DNA that exist outside of the main chromosome (extra-chromosomal DNA). Carbapenemase genes can be easily passed between bacteria, even across different species, through these mobile genetic elements.[12] When the mobile genetic elements share the genetic code for carbapenemase production, more organisms can become carbapenemase-producing organisms. Carbapenemase-producing organisms are a major health concern because they are resistant to some of the strongest (last-line) antibiotics and can spread easily.

Carbapenem resistance doesn't always come from carbapenemase genes that spread between bacteria. Sometimes, bacteria can develop resistance to carbapenem antibiotics on their own after they are exposed to antibiotics. This usually happens because of a genetic mutation. This resistance is usually not easily transmitted to other bacteria. These mutations can make the bacteria produce a completely new (novel) type of carbapenemase enzyme. However, there is not much data available to show how often this happens.[13] Bacteria that could produce novel carbapenemase are sent to the regional Antibiotic Resistance Laboratory Network (ARLN) laboratory in Utah for more testing and analysis.

Treatment

CPOs should only be treated if they are causing an active infection. If a patient is colonized but not infected they should not be given antibiotics. For patients who are infected and have symptoms, choose antibiotics based on the results of antimicrobial susceptibility testing (AST), which will show which antibiotics will work against the bacteria. If the infection is in an abscess or wound, cutting and draining the wound (incision and drainage [I&D]) can also help. Consider consulting an infectious disease specialist to choose the best antibiotic treatment.

Case fatality (death rate)

The percentage of people who die from CPO infections (case fatality rate) is hard to determine. People infected with CPOs are associated with higher mortality rates compared to people who have infections caused by bacteria that are susceptible to antimicrobials (can be treated with antibiotics). The case fatality rate from carbapenemase-producing CRE infections is estimated to be as high as 50% among hospitalized patients.[14]

Reservoir

A reservoir is the habitat where a microorganism can live, grow, and multiply. CPOs can be found in the environment, such as in soil and water. Humans, both infected and colonized, are the most common reservoirs for CPOs in healthcare settings. CPOs can also survive in the environment for long periods of time. CPOs can spread from the environment to people when the environment is not properly cleaned and disinfected and when people do not properly wash or disinfect their hands. CPOs can stick to the plumbing of water sources (such as sink drains, toilets, or hoppers) if water systems are not maintained properly. CPOs can grow in these places by forming biofilms.

- CRE:
  - **Patients:** CRE commonly colonizes in the digestive tract, but can also colonize in other body sites. Patients colonized with CRE can be colonized from months to years.[1,2]
  - **Environmental reservoirs:** CRE can contaminate shared medical equipment. Sinks, drains, and toilets are another reservoir that contributes to the spread of CRE.

- CRA:
  - **Patients:** CRA commonly colonizes in:
    - the digestive tract
    - the respiratory tract
    - skin
    - wounds

    CRA can also colonize other body sites. Patients colonized with CRA may remain colonized indefinitely.[1,15]
  - **Environmental reservoirs:** CRA can contaminate environmental surfaces and shared medical equipment. CRA can live in the environment from days to weeks if the environment is not properly cleaned and disinfected.

- CRPA:
  - **Patients:** CRPA commonly colonizes in:
    - the respiratory tract
    - wounds
    - the digestive tract

    CRPA can colonize other body sites. Patients colonized with CRPA can be colonized from months to years. [1,16]
  - **Environmental reservoirs:** CRPA can contaminate environmental surfaces and shared medical equipment. *Pseudomonas* thrives in water sources. Sinks, drains, and toilets have become a common reservoir for CRPA.

Transmission

CPOs usually spread in healthcare settings through:

- the hands of healthcare workers
- direct or indirect contact with a patient or resident who has a CPO
- direct contact with contaminated environments, such as:
  - medical equipment (physical therapy equipment, hoyer lift, etc.)
  - surfaces (bed rails, door knobs, etc.)

Patients can be colonized with a CPO for long periods of time without any signs or symptoms. This means undetected patients who are colonized with a CPO can unknowingly spread it to others. This makes it harder to control the spread of CPOs in healthcare settings.

Risk factors for CPO colonization

Hospitalized patients and long-term care residents are at risk for CPO colonization and infection, specifically those who:

- Receive complex medical care. This includes patients who:
  - are admitted to the intensive care unit
  - have an invasive device such as:
    - mechanical ventilation
    - central venous line
    - urinary catheter
- Have severe or chronic wounds
- Have recently been treated with certain antibiotics
- Need help with activities like toileting, bathing, and dressing
- Were admitted to the same room or unit as a person colonized or infected with a CPO

Anyone who stayed in a hospital or had an invasive medical procedure outside the U.S. in the past 6 months is also at risk for CPO colonization. An invasive medical procedure is any procedure that enters the body. This usually happens by cutting or puncturing the skin or inserting medical equipment into the body.[1-2,15-16]

Incubation period

There is no predictable time frame for signs and symptoms to develop after exposure to a CPO. Some people may never have symptoms.

Period of communicability

Patients who have had a CPO infection or have been colonized with CPO bacteria in the past can still spread it to others. This is because CPO bacteria are hard to completely remove from the body and can stay for long periods of time, even indefinitely. Therefore, a patient diagnosed with 1 of these organisms should generally be considered colonized for long periods of time or for the rest of their lives. It is important for healthcare providers to know if a patient has a history of CPO infection or colonization so they can take proper infection control measures to prevent the spread of the bacteria to others.

Epidemiology

Due to better surveillance (tracking), it is easier to see how many people are infected with CPOs and where these infections are happening in the U.S.

CRE

CRE cases decreased in the U.S. from 13,100 in 2017 to 12,700 in 2020 and CRE deaths decreased from 1,100 in 2017 to 1,000 in 2020 from CDC estimates.[4,7]

CRA

CRA cases remained stable in the U.S. with 8,500 cases reported in 2017 and 7,500 cases in 2020 and CRE deaths stayed the same at 700 deaths for 2017 and 2020 from CDC estimates.[4,7]

CRPA

CRPA cases decreased in the U.S. from 32,600 in 2017 to 28,800 in 2020 and CRPA deaths declined from 2,700 in 2017 to 2,500 in 2020 from CDC estimates. [4,7]

Public health control measures

Health department responsibility

To prevent and contain the spread of CPOs, DHHS has a goal to:

- Make sure all CRE, CRA or CRPA specimens are sent to UPHL or other laboratories that have the capability to test to see if these organisms produce carbapenemase.
- Investigate cases of CPOs.
- Perform surveillance (tracking) to identify CPO cases.
- Make sure carbapenem-resistant organisms (CROs) and pan-not susceptible organisms are tested for carbapenemase-producing genes.
- Conduct point-prevalence surveys (testing groups of patients in a facility) to detect whether CPOs are spreading if there are CPO cases in healthcare settings.
- Assess whole genome sequencing (WGS) results to detect if CPOs are actively spreading within a healthcare facility.
- Educate facilities on how to:
    - Use infection prevention and control measures to prevent the spread of CPOs in their healthcare settings.
    - Put core elements of antimicrobial stewardship into practice to prevent the development of antimicrobial-resistant organisms.
    - Conduct infection control assessment and response (ICAR) and/or water infection control risk assessment (WICRA).
    - Use appropriate transmission-based precautions for patients and residents infected or colonized with a CPO. See the CDC Interim Guidance for a Public Health Response to Contain Novel or Targeted Multidrug-resistant Organisms (MDROs) updated December 2022 for more information on these precautions.
    - Regularly disinfect medical equipment and environmental surfaces with disinfectants approved by the Environmental Protection Agency (EPA) for CPO: EPA List K.
    - Communicate a patient's CPO status (infection or colonization) to other healthcare facilities when the patient is transferred. Healthcare facilities are encouraged to use the interfacility infection control transfer form to

communicate CPO status.

- Work with facilities to stop the spread of CPOs by following the strategies listed in the CDC Interim Guidance for a Public Health Response to Contain Novel or Targeted Multidrug-resistant Organisms (MDROs) manual.

Prevention

Preventing CPO infections is critical because some CPOs are resistant to all available antibiotic treatment. Prevention activities include:

1. **Timely and accurate identification of patients with a CPO**
    - Make sure your clinical laboratory can identify CPOs and carbapenemase production or work with Utah DHHS to find out where this testing is available.
    - Follow public health recommendations for CPO colonization screening.
    - When you transfer a patient colonized or infected with CPO, notify the accepting facility of the patient's CPO history.[2]

2. **Perform hand hygiene**
    - Use alcohol-based hand sanitizer or wash your hands with soap and water to perform proper hand hygiene.
        - Alcohol-based hand sanitizers are the preferred method for cleaning your hands in most situations.
        - Wash your hands with soap and water whenever they are visibly dirty, before you eat, and after you use the restroom.
    - Perform hand hygiene:
        - Immediately before you touch a patient.
        - Before you perform an aseptic task (placing an indwelling device like a catheter or tube).
        - Before you handle invasive medical devices.
        - Before you move from work on a soiled body site to a clean body site on the same patient.
        - After you touch a patient or the patient's immediate environment.
        - After contact with blood, body fluids, or contaminated surfaces.
        - Immediately after you take off your gloves.[2]

3. **Wear PPE when you care for patients with CPO**
    - CPOs can contaminate your hands, arms, and clothes while you care for a patient with a CPO or work in their environment. That puts patients you care for afterward at risk of getting CPOs. Make sure you:
        - Wear a gown and gloves for patient care according to the guidelines for your setting (contact precautions in acute care, enhanced barrier precautions [EBP] in long-term care) to protect your patients.
        - Don and doff your PPE in the right order and make sure you don't contaminate yourself during doffing.
        - Always change your PPE between patients or residents.[2]

4. **Clean and disinfect the patient environment and medical equipment**
    - Follow your facility's cleaning and disinfection protocols.
    - Make sure protocols include use of EPA list K disinfection products to target multidrug-resistant organisms (MDROs).
    - Make sure high-touch surfaces (bed rails, light switches, call buttons) are cleaned often.
    - Whenever possible, dedicate non-critical medical equipment (stethoscopes, blood pressure cuffs) to patients colonized or infected with CRE and always clean and disinfect them between patients.
    - Make sure shared medical equipment (portable X-ray machine, etc.) is cleaned and disinfected between each patient.[2]

5. **Prevent the spread of CPOs from sinks, toilets, and other wastewater plumbing**
    - Sinks, drains, toilets, and hoppers can be reservoirs for MDROs—including CPOs.
        - These bacteria can stick to the pipes and form biofilms which can be hard to remove. Biofilms allow a protected environment for bacteria to thrive and share antibiotic resistant genes with other bacterial species.
        - Patients can be exposed to these bacteria when water splashes from sinks, drains, toilets, or hoppers. Splashing can happen when water hits the sink drain cover or when toilets or hoppers are flushed.
            - Droplets from the splashes can displace CPOs from biofilms and contaminate the environment, patient care items, or the skin of healthcare workers or patients.[17]
    - To reduce the risk of MDRO exposure from water sources, facilities should:
        - Clean and disinfect countertops, handles, faucets, and sink basins at least once a day.
        - Keep patient care items at least 3 feet away from sinks, toilets, and hoppers.
        - Don't dump bodily fluids or patient waste down sinks.
        - Don't dump beverages or other sources of nutrients down sinks or toilets.

6. **Antimicrobial stewardship**
    - Use antibiotics appropriately to prevent CPOs and other MDROs from developing. Use CDC's 7 core elements of antibiotic stewardship.

7. **Communicate a patient's CPO status among care providers**
    - Use the interfacility transfer form to communicate the CPO status and other infectious disease status of patients when they are transferred to other healthcare providers or healthcare settings.
        - This allows the next healthcare provider to put appropriate infection prevention and control measures in place to reduce the risk of transmission of infectious diseases in their healthcare settings.

The facility is responsible for educating healthcare workers, patients, and visitors (including the patient's family) on how best to prevent the spread of CPOs. Health departments can provide materials to the facility to help with this education.

Infection control guidance

- The Healthcare Infection Control Practices Advisory Committee–2006 (HICPAC) developed guidance on Management of Multidrug-Resistant Organisms in Healthcare Settings. This guidance is the current gold standard for infection control in healthcare facilities.
- CDC Interim Guidance for a Public Health Response to Contain Novel or Targeted Multidrug-resistant Organisms (MDROs) informs health departments on how to respond to cases of CPOs in healthcare facilities.
- Refer to the case investigation and health department response to contain CPOs for a summary of case definitions and public health and facility actions. For all probable and confirmed cases, the DHHS HAI/AR program should coordinate with the facility to make sure:
    - transmission-based precautions are used around the patient
    - the patient's MDRO status is communicated to the next provider through use of the infection control transfer form.

Chemoprophylaxis

None.

Vaccine

None.

Isolation and quarantine requirements

Defining precautions

- **Standard precautions:** Standard precautions are used for the care of every patient in all healthcare settings whether the patient's infection status is suspected or confirmed. Healthcare workers should assess the level of risk for coming into contact with infectious organisms and use common sense when they decide which standard precautions to use. Healthcare workers use PPE to protect themselves from infection and prevent the spread of infectious organisms from one patient to the next with standard precautions. When standard precautions are used, healthcare workers should:
    - Perform hand hygiene.
    - Use PPE when you may be exposed to infectious material (blood or bodily fluids).
    - Use respiratory hygiene and cough etiquette (cover coughs and

sneezes).

- Make sure the patient is placed appropriately.
    - When there is a limited number of single-patient rooms, prioritize them for patients who:
        - Have conditions that can spread disease easily such as wounds that need to be drained, stool incontinence, or secretions that cannot be contained, or
        - Are more at risk for becoming infected with or developing complications from healthcare-associated infections such as having a weakened immune system, having an open wound or indwelling catheter (stays inside the body), are expected to stay in the facility for a long time, or are totally dependent on healthcare workers for daily tasks of living.
- Properly clean and disinfect patient care equipment and instruments/devices.
- Handle textiles (clothing, towels, bedding, etc.) and laundry carefully.
- Follow safe injection practices.[18]

- **Transmission-based precautions:** Transmission-based precautions are the second tier of basic infection control and should be used in addition to standard precautions to prevent the spread of CPOs and pan-not susceptible organisms.
    - Contact precautions: Wear a gown and gloves any time you might be in contact with the patient or the patient's environment. Don PPE when you enter the patient's room and properly throw it away before you leave the room. This will help to contain pathogens.
        - Avoid using the same equipment for multiple patients. If you must use the same equipment for multiple patients, clean and disinfect the equipment before you use it on another patient.
        - Post a contact precautions sign on the door outside the patient or resident's room. This will let others know what steps to take and what PPE to use when they enter the room.
        - Limit the movement of the patient and make sure there is only 1 patient per room.[19]
- Enhanced barrier precautions **(EBP):** Wear a gown and gloves during high-contact care activities where there is a chance MDROs could spread to your hands/arms and clothing. These high-contact care activities include times when you:
        - dress a patient
        - bathe/shower a patient

- transfer a patient
- provide hygiene to a patient, such as oral care, shaving, etc.
- change linens
- change a patient's briefs
- help a patient use the toilet
- treat a patient's wound
- care for or using a patient's device such as a:
  - central line
  - urinary catheter
  - feeding tube
  - tracheostomy/ventilator

- Change PPE before you care for another resident.
- You may also need face protection if you will be performing an activity where you could be splashed or sprayed with body fluids.
- Patients on enhanced barrier precautions do not need to be isolated or in a private room.[20]
- Post an EBP sign on the door outside of the patient or resident's room. This will let others know what steps to take and what PPE to use when they enter the room.[20] Signs in Spanish are available for EBP and contact precautions.

- **Acute care settings (acute care hospitals, long-term acute care hospitals, dialysis centers)**
  - **Contact precautions**: Patients should be isolated (kept away from others) and placed on transmission-based precautions in addition to standard precautions if they are colonized or infected with a CPO.
- **Long-term care settings (skilled nursing facilities [SNF], nursing homes)**
  - **Contact precautions**: Patients should be isolated (kept away from others) and placed on contact precautions in addition to standard precautions if they are:
    - Colonized or infected with a CPO **and**
      - have acute diarrhea (without using laxatives) or
      - have secretions or excretions that cannot be contained by incontinence briefs, wound dressings, or other external means.
  - **Enhanced barrier precautions**: Patients may be placed on enhanced barrier precautions in addition to standard precautions if:
    - They are colonized or infected with a CPO **and**
      - **do not** have acute diarrhea
      - have secretions or excretions that **can** be contained with incontinence briefs, wound dressings, or other external

means.

Patients on enhanced barrier precautions **do not** need to be isolated or in a private room.[21]

Quarantine

Patients at high risk for CPO colonization will be tested for CPOs when they are admitted to the healthcare facility. You can prevent the spread of CPOs if you place the patient in a private room and use contact precautions or enhanced barrier precautions (depending on the criteria above) while you wait for their test results.[2]

Patients at high risk for CPO colonization include those who:

- have a history of an overnight stay at a healthcare facility outside the U.S. in the past 6 months
- have had an invasive procedure outside the U.S. in the past 6 months
- were transferred from a facility or unit experiencing
    - a known CPO outbreak or
    - prevalence of MDRO cases that is higher than normal (above baseline)

Take additional steps to stop the spread of CPOs. To prevent the spread of CPOs:

- Do not transfer the patient to other rooms frequently.
    - Moving a patient between rooms increases the chances of spreading CPOs to different areas within the healthcare facility. It also increases the number of healthcare workers, patients, and surfaces potentially exposed.
- Make sure everyone performs proper hand hygiene, properly cleans and disinfects the healthcare setting environment, and follows standard precautions.

Whenever patients share a room, take precautions to prevent the spread of infectious organisms between them. Do this even if you don't know whether the patients are infected or colonized with a multidrug-resistant organism (MDRO). To prevent the spread of germs:

- Maintain at least 3 feet of space between beds.
- Use privacy curtains to limit direct contact.
- Clean and disinfect any shared reusable equipment.
- Clean and disinfect environmental surfaces more frequently than rooms that are not shared.
- Change personal protective equipment (PPE) (if you are wearing it) and perform hand hygiene when you switch care from one roommate to another.

Case investigation

Surveillance and reporting

The process of identifying where and when CPOs occur is called surveillance. Quick and complete surveillance (tracking) can stop the spread of CPOs. Laboratories do most of the

work of surveillance by reporting CPOs to Utah DHHS. To have complete laboratory surveillance, each testing laboratory must have an automated process that identifies which results to submit to Utah DHHS.

CRE, CRA, and CRPA are reportable diseases that must be reported to Utah DHHS **within 3 work days** from the day they were identified. While Utah DHHS encourages all facilities to report CPOs, most reports come from laboratories that perform CRO and CPO testing. When state and local health department staff receive the test results, they should enter the information into EpiTrax as soon as possible so **investigations can be performed while the patient is still in the facility**.

Case definition

State health departments are required to report CPOs to CDC's National Notifiable Diseases Surveillance System (NNDSS). Utah follows the CSTE position statement criteria for defining a CPO in Table 1. CRA and CRPA, in addition to CRE, are reportable by Utah law.

Note: The following section (including the tables) is copied directly from CSTE position statement 22-ID-04.

Table 1. Criteria for defining a case of CPO[1,2]

Criterion	Confirmed CPO
Clinical evidence	
N/A	
Laboratory evidence	
Positive for phenotypic carbapenemase production (e.g., mCIM, CIM CarbaNP) but negative by PCR (e.g., Xpert Carba-R) for all known resistance mechanisms *bla* $_{KPC}$,*bla* $_{NDM}$, *bla*$_{VIM}$,*bla* $_{IMP}$, *bla*$_{OXA-48}$, *bla*$_{SIM}$, *bla*$_{GIM}$, *bla*$_{SPM}$, other OXA genes) e.g., likely novel carbapenemase	S
Positive molecular test** result detecting a carbapenemase gene*** (with or without organism identification) (Polymerase chain reaction (PCR) positive [for *bla* $_{KPC}$,*bla* $_{NDM}$, *bla*$_{VIM}$,*bla* $_{IMP}$, *bla*$_{OXA-48}$, *bla*$_{SIM}$, *bla*$_{GIM}$, *bla*$_{SPM}$, other OXA genes])	S
Detection of carbapenemase gene*** by next generation sequencing (NGS)‡	S
Epidemiologic linkage evidence	
N/A	
Criteria to distinguish a new case	
A specific organism/carbapenemase combination in a person should be counted as a separate case from other organism/carbapenemase combinations in the same person.‡‡	N
A person classified as a clinical case should not be counted as a screening case thereafter for the same organism/carbapenemase combination. (e.g., patient with known infection who later has	N

colonization of gastrointestinal [GI] tract is not counted as more than 1 case)	
A person classified as a screening case can be later counted as a clinical case with the same organism/carbapenemase combination. (e.g., a patient with positive peri-rectal screening swab who later develops blood stream infection would be counted in both categories).	N
A case with a known carbapenemase but unknown organism should only be counted once for that carbapenemase.	N

Notes: S = This criterion alone is SUFFICIENT to classify a case.
N = All "N" criteria in the same column are NECESSARY to classify a case.
* Phenotypic testing methods include but are not limited to: metallo-β-lactamase test, modified Hodge test, Carba NP, carbapenem inactivation method (CIM), modified carbapenem inactivation method (mCIM), EDTA-modified carbapenem inactivation method (eCIM), or immunochromatography tests (ICT).
** Molecular tests for carbapenemase genes include but are not limited to: Xpert Carba-R, VERIGENE, Streck ARM-D, Cepheid, validated laboratory-developed NAAT.
*** Common carbapenemase genes include: blaKPC, blaNDM, blaVIM, blaIMP, blaOXA-48, but other carbapenemase genes include but are not limited to: blaSIM, blaGIM, blaSPM, other OXA genes, etc.
‡ It is not necessary to report organisms with known chromosomal carbapenemase genes, including but not limited to SME+ *Serratia marcescens*, unless they have additional non-chromosomal carbapenemase genes.
‡‡A specific organism/carbapenemase combination can include a carbapenemase gene(s) without an organism detected.

Case counting for public health purposes

Each unique CPO will generate a case. CPO lab reports will create a new case in EpiTrax.

Clinical criteria

N/A

Laboratory criteria

Confirmatory laboratory evidence:

- Positive phenotypic test* result for carbapenemase production in a specimen, **OR**
- Positive molecular test** result detecting a carbapenemase gene*** (with or without organism identification), **OR**
- Detection of carbapenemase gene*** by next generation sequencing (NGS).‡

Presumptive laboratory evidence:

N/A

Supportive laboratory evidence:

N/A

* Phenotypic testing methods include but are not limited to: metallo-β-lactamase test, modified Hodge test, Carba NP, carbapenem inactivation method (CIM), modified carbapenem inactivation method (mCIM), EDTA-modified carbapenem inactivation method (eCIM), or

immunochromatography tests (ICT).

** Molecular tests for carbapenemase genes include, but are not limited to: Cepheid Xpert Carba-R, Nanosphere VERIGENE, Streck ARM-D, validated laboratory-developed NAAT.

*** Carbapenemase genes include: bla_{KPC}, bla_{NDM}, bla_{VIM}, bla_{IMP}, bla_{OXA-48}, but other carbapenemase genes include, but are not limited to: bla_{SIM}, bla_{GIM}, bla_{SPM}, other bla_{OXA}, etc.

‡ It is not necessary to report organisms with known chromosomal carbapenemase genes, including, but not limited to, SME+ *Serratia marcescens*, unless they have additional non-chromosomal carbapenemase genes.

Note: The categorical labels used here to stratify laboratory evidence are intended to support the standardization of case classifications for public health surveillance. The categorical labels should not be used to interpret the utility or validity of any laboratory test methodology.[17]

Epidemiologic linkage

N/A

Case classifications

Confirmed: Any specimen that meets the confirmatory laboratory evidence.

Table 2. MIC values that define carbapenem resistance for *Acinetobacter*, *Pseudomonas aeruginosa*, and CRE[11]

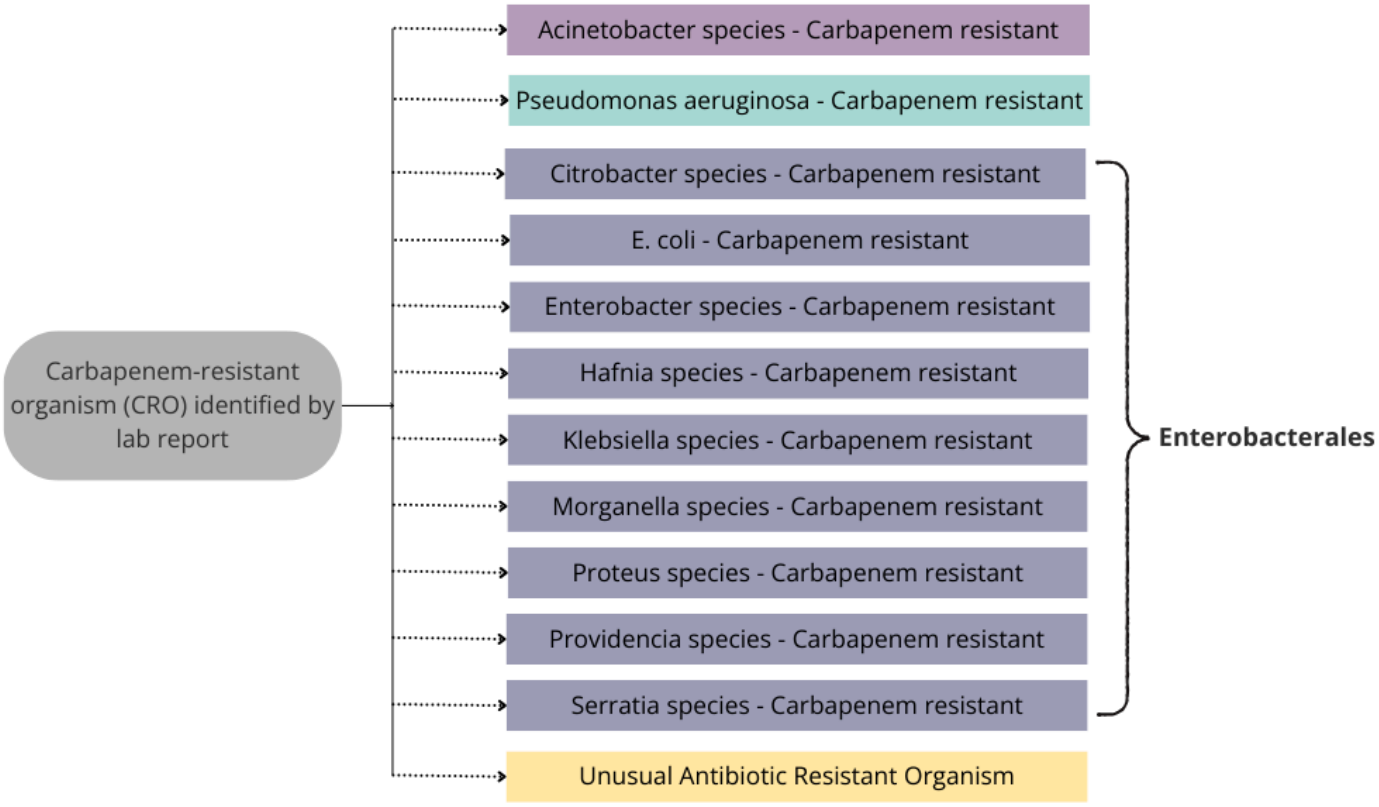
	Doripenem		Ertapenem		Imipenem		Meropenem	
	Intermediate	Resistant	Intermediate	Resistant	Intermediate	Resistant	Intermediate	Resistant
Carbapenem-resistant *Acinetobacter* spp.	≥4 ug/mL	≥8 ug/mL	N/A	N/A	≥4 ug/mL	≥8 ug/mL	≥4 ug/mL	≥8 ug/mL
Carbapenem-resistant *Pseudomonas aeruginosa*	≥4 ug/mL	≥8 ug/mL	N/A	N/A	≥4 ug/mL	≥8 ug/mL	≥4 ug/mL	≥8 ug/mL
Carbapenem-resistant Enterobacterales*	≥2 ug/mL	≥4 ug/mL	≥1 ug/mL	≥2 ug/mL	≥2 ug/mL	≥4 ug/mL	≥2 ug/mL	≥4 ug/mL

***Includes *E. coli*, *Enterobacter spp*, *Klebsiella* spp, and other *Enterobacteriaceae*.**

Note: Resistance is based on the MIC value, **NOT** the lab interpretation. Some labs in Utah use different breakpoints and may indicate that a resistant isolate is 'intermediate' or possibly even 'susceptible.' The HAI/AR epidemiologist is available to consult about interpretations and breakpoints.

Case classification in EpiTrax

Step 1: Organism identification and antibiotic susceptibility testing



Step 2: Screening for carbapenemase-producing resistance mechanisms

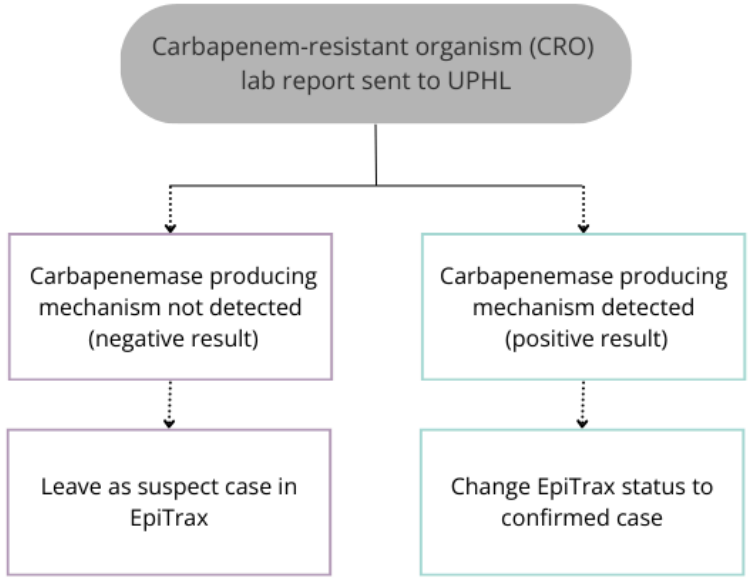
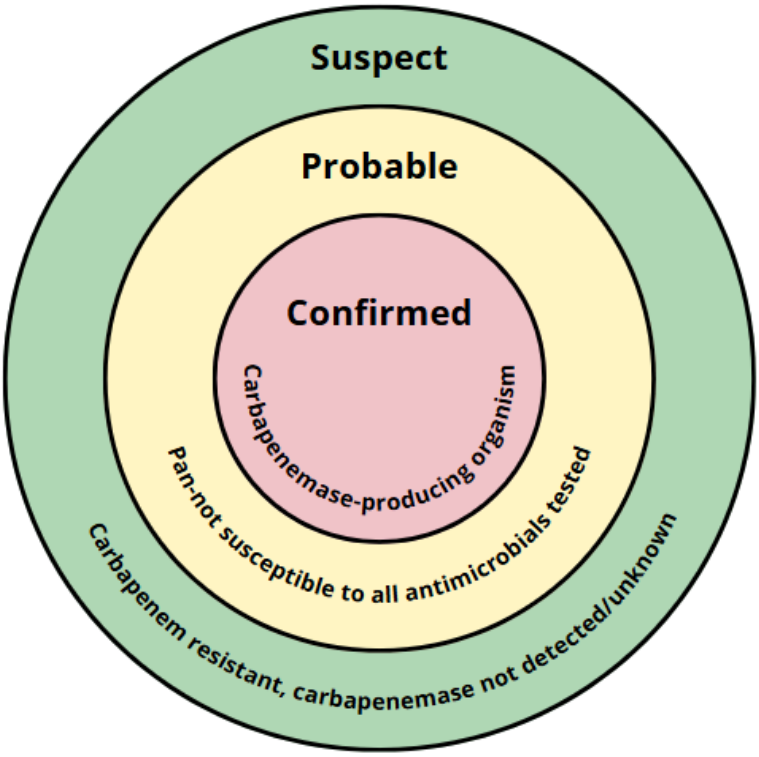


Table 3. Carbapenem-resistant organism case classification

	Suspect	Probable	Confirmed
	Carbapenem-resistant organism (CRO)	Pan-not susceptible organism	Carbapenemase-producing organism (CPO)
Carbapenem resistant	+	+	+
Not susceptible to all 1st and 2nd line antibiotics (pan-not susceptible)	-	+	+/-
Carbapenemase production	- Or not tested	- Or not tested	+ (phenotypic or genotypic confirmation)
Investigation required	No	Yes	Yes
Transmission-based precautions	No	Yes	Yes

Figure 1. Case status cheat sheet



Confirmed

CRA, CRPA, or CRE from any isolate that is:

Positive for a known carbapenemase-generating antibiotic resistance mechanism (e.g.,*bla* $_{KPC}$,*bla* $_{NDM}$, *bla*$_{VIM}$,*bla*$_{IMP}$, *bla*$_{OXA-48}$, *bla*$_{SIM}$, *bla*$_{GIM}$, *bla*$_{SPM}$, other OXA genes) demonstrated by a recognized test (e.g., PCR or WGS) confirmed by UPHL

OR

Positive on a phenotypic test for carbapenemase production (e.g., metallo-β-lactamase test, Carba NP, carbapenem inactivation method (CIM), or modified CIM (mCIM)) confirmed by UPHL

AND

Resistant to doripenem, meropenem, imipenem or ertapenem* (MIC values given in Table 2 based on current CLSI breakpoints).

**Consult with AR Lab Network experts to determine case classification of CPOs with discordant phenotypic test and genotypic test results.

Probable

CRA, CRPA, or CRE from any isolate that is:

Resistant to doripenem, meropenem, imipenem, or ertapenem*

AND

Non-susceptible to all antibiotics tested by the submitting clinical lab (pan-not susceptible)

OR

Positive for a known carbapenemase-generating antibiotic resistance mechanism (*bla* $_{KPC}$,*bla* $_{NDM}$, *bla*$_{VIM}$,*bla*$_{IMP}$, *bla*$_{OXA-48}$, *bla*$_{SIM}$, *bla*$_{GIM}$, *bla*$_{SPM}$, other OXA genes) demonstrated by a recognized test (e.g., PCR or WGS) unconfirmed by UPHL**

OR

Positive on a phenotypic test for carbapenemase production (metallo-β-lactamase test, Carba NP, carbapenem inactivation method (CIM), or modified CIM (mCIM)) unconfirmed by UPHL**

Suspect

CRA, CRPA, or CRE from any isolate that is:

Resistant to doripenem, meropenem, imipenem, or ertapenem*

AND

The isolate was not tested for or does not have any evidence of a carbapenemase.

**Only Enterobacterales are tested for susceptibility to ertapenem. Acinetobacter species and Pseudomonas aeruginosa are naturally resistant to ertapenem and should not be tested against ertapenem. If Acinetobacter species and Pseudomonas aeruginosa have resistance to only ertapenem then they do not count as CRA or CRPA.*[11] *Providencia, Proteus, and Morganella species are all resistant*

to imipenem and should not be tested against imipenem. If Providencia, Proteus, and Morganella species have resistance to imipenem only then they do not count as a case of CRE.

Notes:

1. Cases involving isolates that are phenotypically positive for carbapenemase production (e.g., mCIM), but negative for *bla* $_{KPC}$,*bla* $_{NDM}$, *bla*$_{VIM}$,*bla* $_{IMP}$, *bla*$_{OXA-48}$, *bla*$_{SIM}$, *bla*$_{GIM}$, *bla*$_{SPM}$, other OXA genes should be classified as confirmed CP-CRE*, CP-CRA, or CP-CRPA. Isolates should be submitted to the regional laboratories of the ARLN for further characterization (potential novel mechanism).

    *In the rare case of *Enterobacter* spp. with a positive phenotypic carbapenemase test **AND** susceptible to Cefepime **AND** negative for *bla* $_{KPC}$,*bla* $_{NDM}$, *bla*$_{VIM}$,*bla* $_{IMP}$, *bla*$_{OXA-48}$, *bla*$_{SIM}$, *bla*$_{GIM}$, *bla*$_{SPM}$, other OXA genes, these cases are likely caused by a hyper ampC production and will **NOT** be counted as a confirmed case. Instead, they will be counted as a suspect case. **Consult with an ARLN expert to determine case classification of CPOs unconfirmed by UPHL.

2. If the isolate is indeterminate on mCIM and negative by PCR for *bla* $_{KPC}$,*bla* $_{NDM}$, *bla*$_{VIM}$,*bla* $_{IMP}$, *bla*$_{OXA-48}$, *bla*$_{SIM}$, *bla*$_{GIM}$, *bla*$_{SPM}$, other OXA genes, the isolate should be sent to the ARLN regional laboratory for further testing.

3. Carbapenemase testing in *Acinetobacter* is done by PCR methodology using the Cepheid Genexpert because there are currently limited options for phenotypic testing. However, one of the more common carbapenemase genes in *Acinetobacter* is OXA-23, which is not currently identified in commonly used Cepheid PCR testing methodology, so carbapenemase production cannot be ruled out in CRA cases without whole genome sequencing (WGS).

Case classification comments

The following section provides guidance for health departments to further classify CPO cases. Each CPO report should be classified by whether the specimen was collected for **clinical** purposes (to diagnose or treat a disease during regular medical care) or for **screening** (to check for colonization and not to diagnose or treat disease).

It can be hard to tell whether a specimen was taken for clinical or screening purposes based on microbiology records. Because of this, **screening** cases should generally be limited to CPO identified in the following specimens:

- rectal
- perirectal
- axilla
- groin
- stool

Specimens from these sites can be assumed to be for screening unless specifically noted otherwise. Laboratories may also note screening specimens from other sites (wound, tracheostomy, or central line sites). Laboratories do not need to change their practice; Utah DHHS

wants to identify all CPOs whether they come from screening or clinical specimens.

Each report should also specify carbapenemase gene(s) when known (blaKPC, blaNDM, blaOXA-48, blaVIM, blaIMP, etc.) and list all genes within the same specimen (NDM+ OXA-48+ E. coli).

Case investigation process

1. Testing documentation is an essential part of the investigation process. DHHS will review all new CPO events during normal business hours, Monday through Friday. The DHHS Healthcare-Associated Infections/Antimicrobial Resistance (HAI/AR) epidemiologist will verify that the antibiotic susceptibility results are attached to EpiTrax, either by PDF or electronic laboratory reporting (ELR). The susceptibility report should include all of the antibiotics that were tested (MIC values and interpretations). If the report does not include these things, the HAI/AR epidemiologist will call the lab that performed the testing and ask them to fax over the complete susceptibility pattern. The DHHS fax number is 801-538-9923.

2. According to the Utah Communicable Disease Rule, all CRE, CRA, and CRPA isolates should be submitted to the Utah Public Health Laboratory (UPHL) for follow-up carbapenemase testing. Submit isolates with the public health isolate submission form.

   Isolates should be shipped to UPHL at

   4431 South 2700 West
   Taylorsville, UT 84129
   Phone: 801-965-2400.

   If the reporting lab is in Utah, a UPHL courier can help with delivery.

3. The DHHS HAI/AR epidemiologist will verify that the event has been routed to the appropriate local health department (LHD).

   - CRE and CRA investigations are based on the facility, not the person. This means the jurisdiction that performs these investigations is based on where the facility is located. If the patient was not in a hospital or a long-term care facility, the jurisdiction that performs the investigation is based on the patient's home address.

   - CRPA is a surveillance event captured by electronic laboratory reporting (ELR). CRPA cases are assigned to the state as the investigating agency. However, cases with confirmed carbapenemase production are routed to the jurisdiction for investigation.

   Determining jurisdiction

   - Healthcare-associated infection (HAI) conditions are routed to the jurisdiction of the location of the facility or clinic, not by case home address.
   - If no facility is listed, the event is defaulted to the local health jurisdiction based on the patient's home address.

- Out-of-state patients in Utah facilities are routed to the appropriate Utah facility jurisdiction.
- If a Utah patient is in a facility in another state, this becomes an 'out-of-state' case.
- Backup: If the system flags and does not know where to route it to, it defaults to the Utah state HAI queue and will be manually assigned to the correct jurisdiction by a member of the HAI/AR program.

CPO investigations should be completed by the public health investigator within 30 days of notification to public health. When a case travels to a different jurisdiction, the investigating agency stays the same, but the CMR will be shared with the new jurisdiction.

4. Setting the case status and investigation.

   Is the case a CRE, CRA or CRPA species that is resistant to *ertapenem, meropenem, doripenem, or imipenem? (Refer to Table 1.)

   - If yes—

     Mark the **Case status** as **Suspect**.
   - If no—

     Mark the **Case status** to **Not a Case** and the jurisdiction will close the event without an investigation. (**Note:** due to the technicality of these labs, there is a relatively high frequency of "Not a Case" events.)

   Do the AST results show non-susceptibility (resistant or intermediate) to all tested antibiotics? (See **"test-specific rules" in the** [CPO infection rules to enter laboratory test results](#) **section for more information on non-susceptibility criteria.)**

   - If yes (pan-not susceptible)—

     Investigators will fill out the investigation form and may schedule an on-site investigation. Mark the **Case status** to **Probable**. Consult with a DHHS HAI/AR epidemiologist for further guidance.
   - If no—

     Wait for the carbapenemase test results.

   Does the isolate test positive for a carbapenemase?

   - If yes—

     Investigators will fill out the investigation form and may schedule an on-site investigation. Mark the **Case status** to **Confirmed**. Consult with an DHHS HAI/AR epidemiologist for further guidance.
   - If no—

     Keep the **Case status** as **Suspect** and close the case without further investigation.

   *Only Enterobacterales are tested for susceptibility to ertapenem. *Acinetobacter* species and *Pseudomonas aeruginosa* are naturally resistant to ertapenem and should not be tested against ertapenem. If *Acinetobacter* species and *Pseudomonas aeruginosa* have

resistance to only ertapenem then they do not count as a case of CRA or CRPA.[11] *Providencia*, *Proteus*, and *Morganella* species are all resistant to imipenem and should not be tested against imipenem. If *Providencia, Proteus*, and *Morganella* species have resistance to imipenem only then they do not count as a case of CRE.

5. Investigation

    - Fill out the MDRO case investigation form for all probable and confirmed cases. The LHD and DHHS investigators should coordinate to determine whether to conduct an on-site investigation.
    - Carbapenemase-producing isolates that are submitted by outpatient facilities (such as urgent care or family medicine) will be considered community cases and require an investigation to assess the risk of spread. Investigators should encourage patients to tell their healthcare provider at any future healthcare visit that they have a highly resistant organism.

A team of LHD (if capacity allows) and DHHS representatives will offer an on-site consultation visit with the facility for confirmed CPO cases based on investigation findings. During this visit, the representatives may:

- Review the facility's infection prevention and control (IPC) program, including:
    - hand hygiene compliance (the rate of hand hygiene events per hand hygiene opportunities)
    - cleaning and disinfection practices
    - the transmission-based precautions the facility uses for patients with CPOs
    - antibiotic stewardship
    - how the facility communicates a patient's infectious status to the next care providers when the patient is transferred
- Conduct a contact investigation.
    - Find out any other patients who may have come into contact with the patient with the CPO or received shared services (e.g., physical therapy, wound care) as the patient with the CPO
- Consider screening roommates or close household contacts if the case was not in transmission-based precautions for their entire stay.
- Conduct a point prevalence study (PPS) if needed.
    - A point-prevalence study is when all patients in a facility are screened for CPOs. This measures the prevalence of CPOs in the facility at a specific point in time.
- Collect environmental samples if needed.
- Consider screening of healthcare personnel if needed.

Health department response to contain CPOs

Depending on the local health department jurisdiction, investigations may be conducted by the state and/or local health department.

Criteria

At least 1 facility CPO
OR
Pan-not susceptible organism

Refer to page Appendix B for the CPO containment algorithm which guides what response activities are recommended based on test results and other information.

Tier listings

The CDC has 4 tiers to categorize MDROs.[22] The tiers are defined below:

Tier 1 organisms: Tier 1 organisms or resistance mechanisms have never (or very rarely) been identified in the U.S. Healthcare providers and public health departments usually have very little experience with these organisms. These organisms or resistance mechanisms need more extensive evaluation to find out how easily these organisms or resistance mechanisms spread and how far they have spread in a facility or community. These organisms are moved to lower tiers once experts better understand how they spread.

Tier 2 organisms: Tier 2 organisms include:

1. MDROs that are usually associated with healthcare settings and are not commonly found in the region and
2. Organisms that resist all known antibiotics (pan-not susceptible organisms) and that can spread more widely within a region (have plasmid-mediated resistance mechanisms, which are genes that can transfer resistance to other bacteria).
    - These organisms might be more common in other areas of the U.S.
    - There is information available about how these organisms spread and which groups are most at risk.
    - Usually, tier 2 organisms have either not been found in the region before or have been found only in sporadic cases or small outbreaks (correspond to “not detected” or “limited to moderate spread” epidemiologic stages).
        - Even if these MDROs might be found more commonly in other areas of the U.S. or even in other regions or patient sharing networks within the same jurisdiction, they can still be considered tier 2 organisms in that specific region or patient sharing network.

Tier 3 organisms: Tier 3 organisms include CPOs the facility or region is specifically monitoring because they are considered epidemiologically important (could pose a public health risk).

- Tier 3 organisms have been found frequently in a region, showing advanced spread, but are not considered endemic (consistently found in the area).

- These organisms might be more common in other areas of the U.S. There is information available about how these organisms spread and which groups are most at risk.

Endemic (Tier 4) organisms: Tier 4 organisms are endemic (consistently found) in a region and are specifically monitored by public health for their clinical significance (ability to cause serious infections) and potential to spread rapidly to other regions where they are less common or from healthcare settings into the community.

The DHHS HAI/AR program worked closely with the CDC to create a standardized method to classify organisms into tiers. Organisms are classified depending on the number of cases of the organism and the organism's carbapenemase-producing gene combinations. If you have any questions about a specific organism and what tier it would fall under, reach out to DHHS HAI/AR at hai@utah.gov.

Relationship between prevention and containment

- Prevention involves proactive measures to stop infections from occurring, such as hand hygiene, antimicrobial stewardship, and proper disinfection.
- Containment focuses on ways to limit the spread of infections when they do occur, such as isolating infected patients, conducting contact tracing, and using protective equipment.

Consider the relationship between prevention and containment activities and how you can combine these strategies to create a more effective plan. It would be ideal for response strategies to be layered on existing prevention interventions.

Table 4. Outbreak activity guidance

Containment tiers

Epidemic stages	No cases identified Limited spread	Limited to moderate spread	Moderate to advanced spread	Endemic
Healthcare investigation				
Tiers with definitions	**Tier 1** Organisms or resistance mechanisms never or very rarely identified in the U.S.	**Tier 2** Mechanisms and organisms not regularly found in a region. Pan-not susceptible organisms with the potential for wider spread in a region	**Tier 3** Mechanisms and organisms regularly (frequently) found in a region but not endemic	**Tier 4** Mechanisms and organisms that are endemic

Response elements

Elements	Tier 1	Tier 2	Tier 3	Tier 4
Healthcare investigation				
Review the patient's healthcare exposures before and after the positive culture	**Always** **Typical review period:** 30 days prior to culture collection to present	**Always** **Typical review period:** 30 days prior to culture collection to present	**Always** **Typical review period:** Current admission and sometimes immediately prior to admission	**Prioritize prevention**; containment principles generally do not apply
Contact screening				
Screening of healthcare contacts (residents and patients)	Always	Always	Usually	**Prioritize prevention**; containment principles generally do not apply
Household contact screening	Usually	Rarely	Rarely	
Healthcare personnel screening	Usually	Rarely	Rarely	
Additional actions if transmission identified in healthcare				
Recurring response-driven point prevalence surveys	Always	Always	Rarely	**Prioritize prevention**; containment principles generally do not apply
Evaluate potential spread to healthcare facilities that regularly share patients with the index healthcare facility	Usually	Usually	Rarely	
Clinical laboratory surveillance				
Retrospective lab surveillance	Always	Always	Rarely	**Prioritize prevention**; containment principles generally do not apply
Prospective lab surveillance	Always	Always	Always	

Environmental cultures				
Environmental sampling	Sometimes	Rarely	Rarely	**Prioritize prevention**; containment principles generally do not apply
Infection control measures				
Notify healthcare providers; promptly implement appropriate transmission-based precautions	Always	Always	Always	**Prioritize prevention**; containment principles generally do not apply
Infection control assessment with observations of practice	Always	Always	Sometimes	
Clear communication of patient status with transferring facilities	Always	Always	Always	

Always: actions that should be a part of every response for a given response tier; **Usually**: actions that are indicated for most responses, but that might not be applicable for all novel and targeted MDRO responses for a given response tier; **Sometimes**: actions that might apply, with implementation based on the specific scenario (including the setting and organism); **Rarely**: actions that generally are not performed for novel and targeted MDRO responses for organisms of a given response tier, but could be considered in certain situations. Consult with the Utah DHHS HAI/AR program when making decisions about implementing actions labeled “sometimes” or “rarely.”

Description of elements

Review the patient’s healthcare exposures before and after the positive culture

(Tier 1: Always; Tier 2: Always; Tier 3: Always)

Get medical records from the facility or facilities where the patient has been. Use these medical records to observe:

- cultures
- healthcare visits
- procedures
- surgeries

- services
- travel history
- etc.

before and after the positive culture. You can also get this information through conversations with facilities, but medical records are the most efficient way.

Screening of healthcare contacts (residents and patients)

(Tier 1: Always; Tier 2: Always; Tier 3: Usually)

The scope of screening can be discussed with the facility. Screening must be scheduled through the HAI/AR program at DHHS. Send an email to hai@utah.gov to schedule a screening. The screening process will be different depending on the organism. In general:

- CRE: Rectal swabs
- CRPA: Rectal swabs
- CRA: Skin (axilla/groin), wound (if applicable), sputum (if applicable)

At the very least, you will want to screen roommates but entire facility screening may be recommended depending on the organism and observed infection prevention and control (IPC) practices. This process will help find out if or how much the organism has spread at the facility.

Household contact screening

(Tier 1: Usually; Tier 2: Rarely; Tier 3: Rarely)

If the case is living in the community and not at a healthcare facility, you may want to consider screening household contacts.

Healthcare personnel screening

(Tier 1: Usually; Tier 2: Rarely; Tier 3: Rarely)

While rare, healthcare personnel screening may be recommended. This screening will be similar to that of resident/patient screening with:

- CRE: Rectal swabs
- CRPA: Rectal swabs
- CRAB: Skin (axilla/groin)

Recurring response driven point prevalence surveys (PPS)

(Tier 1: Always; Tier 2: Always; Tier 3: Rarely)

The CDC recommends 2 negative point prevalence surveys (PPS) screenings at least 2 weeks apart before you consider an outbreak as closed. One negative screening does not mean the outbreak is over. It is not recommended to rescreen those who have already tested positive. A person who has previously tested positive and then tests negative does not change transmission-based precaution recommendations.

Evaluate potential spread to healthcare facilities that regularly share patients with the index healthcare facility

(Tier 1: Usually; Tier 2: Usually; Tier 3: Rarely)

When you conduct a case investigation, determine any facilities where the case has been before and after the reporting facility. You will also want to reach out to the transferring and receiving facilities to see if they were notified of the person's MDRO status. Ask your healthcare facility contact if there are common healthcare facilities they share patients with so they can be alerted of potential cases.

Retrospective lab surveillance

(Tier 1: Always; Tier 2: Always; Tier 3: Rarely)

Facilities should be able to look back at prior lab cultures to see if similar organisms have been detected before in other patients. When it comes to common organisms such as CRPA, it is possible to compare the antimicrobial susceptibility testing (AST) pattern to determine high level relatedness (a high degree of genetic similarity or shared ancestry) between organisms.

Prospective lab surveillance

(Tier 1: Always; Tier 2: Always; Tier 3: Always)

It is recommended that facilities continue to be on the lookout for organisms that are similar to that of their index case. Remind the facility to submit these organisms for further evaluation at UPHL.

Environmental sampling

(Tier 1: Sometimes; Tier 2: Rarely; Tier 3: Rarely)

Environmental sampling may be recommended depending on the organism. This involves sampling high touch areas such as:

- bed rails
- physical therapy equipment
- medical devices
- sink areas
- etc.

to determine if there is a reservoir for the organism.

Notify healthcare providers; promptly implement appropriate transmission-based precautions

(Tier 1: Always; Tier 2: Always; Tier 3: Always)

One of the most important things to do is to notify healthcare providers of a case at their facility. This is important so the facility can make sure they take the proper precautions.

As a reminder, enhanced barrier precautions (EBP) are recommended only for long-term care facility settings. Every other healthcare setting would use contact precautions.

Infection control assessment with observations of practice

(Tier 1: Always; Tier 2: Always; Tier 3: Sometimes)

Infection control assessment and response (ICAR) tools give facilities a chance to have DHHS/LHDs observe infection prevention and control (IPC) practices and provide feedback, which can be very helpful. DHHS/LHDs can then provide resources to the facility to help with any gaps or barriers they may be experiencing and highlight the areas in which the facility is doing well.

Clear communication of patient status with transferring facilities

(Tier 1: Always; Tier 2: Always; Tier 3: Always)

It is always recommended to communicate the patient status to receiving facilities. This can be done through the interfacility transfer form or a phone call. It is extremely important to let the receiving facility know of the patient's status so the new facility can put proper precautions in place, which will reduce the risk of spread.

References

1. Centers for Disease Control and Prevention (CDC). (n.d.). *Carbapenem-resistant Enterobacterales | An Urgent Public Health Threat | Information for Facilities*. https://www.cdc.gov/cre/media/pdfs/cre-handout-508.pdf

2. Centers for Disease Control and Prevention. (2023, March 13). *Strategies for Prevention and Response to Novel & Targeted Multidrug-Resistant Organisms (MDROs)*. https://www.cdc.gov/healthcare-associated-infections/php/preventing-mdros/preventing-mdros-faqs.html

3. Centers for Disease Control and Prevention. (2022, October 5). *About Antimicrobial Resistance*. https://www.cdc.gov/antimicrobial-resistance/about/

4. Centers for Disease Control and Prevention. (2019, December). *Antibiotic Resistance Threats in the United States*. https://www.cdc.gov/antimicrobial-resistance/media/pdfs/2019-ar-threats-report-508.pdf

5. Centers for Disease Control and Prevention. (2021, November 23). *2019 Antibiotic Resistance Threats Report*. https://www.cdc.gov/antimicrobial-resistance/data-research/threats/

6. Nelson, R. E., Hyun, D., Jezek, A., & Samore, M. H. (2022). Mortality, Length of Stay, and Healthcare Costs Associated With Multidrug-Resistant Bacterial Infections Among Elderly Hospitalized Patients in the United States. *Clinical infectious diseases: An official publication of the Infectious Diseases Society of America*, 74(6), 1070–1080. https://doi.org/10.1093/cid/ciab696

7. Centers for Disease Control and Prevention. (2022). *COVID-19 U.S. Impact on Antimicrobial Resistance, Special Report 2022*. https://www.cdc.gov/antimicrobial-resistance/media/pdfs/covid19-impact-report-508.pdf

8. Centers for Disease Control and Prevention. (2022, February 25). *COVID-19 & Antimicrobial Resistance*. https://www.cdc.gov/antimicrobial-resistance/data-research/threats/covid-19.html

9. Centers for Disease Control and Prevention. (2022, December). *Interim Guidance for a Public Health Response to Contain Novel or Targeted Multidrug-resistant Organisms (MDROs)*. https://www.cdc.gov/healthcare-associated-infections/media/pdfs/Health-Response-Contain-MDRO-H.pdf

10. Centers for Disease Control and Prevention. (2023, March 6). *Interim Guidance for a Public Health Strategies to Prevent the Spread of Novel or Targeted Multidrug-resistant Organisms (MDROs)*. https://www.cdc.gov/healthcare-associated-infections/php/preventing-mdros/mdro-prevention-strategies.html

11. Clinical and Laboratory Standards Institute (CLSI). (2024). Performance Standards for Antimicrobial Susceptibility Testing. 34th ed. https://clsi.org/standards/products/microbiology/documents/m100/

12. Council of State and Territorial Epidemiologists (CSTE). (2022). *22-ID-04 Change in Definition from Carbapenemase-Producing Carbapenem-Resistant Enterobacteriaceae (CP-CRE) to Carbapenemase-Producing Organisms (CPO)*. https://cdn.ymaws.com/www.cste.org/resource/resmgr/ps/ps2022/22-ID-04_CPO.pdf

13. Codjoe, F. S., & Donkor, E. S. (2017). Carbapenem Resistance: A Review. *Medical sciences*, 6(1), 1. https://doi.org/10.3390/medsci6010001

14. Centers for Disease Control and Prevention. (2019, November 13). *Clinicians: Information about CRE*. https://www.cdc.gov/cre/hcp/infection-control/

15. Centers for Disease Control and Prevention. (n.d.). *Carbapenem-resistant Acinetobacter baumannii | An Urgent Public Health Threat | Information for Facilities*. https://www.cdc.gov/acinetobacter/media/pdfs/crab-handout-508.pdf

16. Centers for Disease Control and Prevention. (n.d.). *Carbapenem-resistant Pseudomonas aeruginosa| An Urgent Public Health Threat | Information for Facilities*. https://www.cdc.gov/pseudomonas-aeruginosa/media/pdfs/crpa-handout-508.pdf

17. Centers for Disease Control and Prevention. (2019, September 11). *Reduce Risk from Water*. https://www.cdc.gov/healthcare-associated-infections/php/toolkit/water-management.html

18. Centers for Disease Control and Prevention. (2016, January 26). *Standard Precautions for All Patient Care*. https://www.cdc.gov/infection-control/hcp/basics/standard-precautions.html

19. Centers for Disease Control and Prevention. (2016, January 7). *Transmission-Based Precautions*. https://www.cdc.gov/infection-control/hcp/basics/transmission-based-precautions.html

20. Centers for Disease Control and Prevention. (2023, January 25). *Implementation of Personal Protective Equipment (PPE) Use in Nursing Homes to Prevent Spread of Multidrug-resistant Organisms (MDROs)*. https://www.cdc.gov/long-term-care-facilities/hcp/prevent-mdro/ppe.html

21. Centers for Disease Control and Prevention. (2022, July 27). *Frequently Asked Questions (FAQs) about Enhanced Barrier Precautions in Nursing Homes*. https://www.cdc.gov/long-term-care-facilities/hcp/prevent-mdro/faqs.html

22. Centers for Disease Control and Prevention. (2023, March 6). *Interim Guidance for a Public Health Response to Contain Novel or Targeted Multidrug-resistant Organisms (MDROs)*. https://www.cdc.gov/healthcare-associated-infections/php/preventing-mdros/mdro-containment-strategy.html

Version control

V. 12/23: Plan replaces the CRO disease plan to align with CSTE CPO position statement and updated CDC MDRO containment guidance.

EpiTrax minimum/required fields by tab

Optional fields in red

Demographic

- Date first reported to public health
- Last name
- First name
- Middle name
- Parent/guardian
- Current address
- Address at diagnosis
  - Is this a long-term care hospital or nursing home?
  - Name of facility
  - Type of facility
- Date of birth (age)
- Phone type/code/ number/extension
- Birth gender
- Ethnicity
- Race

Clinical

- Disease
- Hospitalized
- Onset date
- Admission date
  - Discharge data (if available—do not hold open to get it)
  - Medical record number
  - Died
  - Date of death
- Diagnostic date
- Reporting facility (this is where the patient was when the doctor ordered the culture)
  - Facility name
  - Facility type
  - Facility address
- Was the patient in contact precautions for the duration, or part of their stay?
- Date first reported to public health

Administrative

- Date first reported to public health
- LHD case status
- Was the infection healthcare facility or community acquired?
  - Does the patient have a history of an MDRO infection?
  - Was the patient's MDRO status communicated to the facility?

Laboratory

- Lab (performing)
- Test type
- Organism
- Test result
- Specimen source
- Collection date
- Specimens sent to state lab
- Antibiotic or antifungal sensitivities (MIC and interpretations if available)

Epidemiological

- None

Reporting contacts

- Healthcare roommate
- Healthcare worker with possible exposure
- Close household contact

Investigation

- Intensive care unit (ICU) facility history
- Surgical procedure history
- Outpatient procedure history
- Invasive device history
- Travel history
- Was MDRO status communicated to the receiving facility?
- Is the patient bed-bound?
- Is the patient incontinent?
- Has the patient been on mechanical ventilation in the past year?

CPO infection rules to enter laboratory test results

Note that the below rules are specific to informatics as a way to standardize what labs are entered into EpiTrax and should not be used for investigational purposes.

[CRE—including *E.coli* carbapenem-resistant, *Enterobacter* species carbapenem resistant and *Klebsiella* species carbapenem-resistant]

Rules for entering laboratory test results

The following rules describe how laboratory results reported to public health should be added to new or existing events in EpiTrax. These rules have been developed for the automated processing of electronic laboratory reports, although they also apply to manual data entry.

Test-specific rules

Test specific rules describe what test type and test result combinations are allowed to create new morbidity events in EpiTrax, and what test type and test result combinations are allowed to update existing events (morbidity or contact) in EpiTrax.

Table 5. Test-specific rules

Test type	Test result	Create a new event	Update an existing event
Meropenem resistance (MIC ≥4 µg/mL or KB zone ≤19 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes
Imipenem resistance (MIC ≥4 µg/mL or KB zone ≤19 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes
Doripenem resistance (MIC ≥4 µg/mL or KB zone ≤19 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes
Ertapenem resistance (MIC ≥2 µg/mL or KB zone ≤18 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes

Whitelist rules describe how long an existing event can have <u>new</u> laboratory data appended to it. If a laboratory result falls outside the whitelist rules for an existing event, it should not be added to that event, and should be evaluated to determine if a new event (CMR) should be created.

Graylist rules describe how long an existing event can have an <u>old</u> laboratory result appended to it. We often receive laboratory reports through ELR that cannot create cases, but can be useful if a case is created in the future. These laboratory results go to the graylist.

Morbidity whitelist rule: Never a new case.

Contact whitelist rule: Never added to contact.

Graylist rule: If the specimen collection date of the laboratory result is 30 days before the event date or up to 7 days after the event date of the morbidity event, the laboratory result should be added to the morbidity event.

Other electronic laboratory processing rules:

- ELR will never add additional test results to a case if an existing event has a state case status of "not a case." New labs will be evaluated to determine if a new CMR should be created.

[CRA— *Acinetobacter* species carbapenem-resistant]

Rules for entering laboratory test results

The following rules describe how laboratory results reported to public health should be added to new or existing events in EpiTrax. These rules have been developed for the automated processing of electronic laboratory reports, although they also apply to manual data entry.

Test-specific rules

Test specific rules describe what test type and test result combinations are allowed to create new morbidity events in EpiTrax, and what test type and test result combinations are allowed to update existing events (morbidity or contact) in EpiTrax.

Table 6. Test-specific rules

Test type	Test result	Create a new event	Update an existing event
Meropenem resistance (MIC ≥8 µg/mL or KB zone ≤14 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes
Imipenem resistance (MIC ≥8 µg/mL or KB	Resistant	Yes	Yes
	Intermediate	No	Yes

zone ≤18 mm)	Susceptible	No	Yes
Doripenem resistance (MIC ≥8 µg/mL or KB zone ≤14 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes

Whitelist rules describe how long an existing event can have <u>new</u> laboratory data appended to it. If a laboratory result falls outside the whitelist rules for an existing event, it should not be added to that event, and should be evaluated to determine if a new event (CMR) should be created.

Graylist rules describe how long an existing event can have an <u>old</u> laboratory result appended to it. We often receive laboratory reports through ELR that cannot create cases, but can be useful if a case is created in the future. These laboratory results go to the graylist.

Morbidity whitelist rule: Never a new case.

Contact whitelist rule: Never added to contact.

Graylist rule: If the specimen collection date of the laboratory result is 30 days before the event date or up to 7 days after the event date of the morbidity event, the laboratory result should be added to the morbidity event.

Other electronic laboratory processing rules

- ELR will never add additional test results to a case if an existing event has a state case status of "not a case." New labs will be evaluated to determine if a new CMR should be created.

[CRPA— *Pseudomonas aeruginosa* carbapenem-resistant]

Rules for entering laboratory test results

The following rules describe how laboratory results reported to public health should be added to new or existing events in UT-NEDSS/EpiTrax. These rules have been developed for the automated processing of electronic laboratory reports, although they also apply to manual data entry.

Test-specific rules

Test specific rules describe what test type and test result combinations are allowed to create new morbidity events in UT-NEDSS/EpiTrax, and what test type and test result combinations are allowed to update existing events (morbidity or contact) in UT-NEDSS/EpiTrax.

Table 7. Test-specific rules

Test type	Test result	Create a new event	Update an existing event
Meropenem resistance (MIC ≥8 µg/mL or KB zone ≤15 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes
Imipenem resistance (MIC ≥8 µg/mL or KB zone ≤15 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes
Doripenem resistance (MIC ≥8 µg/mL or KB zone ≤15 mm)	Resistant	Yes	Yes
	Intermediate	No	Yes
	Susceptible	No	Yes

Whitelist rules describe how long an existing event can have <u>new</u> laboratory data appended to it. If a laboratory result falls outside the whitelist rules for an existing event, it should not be added to that event, and should be evaluated to determine if a new event (CMR) should be created.

Graylist rules describe how long an existing event can have an <u>old</u> laboratory result appended to it. We often receive laboratory reports through ELR that cannot create cases, but can be useful if a case is created in the future. These laboratory results go to the graylist.

Morbidity whitelist rule: Never a new case.

Contact whitelist rule: Never added to contact.

Graylist rule: If the specimen collection date of the laboratory result is 30 days before the event date or up to 7 days after the event date of the morbidity event, the laboratory result should be added to the morbidity event.

Other electronic laboratory processing rules

- ELR will never add additional test results to a case if an existing event has a state case status of “not a case.” New labs will be evaluated to determine if a new CMR should be created.

Appendices

Appendix A: Interfacility transfer form

Infection control transfer form

This form should be sent with the patient/resident upon transfer. It is NOT meant to be used as criteria for admission, only to foster the continuum of care once admission has been accepted.

Place any patient labels here

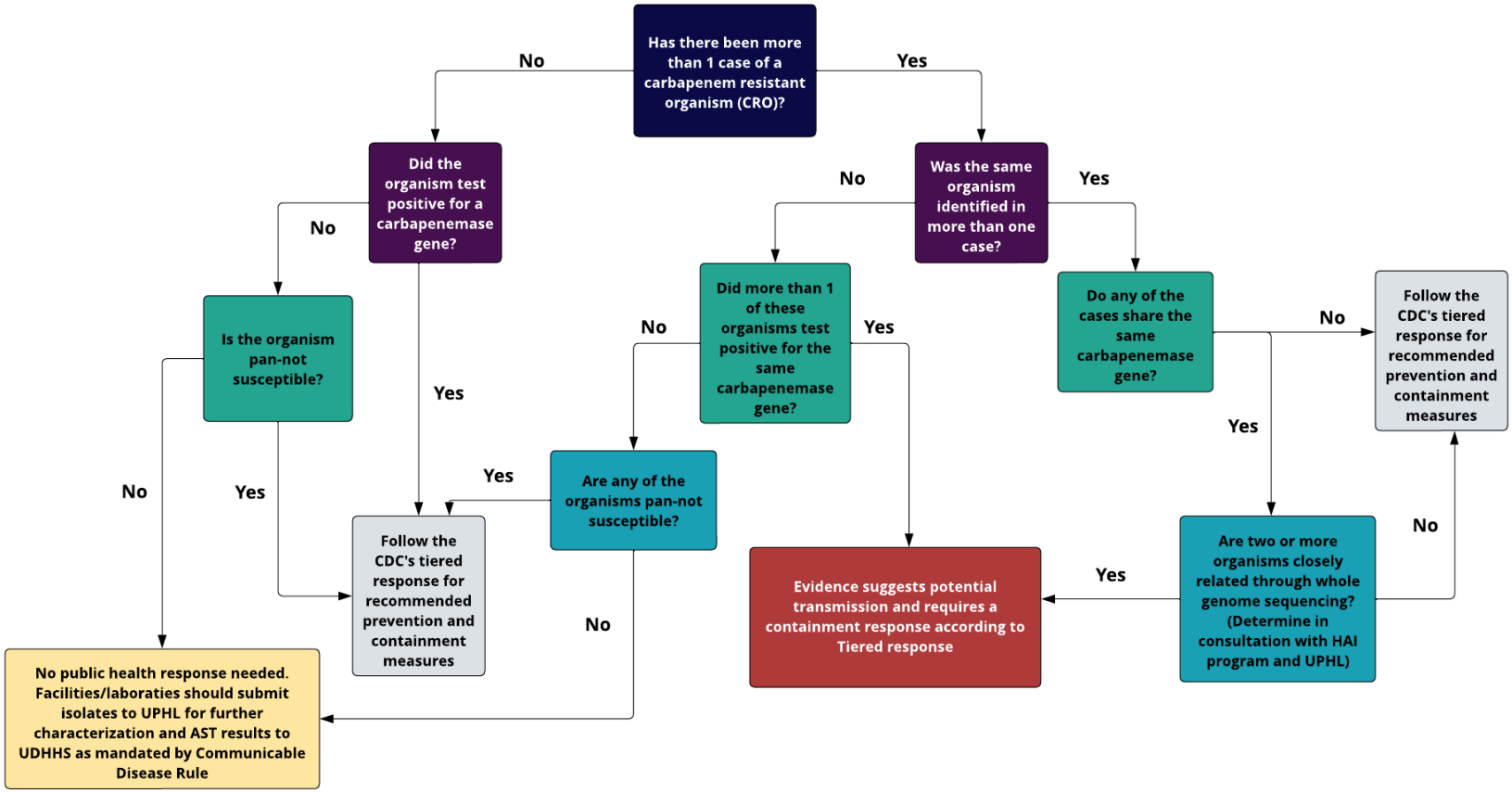
Demographics		
Patient/resident *(last name, first name)*:		
Date of birth:	**MRN:**	**Transfer date:**
Sending facility:		
Sending facility contact information:		
Receiving facility name:		
Verbal report given to *(name/title)*:		
Currently in isolation precautions? ☐ **Yes** ☐ **No** **If yes, check:** ☐ **Contact** ☐ **Droplet** ☐ **Airborne** ☐ **Enhanced barrier (nursing homes only)** ☐ **Other:** _____		

Organisms		
Does the patient/resident currently have an infection, colonization, or a history of positive culture of a multidrug-resistant organism (MDRO) or other potentially transmissible infectious organism? (Check all that apply and attach recent culture results if available)	**Colonization or history** *(Check all that apply)*	**Active infection or treatment** *(Check all that apply)*
Urgent MDRO threats (verbally communicate in addition to filling out this form)		
Carbapenem Resistant Organisms (CRO) **Organism type:** ☐ *Acinetobacter* spp. resistant to carbapenems (CRA) (except ertapenem resistance) ☐ Enterobacterales resistant to carbapenems (e.g. *E. coli*, *Klebsiella* spp., *Enterobacter* spp., or other Enterobacterales organism) (CRE) ☐ *Pseudomonas aeruginosa*, resistant to carbapenems (except ertapenem) and resistant or intermediate to one of the three following antibiotics: ceftolozane/tazobactam, cefepime, ceftazidime **Carbapenemase production (Common CP include: KPC, VIM, NDM, IMP, OXA):** ☐ Yes ☐ No **Pan-resistance *(CRO organism is resistant or intermediate to all antibiotics tested)*:** ☐ Yes ☐ No	☐	☐
Candida auris	☐	☐
Vancomycin- intermediate or resistant *Staphylococcus aureus* (VISA or VRSA)	☐	☐
Other active contagious infections (verbally communicate in addition to filling out this form)		
C. difficile infection (CDI)	**N/A**	☐
Other transmissible infection (i.e., pulmonary TB, norovirus, flu, COVID, disseminated shingles) list here:	**N/A**	☐
Serious MDRO threats		
Extended-Spectrum-Beta Lactamase (ESBL) – producing Enterobacterales	☐	☐
Methicillin-resistant *Staphylococcus aureus* (MRSA)	☐	☐
Vancomycin-resistant Enterococci (VRE)	☐	☐

Symptoms	
Check yes to any that currently apply*: ☐ Acute diarrhea or incontinent stool ☐ Other uncontained bodily fluid/secretions ☐ Vomiting ☐ Incontinent of urine ☐ New or worsening cough ☐ Concerning rash (e.g., vesicular) ***NOTE: Enhanced barrier precautions are not sufficient if acute diarrhea or uncontained bodily fluids/secretions are present.**	☐ None of the listed symptoms

Other MDRO risk factors
Does the patient/resident have any indwelling medical devices (e.g. tracheostomy, central lines, urinary catheters, feeding tubes)? ☐ **Yes** ☐ **No** **Does the patient/resident have any chronic open wounds?** ☐ **Yes** ☐ **No**
Person completing form: _____ **Role:** _____ **Date:** _____

Appendix B: CPO and pan-not susceptible organism containment algorithm



Appendix C: MDRO case report form

A. Public health identifiers	Abstractor initials:	Date of report:
1. CDC MDRO unique patient ID:	2. Patient name:	
3. Has this patient had a prior nMDRO (*Candida auris*, different CP gene/ organism combination EVER detected) ☐ Yes • Specify organism and gene ○ Organism: ○ Gene: ☐ No	4. Patient date of birth:	
	5. Source of record reviewed: ☐ Phone interview ☐ Medical records ☐ Other:	Additional information (i.e., who interviewed, what facility, etc.):
6. Is this patient a part of a cluster or outbreak response?	☐ Yes ☐ No ☐ Unknown Comment:	
7. EpiTrax outbreak ID and CDC outbreak ID		
B. Specimen information	ARLN alert record ID:	NCBI WGS ID:
1. Date of specimen collection:	2. Specimen source:	
2a. Organism detected: ---Select one---	2b. If you choose "other", specify:	
3. Gene(s) detected:	☐ IMP ☐ KPC ☐ VIM ☐ NDM ☐ OXA-23	☐ OXA-235 ☐ OXA-48 ☐ Other:
4. Purpose of specimen collection: ☐ Clinical culture ☐ Colonization screening	5. Pertinent information from susceptibility testing:	

5a. Healthcare setting at time of specimen collection:
- ➔ Healthcare facility name:
- ➔ Healthcare facility type:
- ➔ Comments:

7a. Lead local health department: ---Select one---

7b. Involved local health department(s):

- ☐ Bear River
- ☐ Central
- ☐ Davis
- ☐ Salt Lake
- ☐ San Juan
- ☐ Southeast
- ☐ Southwest
- ☐ Summit
- ☐ TriCounty
- ☐ Tooele
- ☐ Utah
- ☐ Wasatch
- ☐ Weber Morgan

8. Associated state(s):

C. Subsequent isolates for the same organism/gene combination

1. Has this patient/resident had subsequent isolates positive for the same organism/gene combination, regardless of specimen source? *(ex: index isolate was NDM-E. coli from a sputum and the second positive isolate was an NDM-E. coli from blood)*

- ☐ Yes
- ☐ No
- ☐ Unknown

Comment:

D. Underlying medical conditions

- ☐ Acute myocardial infarction
- ☐ Congestive heart failure
- ☐ Peripheral vascular disease
- ☐ Cerebral vascular accident
- ☐ Dementia
- ☐ Pulmonary disease
- ☐ Connective tissue disorder
- ☐ Peptic ulcer disease
- ☐ Liver disease
- ☐ Diabetes mellitus
- ☐ Diabetes complications *(e.g., kidney, ophthalmic, retinopathy, neurologic)*
- ☐ Paralysis
- ☐ Renal disease
- ☐ Moderately to severely immunocompromised
  - ☐ Specify:
- ☐ Cancer
  - ☐ What type of cancer?
  - ☐ Currently on chemotherapy?
- ☐ Other
  - ☐ Specify:

Comment:

E. Functional status/outcomes

1. Is the patient continent (able to control without accidents) of urine?	☐ Yes ☐ No
2. Is the patient continent (able to control without accidents) of stool?	☐ Yes ☐ No
3. Activity level:	Mental status:
Comment:	

F. Devices/specialty care procedures

Does the case-patient/resident have any medical devices or have they received any other specialty care procedures or services in the 30-days prior to the index specimen collection? *Please specify the following devices/procedure/services*

1a. Device/specialty care procedures:

- ☐ Dialysis
  - ☐ *Hemodialysis*
  - ☐ *Peritoneal dialysis*
  - ☐ *Dialysis facility name and location:*
- ☐ BiPAP/CPAP (non-invasive mechanical ventilation)
- ☐ Endotracheal/nasotracheal tube (intubation)
- ☐ Invasive mechanical ventilation
- ☐ Tracheostomy tube
- ☐ Enteral feeding tube
  - ☐ *Nasogastric tube*
  - ☐ *Gastrostomy tube*
- ☐ Central venous catheter *(PICC, IJ, Port, Hickman, PACs)*
- ☐ Urinary catheter
  - ☐ *Non-invasive urinary catheter*
  - ☐ *Invasive/Indwelling urinary catheter*
  - ☐ *Intermittent/straight catheter*
  - ☐ *Suprapubic catheter*
- ☐ Wound
  - ☐ *Chronic ulcer/wound (non-decubitus)*
  - ☐ *Decubitus/pressure ulcer*
  - ☐ *Surgical*
  - ☐ *Where is wound care performed:*
- ☐ Other devices/procedures, specify:
- ☐ No devices

Comment:

1b. Ancillary shared services

- ☐ Respiratory therapy
- ☐ Physical therapy
- ☐ Occupational therapy
- ☐ Speech therapy

1c. Shared medical equipment

- ☐ Hoyer lift
- ☐ Walker
- ☐ Wheelchairs
- ☐ Bladder scanner

☐ Other, specify: ☐ No shared services ➔ Description of patient shared services:	☐ Vital sign machines ☐ Shared shower room ☐ Other, specify: ➔ Description of patient shared services:
Comments:	

G: Outpatient speciality/invasive procedure history (bronchoscopy, endoscopy, urologic procedure, surgical procedure)
30-days prior to incident specimen collection

☐ No outpatient speciality/invasive care procedures in the 30-days PRIOR to the nMDRO positive specimen collection date
☐ Unknown

Outpatient procedure history:	+ **Additional outpatient procedure history:**
➔ Facility name:	➔ Facility name:
➔ Speciality care procedure type:	➔ Speciality care procedure type:
➔ CDC unique facility ID:	➔ CDC unique facility ID:
➔ Visit/procedure date:	➔ Visit/procedure date:
➔ Comment:	➔ Comment:

Healthcare & international travel exposure history

H: Healthcare exposure history

Note: Tier 3 organisms are only required to have medical history for the collection date and one day prior.

☐ No facility history 30 days prior to nMDRO positive specimen collection date
☐ No facility history after nMDRO positive specimen collection date
☐ Unknown

Facility 1:	**Facility 2:**
➔ Facility name:	➔ Facility name:
➔ Facility type:	➔ Facility type:
➔ Unit(s):	➔ Unit(s):

➔ Room number(s): ➔ Roommates/bathroomates: ➔ Admission date: ➔ Discharge date: ➔ Final disposition:	➔ Room number(s): ➔ Roommates/bathroomates: ➔ Admission date: ➔ Discharge date: ➔ Final disposition:
Comment:	Comment:
Facility 3: ➔ Facility name: ➔ Facility type: ➔ Unit(s): ➔ Room number(s): ➔ Roommates/bathroomates: ➔ Admission date: ➔ Discharge date: ➔ Final disposition:	**Facility 4:** ➔ Facility name: ➔ Facility type: ➔ Unit(s): ➔ Room number(s): ➔ Roommates/bathroomates: ➔ Admission date: ➔ Discharge date: ➔ Final disposition:
Comment:	Comment:
Facility 5: ➔ Facility name: ➔ Facility type: ➔ Unit(s): ➔ Room number(s): ➔ Roommates/bathroomates: ➔ Admission date: ➔ Discharge date: ➔ Final disposition:	**Facility 6:** ➔ Facility name: ➔ Facility type: ➔ Unit(s): ➔ Room number(s): ➔ Roommates/bathroomates: ➔ Admission date: ➔ Discharge date: ➔ Final disposition:
Comment:	Comment:

I: International travel/healthcare history *(12-months prior to date of index specimen collection)*	
☐ No *overnight stays in a country outside the United States in the 12-months prior to index specimen collection* ☐ Unknown	
Country 1 ➔ Name of country: ➔ Dates of international stay: ➔ Comment:	**Country 2** ➔ Name of country: ➔ Dates of international stay: ➔ Comment:
1. Medical tourism: Did the case-patient/resident specifically travel to a country outside the United States for the purpose of receiving healthcare?	☐ Yes ☐ No ☐ Unknown
Comment:	
J: Patient expiration status *(Answer question as a follow-up to patient status 30-days after patient specimen collection date)*	
1. Has the patient/resident expired within 30-days after the nMDRO specimen collection date?	☐ Yes ☐ No ☐ Unknown
1b. If yes, cause of death:	
K: Additional information (*Include any other additional general information or investigation details)*	
Comment:	