# Carbapenem-Resistant *Enterobacterales* (CRE) Investigative Guidelines

## October 2024

*REPORT WITHIN 1 WORKING DAY*

## 1. DISEASE REPORTING

### 1.1 Purpose of Reporting and Surveillance

1. To prevent transmission of carbapenem-resistant *Enterobacterales* (CRE) between patients, within or among healthcare facilities, or between healthcare facilities and the community.
2. To identify outbreaks and potential sources of ongoing transmission
3. To educate people about how to reduce their risk of infection
4. To better characterize the epidemiology of this infection including social, environmental, and behavioral contexts for transmission
5. To identify communities and populations at elevated risk for disease or severe illness to inform equity-centered prevention efforts

### 1.2 Laboratory and Clinician Reporting Requirements

Laboratories, clinicians, and other persons providing healthcare are required to report positive lab results and confirmed cases to the Local Public Health Authority (LPHA) by 5pm of the working day following identification or diagnosis. See §3 for case definitions.

Clinical and reference laboratories must forward isolates from any sterile or non-sterile site (e.g., urine, blood, sputum, endotracheal aspirate, bronchoalveolar lavage, wound) that meet the confirmed CRE case definition (see §3) along with the antimicrobial susceptibility testing (AST) system printouts (e.g., Vitek 2, Microscan) to the Oregon State Public Health Laboratory (OSPHL).

Isolates of *Proteus* spp., *Providencia* spp., or *Morganella morganii* that show only imipenem non-susceptibility in the absence of resistance to another carbapenem do not need to be submitted.

### 1.3 Local Health Department Reporting and Follow-Up Responsibilities

1. Confirm that a case meets the case definition by reviewing the isolate susceptibility information (antibiogram), consulting with the Acute and Communicable Disease Prevention Section (ACDP) on-call epidemiologist as necessary. Minimum inhibitory concentration (MIC) values are needed to verify that a case meets the definition. See *§3* for case definitions.
2. Report all confirmed cases to the Oregon Public Health Division (PHD) Acute and Communicable Disease Prevention (ACDP) Section by 5pm of the working day following initial clinician or lab report. Enter information into Orpheus as the investigation occurs.
3. Intervene to prevent the spread of the organism and take action based upon the resistance mechanism of the isolate. See §3.2 for resistance mechanism and §4.2 for case investigation details.
4. Interview all confirmed cases.

## 2. THE DISEASE AND ITS EPIDEMIOLOGY

### 2.1 Etiologic Agent

The *Enterobacterales* are a large order of Gram-negative bacilli, many of which are residents of the human gastrointestinal tract. A full list of genera can be found in Appendix 1.

Some of these *Enterobacterales* and other Gram-negative bacilli can cause healthcare-associated infections (HAI). The broad-spectrum carbapenem antibiotics (e.g., doripenem, ertapenem, imipenem and meropenem) are used to treat severe healthcare-associated infections caused by *Enterobacterales* and other Gram-negative bacilli (e.g., *Acinetobacter baumannii, Pseudomonas aeruginosa*). Unfortunately, when carbapenem resistance develops, few safe and effective treatment options remain and the risk of patient morbidity and mortality increases.

*Enterobacterales* can become resistant to carbapenems by any of several mechanisms, including the production of carbapenemases (enzymes) such as *Klebsiella pneumoniae* carbapenemase, (KPC) or New Delhi metallo-beta-lactamase (NDM). Other examples of carbapenem-destroying enzymes include imipenem-hydrolyzing-lactamase (IMP), Verona integron-encoded metallo-beta-lactamase (VIM), and oxacillinase-48 (OXA-48). Resistance genes code for carbapenemases that can be exchanged between different Gram-negative bacteria via mobile genetic elements called transposons or plasmids ("jumping genes"). *Enterobacterales* that possess these carbapenemase genes are sometimes referred to as carbapenemase-

producing CRE (CP-CRE) or carbapenemase producing organisms (CPOs). Some non-*Enterobacterales* bacteria may also be CPOs. From a public health perspective, CPOs (including CP-CRE) are the most concerning CRE because their resistance genes are easily spread. Additional information about CRE and CPOs is available from CDC.

CRE have been reported in all 50 states. Once CRE have become entrenched in a region or healthcare facility, the carbapenem antibiotics may lose their effectiveness, and patients may die for lack of appropriate treatment. If CRE become prevalent, empiric therapy will necessitate 2nd- and 3rd-line antibiotics, which may be less effective, cost more, and cause more side effects. Incidence of CRE in Oregon has increased by 25% over the last five years, but CPO cases remain rare. If healthcare providers and public health officials can rapidly identify and isolate patients with CRE in Oregon, we may be able to prevent or delay their becoming endemic.

Note, the previous CRE acronym "carbapenem-resistant *Enterobacteriaceae*" was replaced by "carbapenem-resistant *Enterobacterales*" when a 2016 taxonomy change split the family *Enterobacteriaceae* into 7 new families under the renamed order *Enterobacterales.*

## 2.2 Description of Illness

CRE have mainly caused healthcare-associated infections, primarily affecting those with chronic medical conditions (e.g., diabetes, hemodialysis, non-healing wounds), medical conditions that require invasive lines or tubes, and compromised immune function. CRE can cause pneumonia, bloodstream infections, urinary tract infections, intra-abdominal infections, and surgical site infections. Patients who are colonized with CRE (positive culture without symptoms of infection) can serve as a reservoir of infection for other patients or sources for healthcare facility outbreaks and may themselves be more likely to develop a CRE infection.

## 2.3 Reservoirs

Although animals can harbor CRE, humans are the primary reservoir of CRE resulting in human illness.

## 2.4 Sources and Routes of Transmission

CRE colonizes the gut and can be isolated from the stool of colonized or infected patients. CRE are transmitted from person to person through stool or infected body secretions. Transmission often occurs via the hands of healthcare workers, contact with contaminated environmental surfaces, or shared medical equipment that has not been properly cleaned.

## 2.5 Risk Dynamics

Any person can be infected with CRE. However, older adults, people with certain pre-existing conditions, or who engage in certain behaviors may be at greater risk of infection or disease.

The patients most at risk for CRE infection are those with chronic medical conditions, frequent or prolonged stays in healthcare settings, invasive medical devices (e.g., ventilators or intravenous catheters), or a history of taking antibiotics for long periods of time. These risk factors may be associated with age, disability, or medical vulnerability.

The baseline prevalence of CRE and CPOs varies among countries and among regions of the United States.[1,2] Persons with recent overnight healthcare or invasive procedures outside the United States or in regions of the United States where CPOs are endemic may be at higher risk of acquiring a CPO. Medical tourism, or travel for the purposes of receiving medical care, is twice as likely to be associated with multidrug-resistant organisms like CRE than general travel.[3] Medical tourism is often motivated by socioeconomic, social, and structural factors such as access to healthcare, cost of treatment, and lack of adequate health insurance.[4]

For individuals infected or colonized with CRE, effective hand hygiene mitigates the risk of transmission to others.

## 2.6 Incubation Period

Because CRE and other carbapenem-resistant organisms (CROs) can colonize people without causing infection, the incubation period is unknown.

## 2.7 Period of Communicability

Persons can transmit CRE to others if the organism is present in bodily fluids or on the body. Patients may be intermittently positive on serial surveillance cultures and colonized for long periods of time.

## 2.8 Treatment

Infectious disease consultation is recommended for treatment decisions. Differentiating between colonization and infection can be difficult. Treatment

with antibiotics is not typically recommended for persons merely colonized. Antibiotic options may be limited and may cause adverse reactions.

## 3. CASE DEFINITIONS, DIAGNOSIS, AND LABORATORY SERVICES

### 3.1 Confirmed Case

Use the minimum inhibitory concentration (MIC) values to interpret resistance (the automated antimicrobial susceptibility testing result directly from the laboratory is preferred, see Table 1). In some cases, Kirby-Bauer disc diffusion results may be provided; see Table 2.

A confirmed case of CRE is a patient whose clinical or surveillance specimen yields an isolate of the *Enterobacterales* order (see Appendix 1) that:

1. is resistant to any carbapenem (doripenem, ertapenem, imipenem, or meropenem) using current CLSI breakpoints; (See Tables 1 and 2)

**OR**

2. tests positive by molecular test, such as PCR or next-generation sequencing (NGS), for a carbapenemase; (e.g., KPC, NDM, IMP, VIM, or OXA-48)

**OR**

3. tests positive for carbapenemase production by a phenotypic test (e.g., Carba NP or modified carbapenem inactivation method (mCIM)).

**Table 1.** Carbapenem MIC Breakpoints for *Enterobacterales*

| | Current MIC Breakpoints (µg/mL)* | | |
|---|---|---|---|
| | MIC Interpretation[5] | | |
| **Carbapenems** | **Susceptible** | **Intermediate** | **Resistant** |
| Doripenem | ≤1 | 2 | ≥4 |
| Ertapenem‡ | ≤0.5 | 1 | ≥2 |
| Imipenem | ≤1 | 2 | ≥4 |
| Meropenem | ≤1 | 2 | ≥4 |

* MIC = minimum inhibitory concentration

5 CLSI. Table 2A. Zone Diameter and MIC Breakpoints for *Enterobacterales*. In: CLSI M100-ED34:2024 Performance Standards for Antimicrobial Susceptibility Testing, 34rd Edition. Feb 2024. Available from: https://em100.edaptivedocs.net/

‡ A value of >1 indicates resistance by outdated break points. There is no further dilution. If the lab is not doing any other method for confirmation the >1 value is considered resistant and meets our definition.

**Table 2.** Kirby-Bauer Disc Diffusion Interpretations for *Enterobacterales*

| | Current Disk Diffusion Zone Diameters (mm)* | | |
|---|---|---|---|
| | Zone Size Interpretation[5] | | |
| **Carbapenems** | **Susceptible** | **Intermediate** | **Resistant** |
| Doripenem | ≥23 | 20–22 | ≤19 |
| Ertapenem | ≥22 | 19–21 | ≤18 |
| Imipenem | ≥23 | 20–22 | ≤19 |
| Meropenem | ≥23 | 20–22 | ≤19 |

*mm = millimeters

5 CLSI. Table 2A. Zone Diameter and MIC Breakpoints for *Enterobacterales*. In: CLSI M100-ED34:2024 Performance Standards for Antimicrobial Susceptibility Testing, 34rd Edition. Feb 2024. Available from: https://em100.edaptivedocs.net/

In rare cases where susceptibility results for a single isolate are discrepant (e.g. ertapenem resistant by Vitek but ertapenem susceptible by Kirby Bauer), case determination should prioritize the following sources: (1) confirmatory or reference methods used at the clinical lab (e.g. Kirby Bauer or E-Test), (2) initial susceptibility tests performed at the clinical laboratory (e.g. Microscan or Vitek), (3) susceptibility testing performed at a public health laboratory.

A few Oregon labs are still using outdated breakpoints for ertapenem. If an MIC for ertapenem is >1 and the lab is not doing further confirmatory testing, >1 is considered resistant and the organism meets our definition for CRE.

Some labs will suppress carbapenem results on reports, particularly ertapenem. If you receive a report that calls the *Enterobacterales* species isolated a CRE but the available carbapenem results are susceptible, call the lab to ask for any suppressed carbapenem results. These results will be on the automated antimicrobial susceptibility testing report.

Note: *Proteus* spp., *Providencia* spp. and *Morganella morganii* are excluded from this definition if only imipenem resistance is detected because these species have intrinsic resistance to imipenem. For example, isolates that test ertapenem susceptible but imipenem resistant would not meet the definition.

### 3.1.1 Resistance Mechanism

We are more concerned about some CRE than others, with CPOs (see Table 3) being of most concern.

**Table 3.** Type of CRE

| Description | Organisms Included | Recommended Measures |
|---|---|---|
| Carbapenemase producing organism (**CPO**) | *Enterobacterales* positive by Carba NP or positive by PCR or NGS for KPC, NDM, IMP, VIM, OXA-48 | • Most aggressive control measures<br>• See CRO Toolkit |
| CRE with acquired resistance NOT due to carbapenemase production | *Enterobacterales* that meet definition but are PCR and Carba NP negative for carbapenemases | • Intensified control measures including contact precautions<br>• See CRO Toolkit |

### 3.1.2 Repeat Culture Results

Repeat positive culture results for the same carbapenem-resistant organism collected within 30 days of the initial positive collection date should be entered as a new lab in the existing Orpheus case record. After 30 days, review the susceptibility results for both labs. If the new susceptibility results look very similar to the existing case's susceptibility results, the new lab can be added to the existing case. If the susceptibility results look very different, consult with the ACDP on-call epidemiologist to determine whether a new case should be created in Orpheus.

A positive culture for a different CRE organism (different genus or species) or different organism/carbapenemase combination (e.g., KPC+ *E. coli* vs. NDM+

*E. coli*) should be entered as a new incident case, regardless of the collection date.

### 3.2 Services Available at the Oregon State Public Health Laboratories

All CRE isolates received by OSPHL will be tested for carbapenemase production by the Carba NP test and Real-Time PCR for detection of OXA-48, KPC, NDM, IMP, VIM carbapenemases.

## 4. ROUTINE CASE INVESTIGATION

### 4.1 Confirm Case

Confirm that a case meets the case definition by reviewing the isolate's susceptibility information or consult with the ACDP on-call epidemiologist (See §3 for case definitions)

### 4.2 Case Investigation

Routine case investigation should include the documentation of case demographic, clinical and laboratory data. Personal information should be collected based on people's self-reported identities and should include "REAL-D" and "SOGI" information.

Interview the case (or primary caregivers) and any additional persons who may be able to provide pertinent information. Use professional interpretation services rather than relying on family members or community interlocutors unless there is mutual consent between the case and the lay interpreter that they will feel more comfortable communicating without a professional intermediary.

Work with the healthcare facility or physician (if case is an outpatient ) to investigate and institute control measures, as indicated in Oregon's CRO Toolkit (https://rebrand.ly/CRO-Toolkit). If multiple healthcare facilities are involved, work with all facilities to institute appropriate control measures. If a case is to be transferred to a new facility, work with the receiving facility to ensure they are prepared to implement infection control measures. If the case has a CPO, the ACDP MDRO Epidemiologists will assist the LPHA in consulting the facility or physician.

Promptly enter data into Orpheus. Be sure to obtain:

1. Demographic information including name, address, date of birth, REAL-D and SOGI information;
2. Name of organism (as "subtype" in Orpheus);
3. Date of initial culture collection (as "onset" in Orpheus);

**“Risks” Tab in Orpheus**

4. Any medical care outside Oregon during the last 12 months;
5. Any medical care outside the United States during the last 12 months;
6. Any travel outside Oregon during the last 12 months;

**“Follow-up” Tab in Orpheus**

7. Any healthcare transfers and confirmation of interfacility transfer notice;
8. If case was hospitalized or in a long-term care facility, whether they were on contact precautions or enhanced barrier precautions;
9. Whether patient education was provided emphasizing hand hygiene;

**“MDRO” Tab in Orpheus**

10. Patient location on 4th calendar date prior to initial culture date;
11. Hospitalization status at the time of culture;
12. Any admissions to acute or long-term care facilities in the 30 days before specimen collection through the time of investigation (365 days for CPOs). Include facility name and dates of admission and discharge.

In general, infection control measures include (See Table 4 and the CRO Toolkit):

1. Emphasis on hand hygiene;
2. Standard precautions at all times;
3. Transmission-based precautions (e.g., contact precautions) when contact with bodily fluids is a possibility, or there is an active infection;
    a. Acute healthcare facilities should use contact precautions, even for colonized patients to reduce transmission among high-risk populations.
    b. Long-term care facilities should use contact precautions for patients with CRE infections and colonized patients at higher risk of transmission (e.g., draining wounds, patients incontinent of urine or stool). See the CRE Toolkit for additional details. CDC also recommends Enhanced Barrier Precautions (EBP) for patients colonized with CREs or other MDROs when contact precautions do not apply and for CRE-naïve patients at higher risk of acquiring CREs (e.g., patients with indwelling medical devices or

wounds). More information about EBP is available through CDC (https://www.cdc.gov/long-term-care-facilities/hcp/prevent-mdro/PPE.html).

c. CPO cases are rare, and contact precautions are always recommended.
d. In all settings, appropriate transmission-based precautions should be maintained for a minimum of one year for CRE cases and indefinitely for CPO cases.

4. Enhanced environmental cleaning, including high touch surfaces;
5. Interfacility communication of patient's CRE status at transfer or time of discharge.
    a. Interfacility transfer notification is required by OAR 333-019-0052.
    b. CPOs also require communication to the LPHA when there is a new transfer or admission of a case.

### 4.3 Identify Potentially Exposed Persons

Identification of contacts is generally not indicated for CRE that are not carbapenemase-producing. The risk of infection in otherwise healthy people is low. CRE testing for contacts is not recommended.

CPO cases require a containment response which is typically coordinated by ACDP MDRO Epidemiologists. During this response, CPO colonization screening of other patients in healthcare facilities visited by the index case may be recommended. ACDP MDRO Epidemiologists will identify which patients should be tested based. ACDP HAI staff will coordinate with the healthcare facility to collect and test specimens. LPHA staff may be asked to assist with screening or with outreach to people discharged from healthcare facilities.

CPO colonization screening of otherwise healthy friends, family, or healthcare worker contacts is not usually indicated. If a close contact of a person with a CPO infection has frequent or prolonged stays in healthcare settings and has medical risk factors like indwelling medical devices (e.g., ventilators or urinary catheters), consult with an ACDP MDRO Epidemiologist to determine if the person should be screened for CPO colonization.

**Table 4.** Summary of Infection Control Recommendations by Healthcare Setting

| Response and Control Measures by Local Public Health Authorities | ACH | SNF | LTACH/vSNF | Other residential | Outpatient |
|---|---|---|---|---|---|
| Advise facility infection preventionist (IP) or staff responsible for infection prevention and control | Always | | | | |
| • Review and share relevant section of CRO Toolkit | CRE: p. 21-22<br>CPO: p. 22-24 | CRE: p. 25-26<br>CPO: p. 26-28 | CRE: p. 16-17<br>CPO: p. 17-18 | CRE: p. 31-33<br>CPO: p. 33-34 | CRE: p. 35-36<br>CPO: p. 36-37 |
| • Provide additional resources as appropriate | CRO/CPO Patient FAQ (spanish)<br>CPO Provider FAQ<br>CPO Wallet Card (spanish) | | | | |
| Confirm key infection control measures are in place: | Always | | | | |
| • Appropriate transmission-based precautions | Contact precautions* | See CRO Toolkit, p. 28-30* | Contact precautions* | Standard precautions | Standard precautions |
| • Private room and bathroom | Yes | Yes | Yes | Yes | n/a |
| • Chart flag in medical record and clinical team notified | Always | | | | |
| Remind facility of required notification: | Always | | | | |
| • If patient is transferred, discharging facility must notify receiving facility in writing | Always | | | | |
| • If patient is re-hospitalized, dies, or is transferred the LPHA must be notified | CPO only | | | | |
| Provide education to patient. Emphasize hand hygiene. | Always | | | | |
| Mail CPO wallet card to case | CPO only | | | | |

* Contact precautions are recommended for a minimum of one year for non-CPO CRE cases, and indefinitely for CPO cases.

**ACH** - acute care hospital
**LTACH** – long-term acute care hospital
**SNF** – skilled nursing facility
**other residential** – e.g. memory care, assisted living
**vSNF** – ventilator-capable skilled nursing facility

# 5. CONTROLLING FURTHER SPREAD

## 5.1 Education

Cases and those providing medical care for cases should be educated about proper hand hygiene particularly after using the toilet, touching any areas of the body with an infection (e.g., infected wounds), or touching surfaces that may be contaminated from stool or bodily fluids (e.g., toilets, medical devices such as catheters).

These educational resources can be shared with cases and medical practitioners:

**CRO/CPO for patients** – Recommended for persons infected or colonized with CRE or CPO
English (https://rebrand.ly/CROCPOInfectedColonizedFAQ)
Spanish (https://rebrand.ly/CPOPatientSP)

**CPO wallet card** – It is strongly recommended that LPHAs print and distribute these to any persons infected or colonized with CPO. These cards can be shown to healthcare professionals on admit to ensure appropriate patient care.
English (https://rebrand.ly/CPOWalletCard)
Spanish (https://rebrand.ly/CPOWalletSP)

**CRE for providers** – Recommended for professionals providing healthcare to patients with CRE
English (https://www.cdc.gov/cre/media/pdfs/cre-handout-508.pdf)

**CPO for providers** – Recommended for professionals providing healthcare to patients with CPO
English (http://www.rebrand.ly/CPOProviderFAQ)

**CRO Toolkit** (comprehensive infection control guidance for CRO and CPO) – Recommended for infection prevention and healthcare staff
English (https://rebrand.ly/CRO-Toolkit)

When providing health education, it is important to remember that Oregonians represent a diverse array of cultures and vary in their preferred languages, ideas about health, and health literacy. Best practices include:

- Make every effort to provide information in the case's preferred language. Provide translated health education materials and utilize professional interpreter services whenever possible.
- Consult with ACDP epidemiologists about accessing OHA Interpretation Services when preferred language materials and services are not available at the LPHA. Avoid using family

members, community leaders, or “lay” interpreters. However, respect people’s preference if they desire a lay interpreter instead of interpretation services.

- In all oral communication and written materials, use plain language and equity-centered communication to convey inclusive and easily understood health messages.
- Tailor communications to the specific cultures of the intended audiences, for example using locally preferred names for places, body parts etc.
- When relevant and possible, consult with relevant community leaders and organizations about how to conduct investigations in the most appropriate (culturally and scientifically) manner.

When a potential outbreak may be concentrated in a particular community, it is critical that that investigations proceed in a manner that is culturally (and scientifically) appropriate, which may require requesting guidance from relevant community leaders and organizations. The ability to conduct these investigations effectively requires that local public health authorities systematically engage cultural leaders and organizations in all of their work, prior to the need for investigating a potential outbreak.

### 5.2 Isolation and Work or Child Care Restrictions

Not applicable outside of healthcare settings. Appropriate transmission-based precautions should be used in healthcare settings.

### 5.3 Case Follow-up

Generally not indicated. If you are notified of a transfer CRO or CPO case, provide education and infection control guidance to the receiving facility. Update Orpheus if notified of the death of a person infected or colonized with CPO.

### 5.4 Protection of Contacts

There is no prophylaxis, restrictions, or requirements for contacts of CRE cases. The importance of good hand washing should be stressed.

Healthcare contacts may be more likely to become ill or colonized if they have certain medical risk factors (See §2.5 Risk Dynamics) or if appropriate infection control measures are not implemented in healthcare settings or

poorly adhered to by healthcare workers. Ensure healthcare facilities have a plan for infection control and staff education.

### 5.5 Environmental Measures

In healthcare settings, environmental services staff should be notified of new cases. Frequent and thorough disinfection of patient rooms, bathrooms, and high-touch surfaces can reduce the risk of transmission through the environment. Review the CRO Toolkit for more information.

Bleach-based products can be used at home to clean toilets, bathrooms, and high-touch surfaces.

## 6. MANAGING SPECIAL SITUATIONS

### 6.1 Health Equity

OHA's strategic goal is to eliminate health inequities in Oregon by 2030. Health inequities are systematic, avoidable differences in health that are rooted in social and economic injustices, not simply differences in disease incidence, health outcomes and access to healthcare. When managing special situations, tailor interventions and communications based on individual circumstances and community history and culture, including intergenerational experiences that have contributed to inequities (e.g., displacement, economic exploitation, racial segregation). As appropriate, consult with culturally rooted organizations, such as Indigenous/tribal agencies, Oregon Health Authority Regional Health Equity Coalitions (https://www.oregon.gov/oha/EI/Pages/RHEC.aspx), or culturally specific service providers to develop effective plans for conducting investigations, with an eye toward building trusting relationships.

### 6.2 Case is Deceased

If a case is deceased, collect as much information as possible from the case's medical record. To collect information that cannot be obtained from the medical record, attempt a proxy interview of a family member, caregiver, or other person with knowledge of the case's recent medical history. When interviewing family or friends of the case, maintain a compassionate trauma-informed approach and allow them to determine the extent of their involvement.

When possible, complete a full case investigation, including the collection of REAL-D and SOGI information from a proxy. Complete case information

allows us to better understand these pathogens, risk factors associated with mortality, and inequities.

In situations where a proxy interview must be limited, prioritize actionable information. This includes information about healthcare procedures, hospitalizations, or residential care in the past 30 days (12 months for CPOs). Notify these healthcare facilities so they can monitor for additional CRE cases.

### 6.3 Possible Common-source Outbreak

If the number of reported cases in your county is higher than usual, note possible epidemiologic connections, especially procedures or encounters at healthcare facilities. CRE and CPO outbreaks are most commonly associated with healthcare settings.

If there are indications of a potential common-source outbreak, contact communicable disease epidemiologists at ACDP immediately at 971-673-1111

## GLOSSARY

**CRE** – carbapenem-resistant *Enterobacterales.*

**CRO** – carbapenem-resistant organisms; includes CRE and other carbapenem resistant pathogens (e.g., carbapenem-resistant *Acinetobacter* spp., carbapenem-resistant *Pseudomonas aeruginosa*).

**CPO** – carbapenemase producing organisms; a subset of CRO that produce carbapenemase enzymes as the mechanism of carbapenem resistance.

**IMP** – imipenem-hydrolyzing-lactamase; a carbapenemase.

**KPC** – *Klebsiella pneumoniae* carbapenemase.

**NDM** – New Delhi metallo-beta-lactamase; a carbapenemase.

**OXA-48** – oxacillinase-48; a carbapenemase.

**PCR** – polymerase chain reaction; used to detect genes that code for carbapenemase production.

**VIM** – Verona integron-encoded metallo-beta-lactamase; a carbapenemase.

## APPENDIX

**Appendix 1.** List of Genera in the *Enterobacterales* Order†

| | | | | |
|---|---|---|---|---|
| *Acerihabitans* | *Edwardsiella* | *Kluyvera* | *Phytobacter* | *Scandinavium* |
| *Arsenophonus* | *Enterobacter* | *Leclercia* | *Plesiomonas* | *Serratia* |
| *Biostraticola* | *Erwinia* | *Lelliottia* | *Pluralibacter* | *Shigella* |
| *Brenneria* | *Escherichia* | *Leminorella* | *Pragia* | *Shimwellia* |
| *Buchnera* | *Ewingella* | *Limnobaculum* | ***Proteus**** | *Siccibacter* |
| *Budvicia* | *Franconibacter* | *Lonsdalea* | ***Providencia**** | *Sodalis* |
| *Buttiauxella* | *Gibbsiella* | *Mangrovibacter* | *Pseudescherichia* | *Tatumella* |
| *Cedecea* | *Hafnia* | *Mixta* | *Pseudocitrobacter* | *Trabulsiella* |
| *Chania* | *Insectihabitans* | *Moellerella* | *Rahnella* | *Wigglesworthia* |
| *Chimaeribacter* | *Intestinirhabdus* | ***Morganella**** | *Raoultella* | *Xenorhabdus* |
| *Citrobacter* | *Izhakiella* | *Obesumbacterium* | *Rosenbergiella* | *Yersinia* |
| *Cosenzaea* | *Jinshanibacter* | *Pantoea* | *Rouxiella* | *Yokenella* |
| *Cronobacter* | *Kalamiella* | *Pectobacterium* | *Saccharobacter* | |
| *Dickeya* | *Klebsiella* | *Phaseolibacter* | *Salmonella* | |

* Elevated MICs to imipenem in ***Morganella* spp.**, ***Proteus* spp.**, and ***Providencia* spp.** are frequently due to mechanisms other than carbapenemases. Please do NOT send isolates of these genera to OSPHL unless there is also resistance to other carbapenems.

† The most common CRE genera are highlighted

## REFERENCES

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## UPDATE LOG

October 2024: Updated to match new CRO Toolkit, improve clarity, and incorporate equity lens (Heather Hertzel, Evelyn Donahoe)

September 2022: Changed "*Enterobacteriaceae*" to "*Enterobacterales*"; corrected Kirby Bauer breakpoints; clarified 4.2 case follow-up requirements; updated genera list. (Heather Hertzel, Maureen Cassidy)

December 2019: Clarified ertapenem information in case definition (Maureen Cassidy)

June 2016: Updated data collection in "Case Follow Up" and updated recommendations tables (Maureen Cassidy)

November 2015: Placed into new template and corrected spelling and link errors. (Leslie Byster)

June 2015: Case definition change (Maureen Cassidy)

June 2014: Updated CRE Tier Assignment §3.2 and minor updates to case follow-up (Maureen Cassidy) April 2014: Updated §4.2 Case follow-up. (Maureen Cassidy, G. Buser)

February 2014: Updated case definition. (Maureen Cassidy)

July 2013: Updated case definition; added link for Oregon CRE Tool kit (M Maureen Cassidy) January 2013. Updated new MIC breakpoint for ertapenem. (Tasha Poissant)

November 2012. Fixed broken hyperlinks; added doripenem resistance to case definition. (Tasha Poissant)

April 2012: Clarified reporting procedure for repeat culture results and added list of genera (Margaret Cunningham)

January 2012: Newly created guidelines to be in line with new reporting requirements. (Margaret Cunningham)