Multidrug Resistant Organisms Reporting, Investigation, and Prevention

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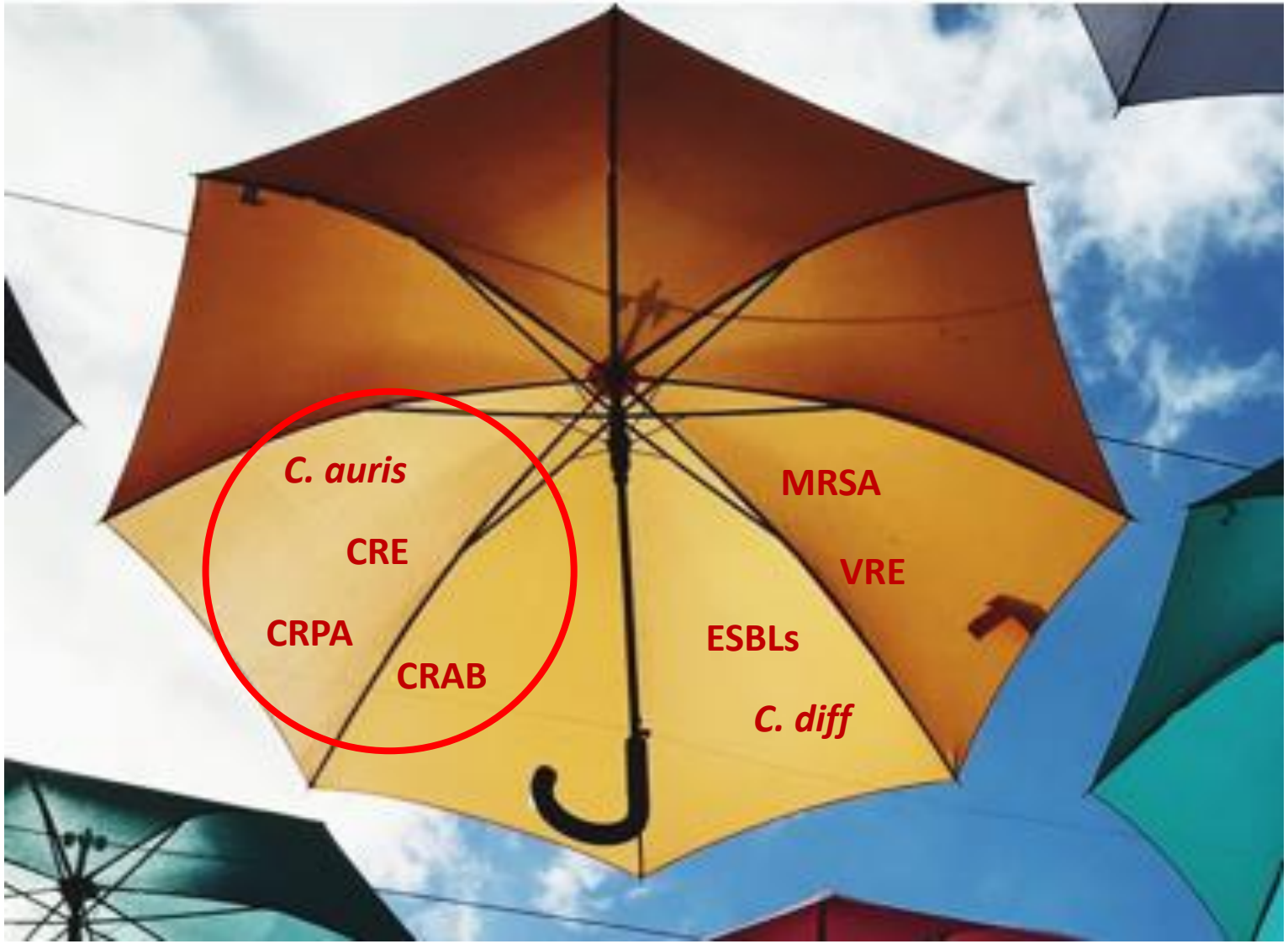
March 6, 2024

Multidrug-resistant Organisms (MDRO)

Covered Today:

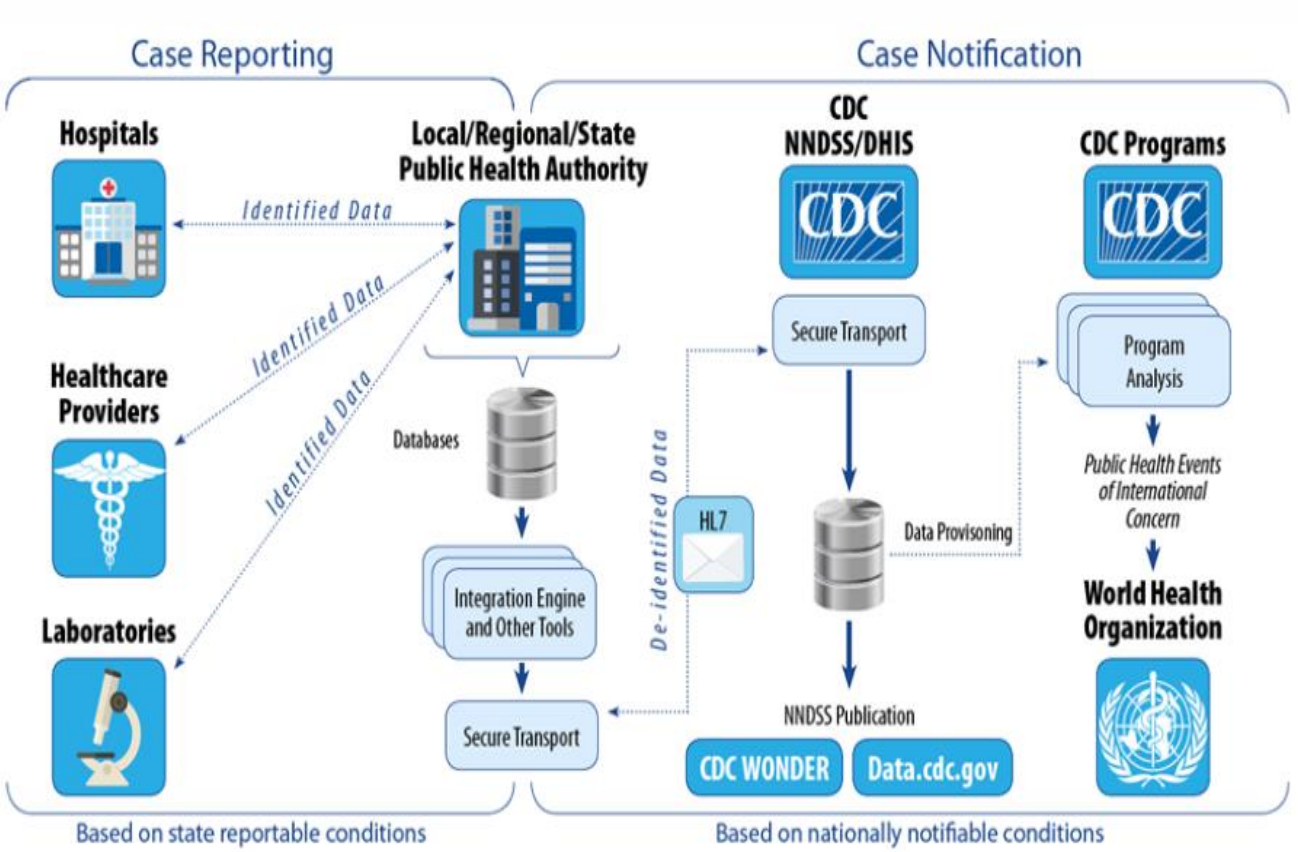
- Candida auris (*C. auris*)
- **Carbapenem-resistant Enterobacterales (CRE)**
- **Carbapenem-resistant *Pseudomonas aeruginosa* (CRPA)**
- **Carbapenem-resistant *Acinetobacter baumannii* (CRAB)**



- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Vancomycin-resistant Enterococci (VRE)
- extended-spectrum beta-lactamases (ESBLs)
- *Clostridioides difficile* (*C. diff*)

Reportable Diseases in Michigan

- Michigan Disease Surveillance System (MDSS) is the state database for collecting surveillance data.
  - Web-based communicable disease reporting system
  - Cases can be reported by:
    - Electronic laboratory report (ELR)
    - Manual case entry
- Healthcare Professional's Guide to Disease Reporting in Michigan describes reporting criteria to MDSS or Local Health Department by healthcare providers and laboratories
- Surveillance case definition endorsed by Council of State & Territorial Epidemiologist (CSTE)/CDC, nationally notifiable
  - Not for clinical diagnosis



Antimicrobial Resistant Reportable Diseases

Candida auris (Candidiasis)

- *C. auris* Case Reporting and Investigation Guidance, 2023
- Report any laboratory finding that meets either of the following criteria:
  - Detection of *C. auris* in a specimen using either **culture** or a **culture independent diagnostic test** (CIDT) (e.g., Polymerase Chain Reaction [PCR])
  - Detection of an organism that commonly represents a ***C. auris* misidentification** in a specimen by culture (e.g., *Candida haemulonii*)
- Laboratories shall immediately submit confirmed or suspect *C. auris* isolates, subcultures, or specimens to the MDHHS Bureau of Laboratory (BOL)

Carbapenemase-Producing Organisms (CPO)

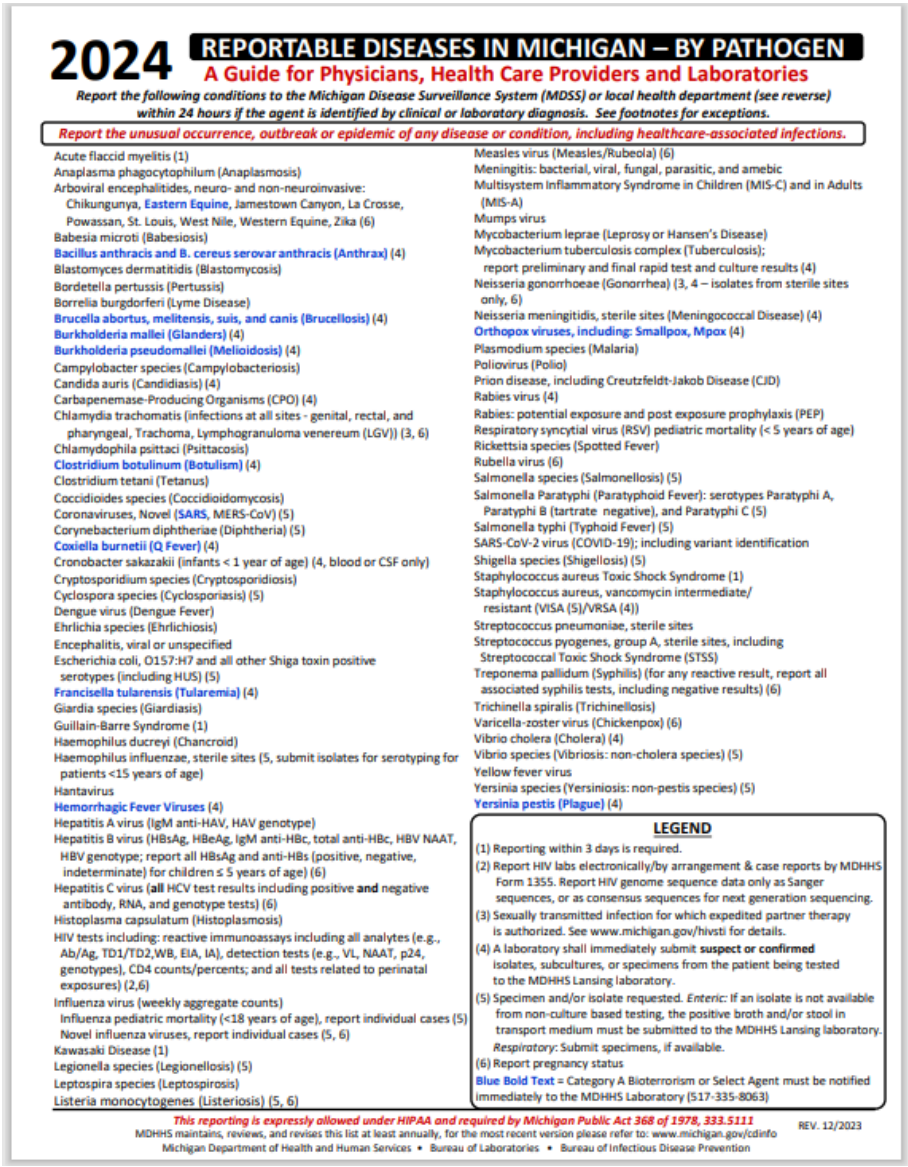
- Reportable in MI starting in 2018; 2024 expanded case definition from Carbapenemase producing – carbapenem resistant Enterobacterales (CP-CRE)
- CPO Reporting and Investigation Guide, 2024
- Report cases according to the CPO Reporting and Investigation Guide for laboratory evidence
- Laboratories are required to submit suspect or confirmed isolates, subcultures, or specimens from the patient being tested to the MDHHS BOL

Staphylococcus aureus

- Vancomycin Intermediate/Resistant (VISA/VRSA) *S. aureus*

Unusual Outbreak or Occurrence

- Can be used for any type of unusual reports, even if not on the list



2024 REPORTABLE DISEASES IN MICHIGAN – BY PATHOGEN

A Guide for Physicians, Health Care Providers and Laboratories

Report the following conditions to the Michigan Disease Surveillance System (MDSS) or local health department (see reverse) within 24 hours if the agent is identified by clinical or laboratory diagnosis. See footnotes for exceptions.

Report the unusual occurrence, outbreak or epidemic of any disease or condition, including healthcare-associated infections.

Acute flaccid myelitis (1)
Anaplasma phagocytophilum (Anaplasmosis)
Arboviral encephalitides, neuro- and non-neuroinvasive: Chikungunya, Eastern Equine, Jamestown Canyon, La Crosse, Powassan, St. Louis, West Nile, Western Equine, Zika (6)
Babesia microti (Babesiosis)
Bacillus anthracis and B. cereus serovar anthracis (Anthrax) (4)
Blastomyces dermatitidis (Blastomycosis)
Bordetella pertussis (Pertussis)
Borrelia burgdorferi (Lyme Disease)
Brucella abortus, melitensis, suis, and canis (Brucellosis) (4)
Burkholderia mallei (Glanders) (4)
Burkholderia pseudomallei (Melioidosis) (4)
Campylobacter species (Campylobacteriosis)
Candida auris (Candidiasis) (4)
Carbapenemase-Producing Organisms (CPO) (4)
Chlamydia trachomatis (infections at all sites - genital, rectal, and pharyngeal, Trachoma, Lymphogranuloma venereum (LGV)) (3, 6)
Chlamydophila psittaci (Psittacosis)
Clostridium botulinum (Botulism) (4)
Clostridium tetani (Tetanus)
Coccidioides species (Coccidioidomycosis)
Coronaviruses, Novel (SARS, MERS-CoV) (5)
Corynebacterium diphtheriae (Diphtheria) (5)
Coxiella burnetii (Q Fever) (4)
Cronobacter sakazakii (infants < 1 year of age) (4, blood or CSF only)
Cryptosporidium species (Cryptosporidiosis)
Cyclospora species (Cyclosporiasis) (5)
Dengue virus (Dengue Fever)
Ehrlichia species (Ehrlichiosis)
Encephalitis, viral or unspecified
Escherichia coli, O157:H7 and all other Shiga toxin positive serotypes (including HUS) (5)
Francisella tularensis (Tularemia) (4)
Giardia species (Giardiasis)
Guillain-Barre Syndrome (1)
Haemophilus ducreyi (Chancroid)
Haemophilus influenzae, sterile sites (5, submit isolates for serotyping for patients <15 years of age)
Hantavirus
Hemorrhagic Fever Viruses (4)
Hepatitis A virus (IgM anti-HAV, HAV genotype)
Hepatitis B virus (HBsAg, HBeAg, IgM anti-HBc, total anti-HBc, HBV NAAT, HBV genotype; report all HBsAg and anti-HBs (positive, negative, indeterminate) for children ≤ 5 years of age) (6)
Hepatitis C virus (**all** HCV test results including positive **and** negative antibody, RNA, and genotype tests) (6)
Histoplasma capsulatum (Histoplasmosis)
HIV tests including: reactive immunoassays including all analytes (e.g., Ab/Ag, TD1/TD2,WB, EIA, IA), detection tests (e.g., VL, NAAT, p24, genotypes), CD4 counts/percents; and all tests related to perinatal exposures) (2,6)
Influenza virus (weekly aggregate counts)
Influenza pediatric mortality (<18 years of age), report individual cases (5)
Novel influenza viruses, report individual cases (5, 6)
Kawasaki Disease (1)
Legionella species (Legionellosis) (5)
Leptospira species (Leptospirosis)
Listeria monocytogenes (Listeriosis) (5, 6)
Measles virus (Measles/Rubeola) (6)
Meningitis: bacterial, viral, fungal, parasitic, and amebic
Multisystem Inflammatory Syndrome in Children (MIS-C) and in Adults (MIS-A)
Mumps virus
Mycobacterium leprae (Leprosy or Hansen's Disease)
Mycobacterium tuberculosis complex (Tuberculosis); report preliminary and final rapid test and culture results (4)
Neisseria gonorrhoeae (Gonorrhea) (3, 4 – isolates from sterile sites only, 6)
Neisseria meningitidis, sterile sites (Meningococcal Disease) (4)
Orthopox viruses, including: Smallpox, Mpox (4)
Plasmodium species (Malaria)
Poliovirus (Polio)
Prion disease, including Creutzfeldt-Jakob Disease (CJD)
Rabies virus (4)
Rabies: potential exposure and post exposure prophylaxis (PEP)
Respiratory syncytial virus (RSV) pediatric mortality (< 5 years of age)
Rickettsia species (Spotted Fever)
Rubella virus (6)
Salmonella species (Salmonellosis) (5)
Salmonella Paratyphi (Paratyphoid Fever): serotypes Paratyphi A, Paratyphi B (tartrate negative), and Paratyphi C (5)
Salmonella typhi (Typhoid Fever) (5)
SARS-CoV-2 virus (COVID-19); including variant identification
Shigella species (Shigellosis) (5)
Staphylococcus aureus Toxic Shock Syndrome (1)
Staphylococcus aureus, vancomycin intermediate/ resistant (VISA (5)/VRSA (4))
Streptococcus pneumoniae, sterile sites
Streptococcus pyogenes, group A, sterile sites, including Streptococcal Toxic Shock Syndrome (STSS)
Treponema pallidum (Syphilis) (for any reactive result, report all associated syphilis tests, including negative results) (6)
Trichinella spiralis (Trichinellosis)
Varicella-zoster virus (Chickenpox) (6)
Vibrio cholera (Cholera) (4)
Vibrio species (Vibriosis: non-cholera species) (5)
Yellow fever virus
Yersinia species (Yersiniosis: non-pestis species) (5)
Yersinia pestis (Plague) (4)

LEGEND

(1) Reporting within 3 days is required.
(2) Report HIV labs electronically/by arrangement & case reports by MDHHS Form 1355. Report HIV genome sequence data only as Sanger sequences, or as consensus sequences for next generation sequencing.
(3) Sexually transmitted infection for which expedited partner therapy is authorized. See www.michigan.gov/hivsti for details.
(4) A laboratory shall immediately submit **suspect or confirmed** isolates, subcultures, or specimens from the patient being tested to the MDHHS Lansing laboratory.
(5) Specimen and/or isolate requested. *Enteric:* If an isolate is not available from non-culture based testing, the positive broth and/or stool in transport medium must be submitted to the MDHHS Lansing laboratory. *Respiratory:* Submit specimens, if available.
(6) Report pregnancy status
Blue Bold Text = Category A Bioterrorism or Select Agent must be notified immediately to the MDHHS Laboratory (517-335-8063)

This reporting is expressly allowed under HIPAA and required by Michigan Public Act 368 of 1978, 333.5111
MDHHS maintains, reviews, and revises this list at least annually, for the most recent version please refer to: www.michigan.gov/cdinfo
Michigan Department of Health and Human Services • Bureau of Laboratories • Bureau of Infectious Disease Prevention
REV. 12/2023

michigan.gov/cdinfo

2024 Brick Book and CD Lists

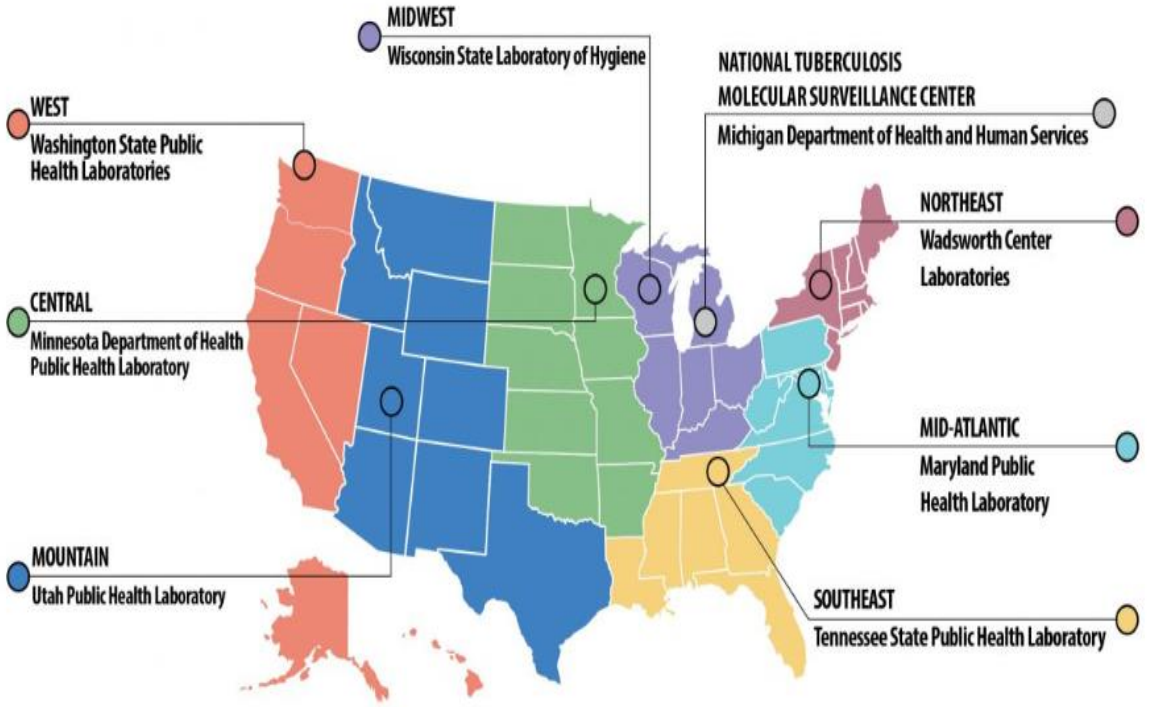
Laboratory Testing Support

MDHHS BOL:

- **Any confirmed or suspected isolates of *Candida auris* and Carbapenamase-producing organisms (CPO) isolates**
- ***Candida species*** from normally sterile sites (including serial isolates from patients receiving antifungal treatment)
- **Unusual *Candida* species** (any species other than *albicans*, *C. parapsilosis*, *C. dubliniensis*, *C. lusitaniae*, *C. tropicalis*, *C. krusei*)
- Any ***Candida*** **species** that was **unable to be identified** after a validated method was attempted

Antimicrobial Resistance Laboratory Network (ARLN):
Collaborating labs coordinate and complement specialized testing activities to inform local response

- ARLN Midwest -Multi-drug resistant *Candida* isolates
- Screening tests (PPS, admission and/or discharge)



ARLABnetwork

Surveillance Updates and Reports

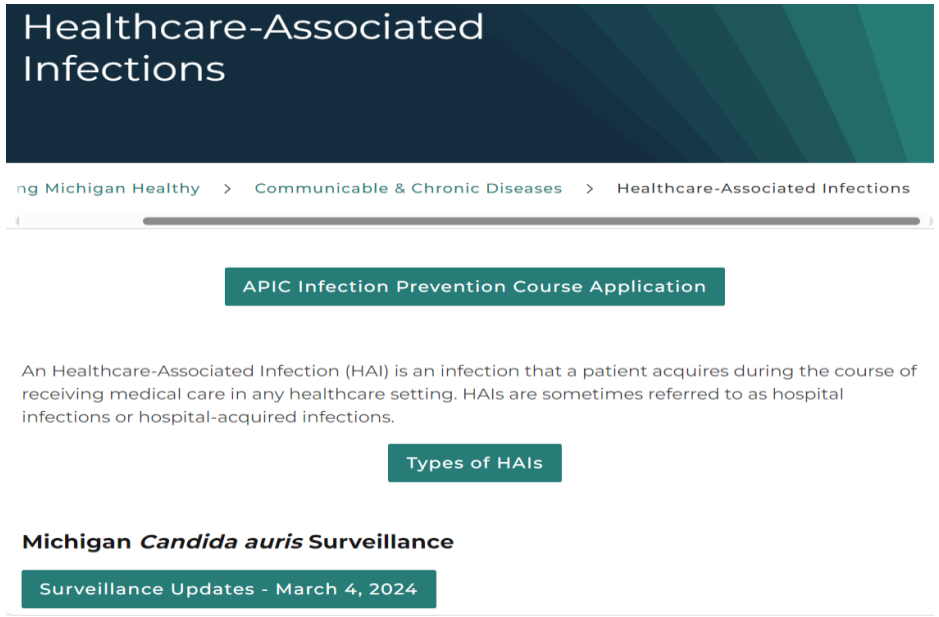
[Healthcare-Associated Infections (michigan.gov)]

Candida auris

- Weekly surveillance updates
- Screening Guidance
- IP Resources & Tools
- *C. auris* Case Reporting and Investigation Guidance

Carbapenemase-producing Carbapenem Resistant Enterobacterales (CP-CRE)

- Surveillance report, 2018-2022
- CPO Reporting and Investigation Guide



Related Content

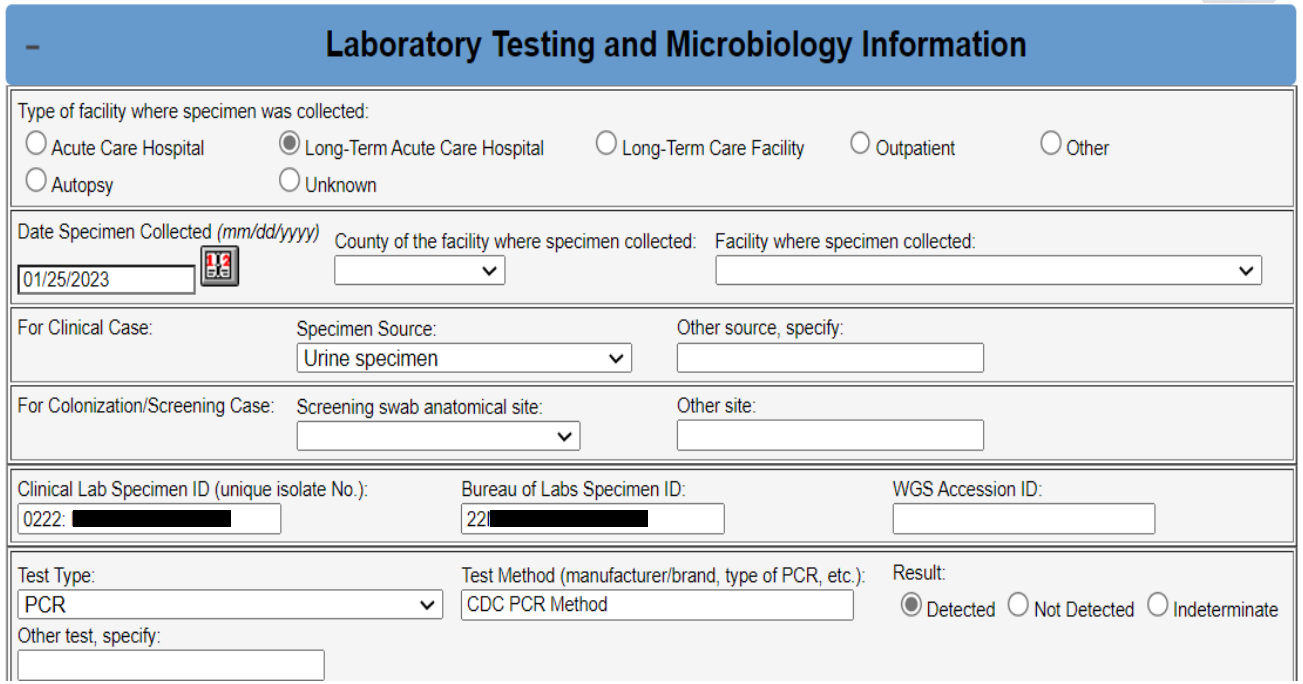
- Reporting and Investigation Guidance
- CP-CRE Surveillance Report
  - CP-CRE Surveillance Report, 2018-2022
- HAI Prevention Plan and HAI Progress Report
- Publications
- Contact Us


C. auris

C. Auris Case Reporting and Classification

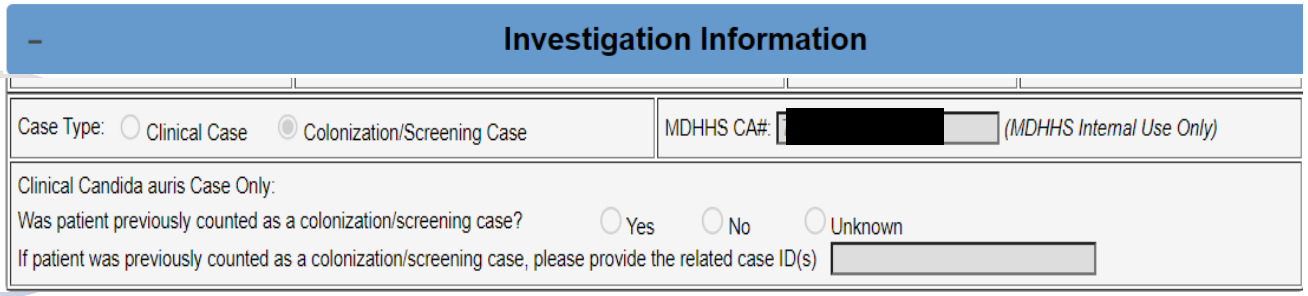
1. **Confirmed**:
   - Detection of *C. auris* from any body site using either culture or a culture independent diagnostic test (CIDT) (e.g., PCR)

2. Probable or Suspect: N/A



Further defined Confirmed Case Type:

1. **Clinical case-** culture often indicates a clinical case (e.g., blood, urine, wound, or respiratory source), but could be a screening test if indicated.
2. Colonization/**Screening case-** typical screening sites include skin sites like axilla/groin, or nares; PCR results often indicate screening/colonization



C. Auris Case Counting: Duplicate Report?

1. A person who is colonized or infected with Candida auris is considered colonized indefinitely.
2. A person is counted as a case when C. auris is identified for the first time in a specimen, whether that be a screening or clinical specimen.

Scenario #1 - If a person is first classified as a clinical case, and later a screening swab is positive, they would <u>not</u> be counted as a screening case.

Laboratory Results	*Interpretation* →	*Action*
Ear culture 1/12/2023 *C. auris* positive isolate	New *C. auris* case for Patient A, case #1	Report as a *C. auris* clinical case, case #1
Axilla/Groin swab 5/13/2023 *C. auris* positive DNA detected	Positive *C. auris* screening case. Not a new case for Patient A.	Enter new lab info in the Lab Reports tab and Merge with case #1 or close out as Superceded

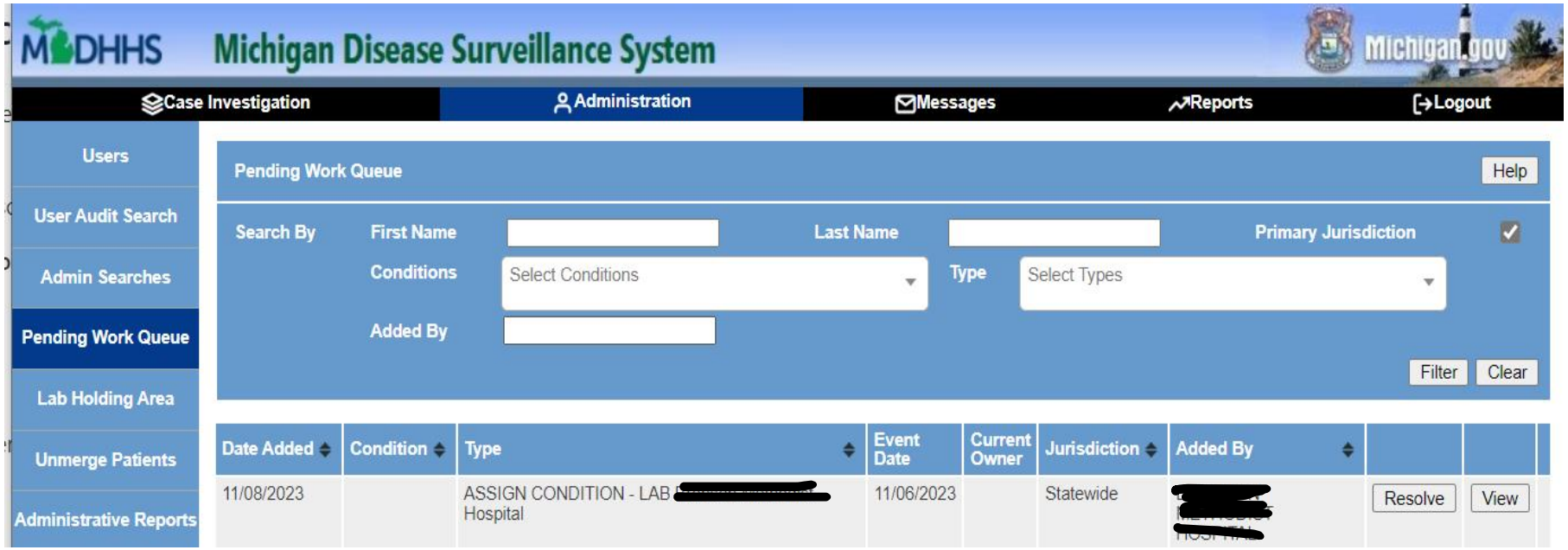
C. Auris Case Counting, cont.

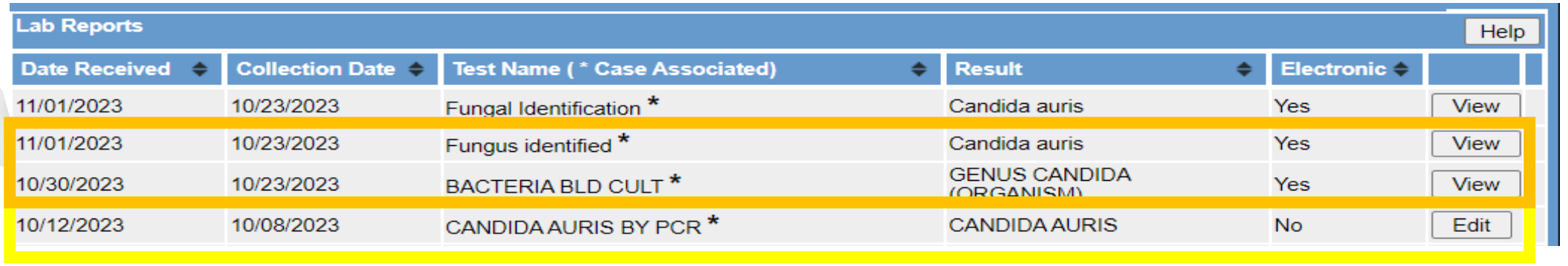
Scenario #2 - A person first classified as a screening case can be later counted again as a clinical case.

This is the only scenario that C. auris can be counted twice for the same person.

Laboratory Results	*Interpretation*	*Action*
Axilla/Groin swab 1/10/2023 C. auris positive DNA detected	New *C. auris* case for Patient A, case #1	Report as a *C. auris* screening case, Case #1
Blood culture 5/12/2023 *C. auris* positive	Positive clinical case New *C. auris* case #2	Report as a *C. auris* clinical case, Case #2

C. Auris Case Counting: MDSS Deduplicating





Electronic Death Records System (EDRS) Reports

Example 1:

Make a note stating COD. Confirm not a case.

Diagnosis Code

Cause Of Death 1A	Cause Of Death 1B	Cause Of Death 1C	Cause Of Death 1D
Alcoholic Cirrhosis	Adult Respiratory Distress Syndrome due to Covid 19 Pneumonia	Candida Glabrata Sepsis	

Code 800	Decedent Mname Med Facility	Other Conditions
K703		chronic kidney disease

Entity Axis Code1	Entity Axis Code2	Entity Axis Code3	Entity Axis Code4
K703	B377	J189	J80

Example 2:

Need to confirm type of candidemia with facility, leave a note, then close it out.

Diagnosis Code

Cause Of Death 1A	Cause Of Death 1B	Cause Of Death 1C	Cause Of Death 1D
septic shock	candidemia		

Code 800	Decedent Mname Med Facility	Other Conditions
B377		gastric cancer

Entity Axis Code1	Entity Axis Code2	Entity Axis Code3	Entity Axis Code4
B377	A419	C169	

Entity Axis Code5	Entity Axis Code6	Entity Axis Code7	Entity Axis Code8

Either way . . . leave a note!


CPO: CRE, CRPA, CRAB

Mechanisms of Carbapenem Resistance

CRO: Carbapenem-Resistant Organisms

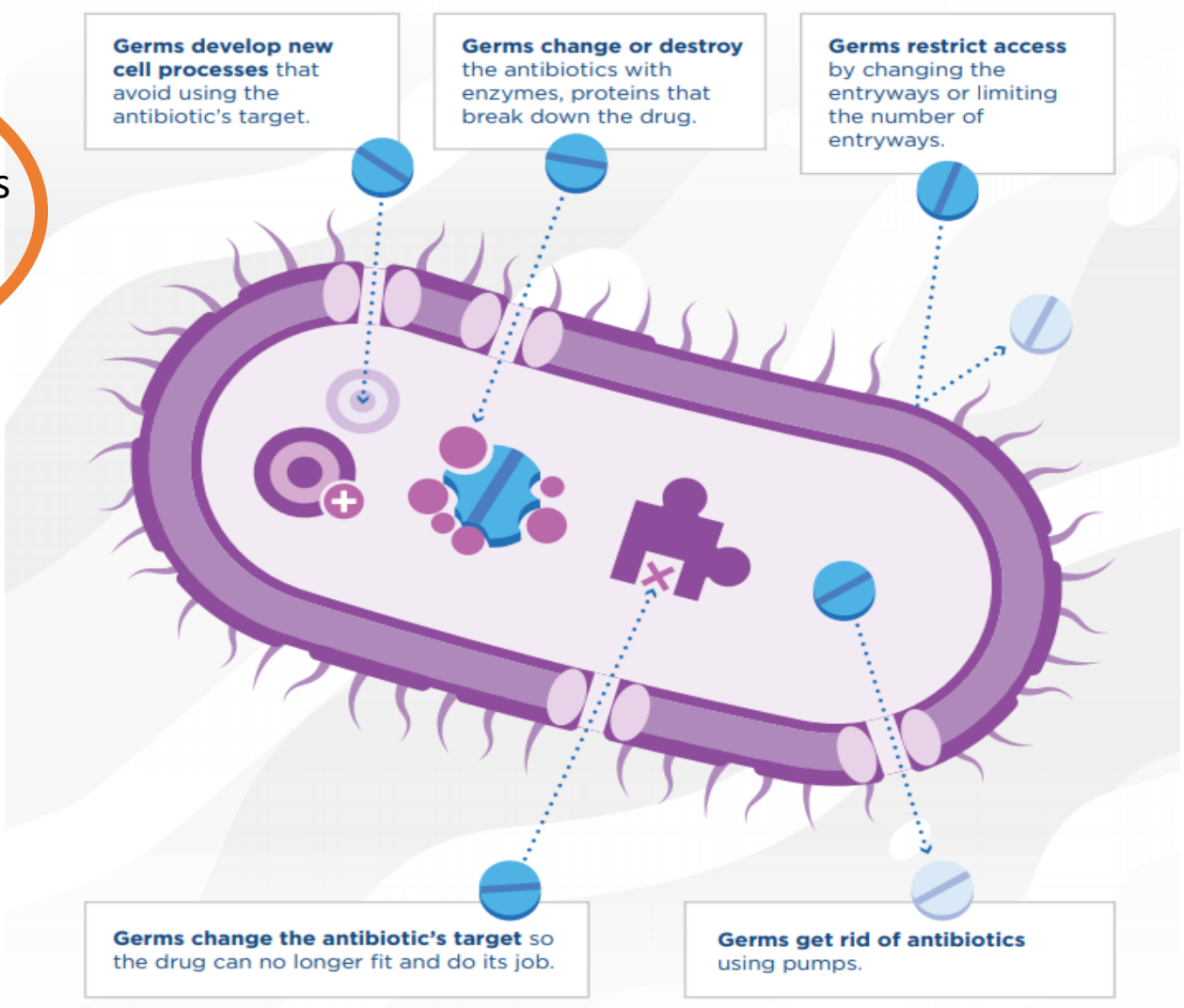
- Any organism resistant to carbapenem antibiotics
- Resistance conferred by mechanisms other than carbapenemase enzyme, e.g., porin modification, efflux pumps

- Altered targets
- Avoidance of targets
- Porin loss
- Efflux pumps
- Enzymes

CPO: Carbapenemase-Producing Organisms

- A special subset of Carbapenem-Resistant Organisms
- Any organism that produces a carbapenemase: common or novel
  - Most common and significant **carbapenemases: KPC, NDM, VIM, IMP, OXA**

Carbapenemases



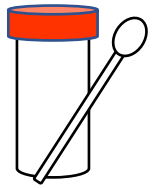
CPO Case Reporting Criteria

Criteria	2022-2023	2024
Condition	Carbapenemase-producing Carbapenem Resistant Enterobacterales (CP-CRE)	Carbapenemase-producing Organisms (CPO)
Organism	Any **Enterobacterales** organism, or carbapenemase positive culture-independent diagnostic test (CIDT)	Any **Enterobacterales**, *Pseudomonas aeruginosa*, or *Acinetobacter* spp. organism, or carbapenemase positive culture-independent diagnostic test (CIDT)
Testing Criteria	An isolate or specimen meeting any of the following: • Positive **phenotypic test** result for carbapenemase production, e.g., Carba-NP, carbapenem inactivation method (CIM), modified carbapenemase inactivation method (mCIM), EDTA-modified carbapenem inactivation method (eCIM) • Positive **molecular test** result detecting a carbapenemase gene (with or without organism identification), e.g., Polymerase chain reaction (PCR), Cepheid Xpert Carba-R®, Verigene BC-GN®, EPlex® BCID GN Panel, FilmArray™ BCID, FilmArray™ pneumonia panel, BD MAX™ Check-Points, whole genome sequencing • Detection of carbapenemase gene by next generation sequencing (**NGS**)	
Laboratory Isolate Submission	All CP-CRE isolates are required to be submitted to MDHHS Bureau of Labs (BOL)	All CPO isolates are required to be submitted to MDHHS Bureau of Labs (BOL)

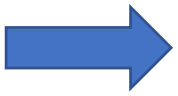
CPO Case Reporting Criteria, cont.

Criteria	2022-2023	2024
Susceptibility Testing	If laboratories are unable to detect CP-CRE (i.e., cannot test for carbapenemase production or carbapenemase genes), any isolate demonstrating resistance profiles defined below should be submitted for further testing. • Any isolate with an MIC of ≥4 µg/mL for doripenem, or imipenem, or meropenem, or ≥ 2 µg/mL for ertapenem • Additional guidance beginning in 2022: *Morganella, Proteus, Providencia* spp. may have intrinsic resistance to imipenem. Only those isolates that are resistant to 1 or more carbapenems other than imipenem should be submitted.	If laboratories are unable to detect CPOs (i.e., cannot test for carbapenemase production or carbapenemase genes), any Enterobacterales, *Pseudomonas aeruginosa*, or *Acinetobacter* spp. isolate demonstrating **resistance profiles defined below** should be submitted for further testing. **Carbapenem-resistant Enterobacterales (CRE)** isolate submissions: • Any isolate with an MIC of ≥4 µg/mL for doripenem, imipenem, or meropenem, or ≥ 2 µg/mL for ertapenem • *Morganella, Proteus, Providencia* spp. may have intrinsic resistance to imipenem. Only those isolates that are resistant to one or more carbapenems other than imipenem should be submitted. **Carbapenem-resistant Pseudomonas aeruginosa isolate submissions:** • Any isolate with an MIC of ≥ 8 µg/mL to doripenem, imipenem, or meropenem AND an MIC of ≥ 16 µg/mL to cefepime or ceftazidime **Carbapenem-resistant Acinetobacter spp. isolate submissions:** • Any isolate with an MIC of ≥ 8 µg/mL for doripenem, imipenem, or meropenem Any Enterobacterales, Pseudomonas aeruginosa, or Acinetobacter spp. isolate that is non-susceptible to all antibiotics tested. If a CPO is detected via a molecular test directly from a clinical specimen, perform a culture to obtain the bacterial isolate and perform subsequent testing to determine carbapenemase production or carbapenemase gene, and antibiotic susceptibility profile when possible, and submit isolate.

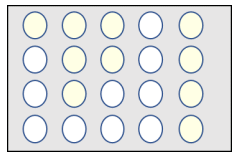
Clinical* Microbiology Laboratory Testing



Specimen Collected



Organism Identification & Quantitation



Antibiotic Susceptibility Testing

Results

Culture, Urine (Order 1339541775)

Culture, Urine

Order: 1339541775

Status: **Final result** Visible to patient: **No (inaccessible in myBeaumontChart)** Next appt: **None**

Specimen Information: Urine, Clean Catch

Culture, Urine — **>100,000 CFU/ml Enterobacter cloacae, CRE, MDR !**

Other - This isolate resulted CRE Non Carbapenemase producer by PCR.
MDR - This isolate is resistant to a carbapenem(s) (CRE). Initiate contact precautions. Consider Infectious Diseases consult.

Susceptibility

Enterobacter cloacae, CRE, MDR (1)

Antibiotic	MIC	Interpretation
Cefazolin	>=64	Resistant
Cefepime	8	Intermediate
Ceftriaxone	>=64	Resistant
Ertapenem	4	Resistant
Gentamicin	<=1	Susceptible
Levofloxacin	<=0.12	Susceptible
Meropenem	0.5	Susceptible
Nitrofurantoin	64	Intermediate
Tobramycin	<=1	Susceptible
Trimethoprim/Sulfa	<=20	Susceptible

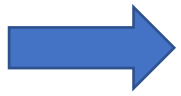
Specimen Collected: 08/09/22 03:40 Last Resulted: 08/17/22 08:28

*Clinical lab example is a hospital lab with a limited range of testing capacity

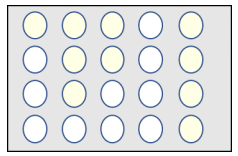
MDHHS BOL Laboratory Antimicrobial Resistance Confirmation (ARC) Testing

Clinical Micro Lab

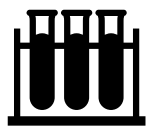
Pure Isolate



Organism ID Confirmation

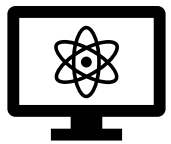


Antibiotic Susceptibility Testing



Phenotypic Testing for Presence of Carbapenemase Enzymes (mCIM Test)

Genotypic Testing for Presence of Carbapenemase Genes (PCR)



Whole Genome Sequencing

Antimicrobial Resistance Confirmation (ARC)

Gram Stain

Gram negative bacilli

Culture Results

Confirmed as Klebsiella pneumoniae

Identification Performed by MALDI-TOF.

Antimicrobial Susceptibility Results

	Klebsiella pneumoniae	
	MIC - Interpretation	
Amikacin	<=4	S
Aztreonam	>16	R
Cefepime	4	SDD
Cefotaxime	32	R
Ceftazidime	>16	R

Modified Carbapenem Inactivation Method

Positive

Phenotypic test

Modified Carbapenem Inactivation Method (mCIM) screen positive - this isolate demonstrates carbapenemase production. The clinical efficacy of the carbapenems has not been established for treating infections caused by Enterobacteriaceae and Pseudomonas aeruginosa that test carbapenem susceptible but demonstrate carbapenemase production in vitro. ISOLATES THAT ARE mCIM POSITIVE SHOULD BE CONSIDERED RESISTANT TO ALL CARBAPENEMS REGARDLESS OF MIC. MIC REPORTED FOR EPIDEMIOLOGIC PURPOSES ONLY.

PCR Result

KPC (bla-KPC) gene DNA Detected

Molecular test

NDM-1 (bla-NDM-1) gene DNA Not Detected

OXA-48 (bla-OXA-48 like) gene DNA Not Detected

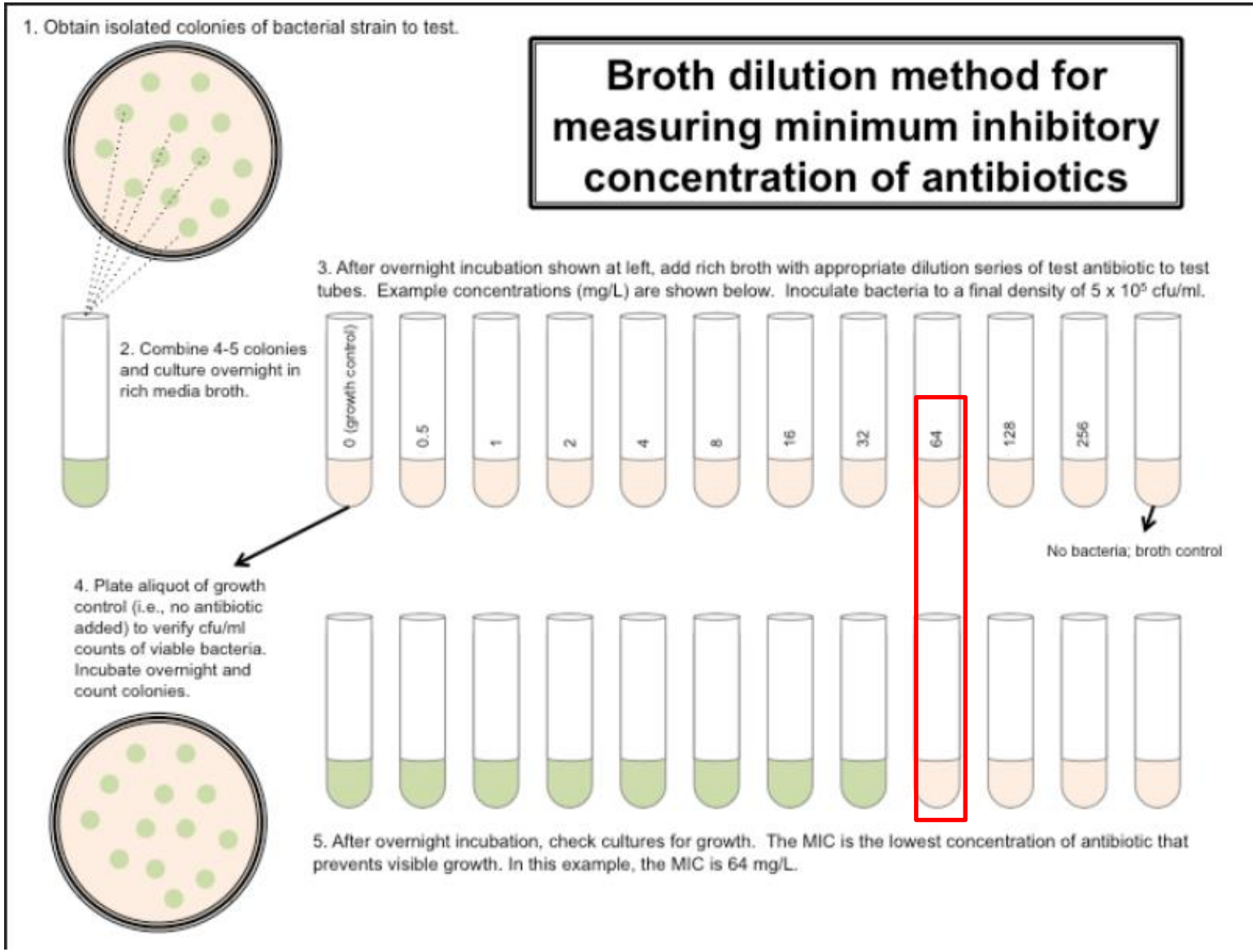
VIM (bla-VIM) gene DNA Not Detected

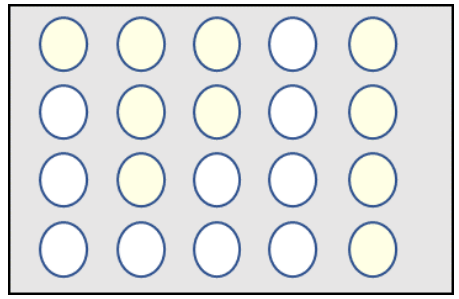
KPC, NDM, OXA-48, and VIM are the most common carbapenemases in the United States, however there are other less common carbapenemases and other mechanisms of carbapenemase resistance not detected by this PCR assay.

IMP PCR Result

IMP (bla-IMP) gene DNA Not Detected

Antimicrobial Susceptibility Testing (AST)





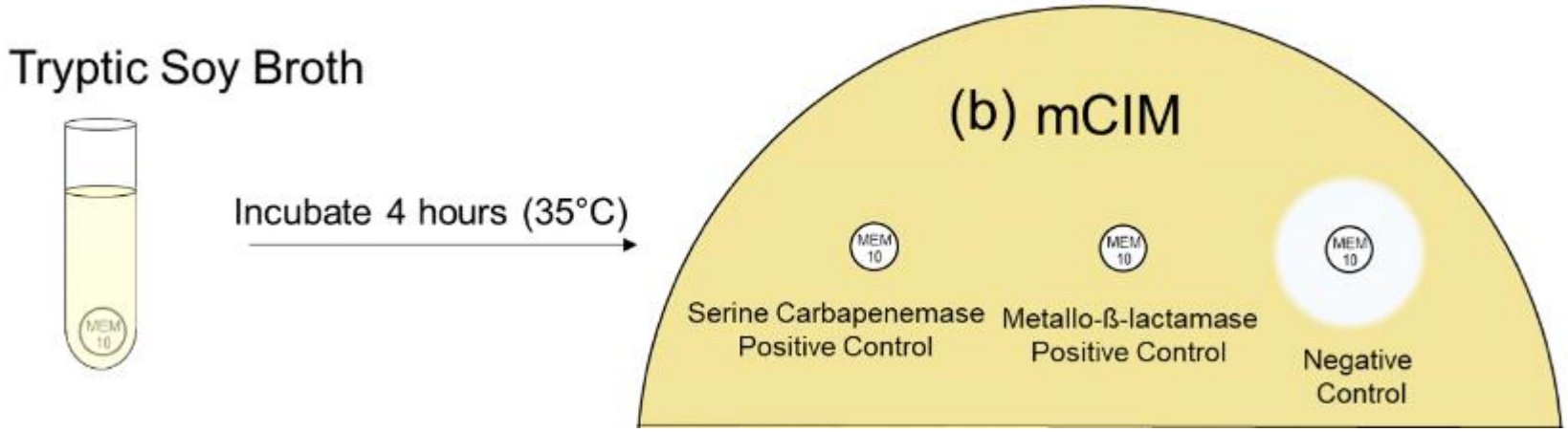
Dilution testing is used to quantitatively determine the minimal concentration (mg/ml) of antimicrobial agent to inhibit or kill the bacteria.

- Two-fold dilutions of the antimicrobial agent is added directly to a micro-broth panel.
- The lowest level that inhibits the visible growth of the organism is considered the **Minimum Inhibitory Concentration (MIC)**.

Phenotypic Test

- Determines if the organism produces any type of carbapenemase enzyme that can break down carbapenem antibiotics
  - Enzyme confers resistance to carbapenem antibiotics.
- Positive result confirms that the organism has carbapenemase activity present.

Modified carbapenem inactivation method (mCIM)

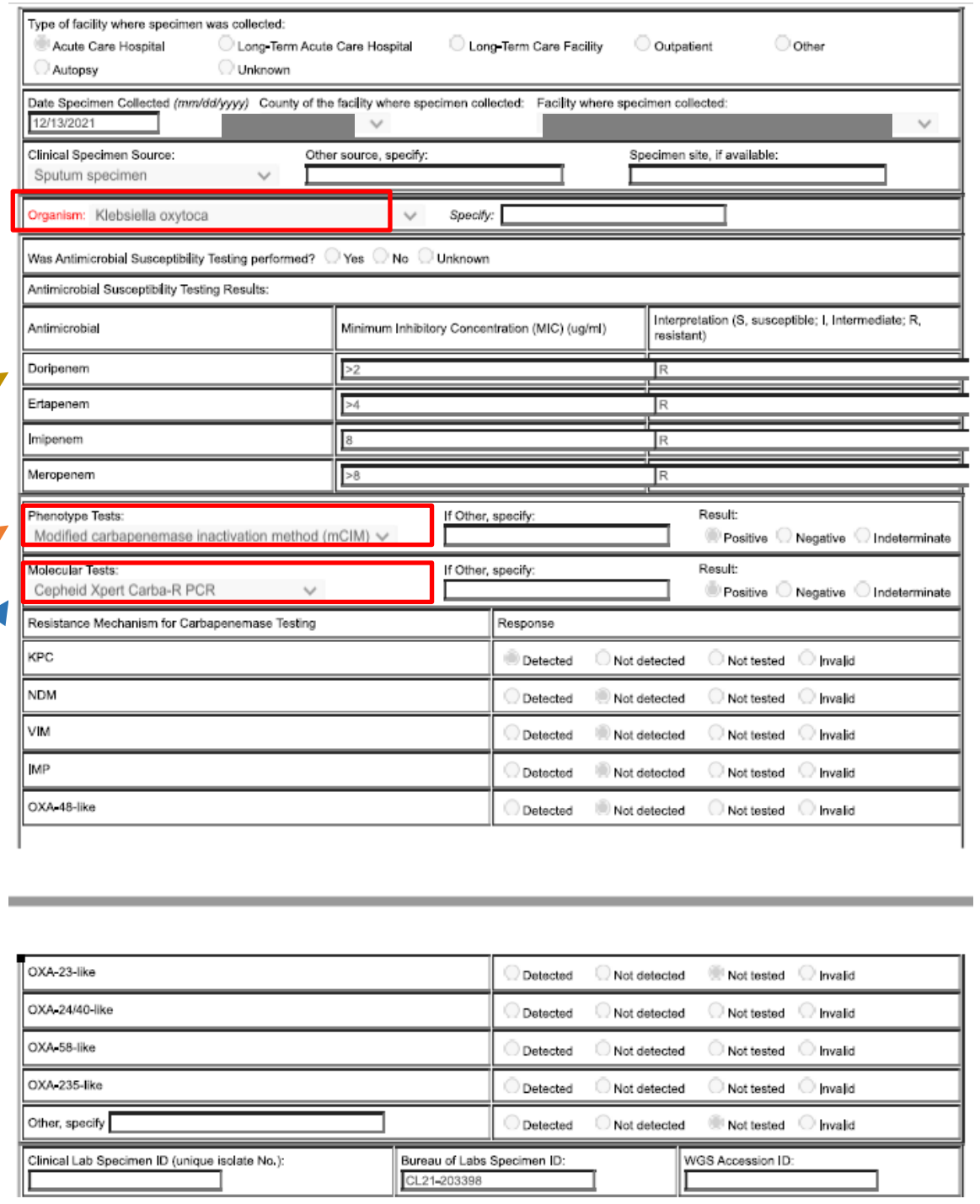


Molecular Test

- Molecular test identifies the specific carbapenemase gene
  - Determines the organism's mechanism of resistance.
  - Only detect gene targets available on the specified panel/probe of the assay.
- Results indicate which gene in the panel was "detected" or "not detected."
- Common carbapenemase genes include
  - KPC, NDM, OXA-48, VIM, and IMP
- BOL typically uses Cepheid Xpert Carba-R PCR

CPO Laboratory Testing Results

- **Laboratory Testing information is required to determine case classification**
  - Date collected
  - Specimen source
  - Organism
  - Susceptibility test: MIC
    - Need actual numerical value
  - Phenotype test: Carbapenemase testing
    - e.g., mCIM, CarbaNP
    - Or “Not tested”
  - Molecular test: Resistance mechanism-gene testing
    - e.g. PCR, CDC, Next Gen.
    - BOL typically uses Cepheid Xpert Carba-R PCR
    - Or “Not tested”



Type of facility where specimen was collected:
Acute Care Hospital | Long-Term Acute Care Hospital | Long-Term Care Facility | Outpatient | Other
Autopsy | Unknown

Date Specimen Collected (mm/dd/yyyy): 12/13/2021 | County of the facility where specimen collected: | Facility where specimen collected:

Clinical Specimen Source: Sputum specimen | Other source, specify: | Specimen site, if available:

Organism: Klebsiella oxytoca | Specify:

Was Antimicrobial Susceptibility Testing performed? Yes | No | Unknown

Antimicrobial Susceptibility Testing Results:

Antimicrobial	Minimum Inhibitory Concentration (MIC) (ug/ml)	Interpretation (S, susceptible; I, Intermediate; R, resistant)
Doripenem	>2	R
Ertapenem	>4	R
Imipenem	8	R
Meropenem	>8	R

Phenotype Tests: Modified carbapenemase inactivation method (mCIM) | If Other, specify: | Result: Positive | Negative | Indeterminate

Molecular Tests: Cepheid Xpert Carba-R PCR | If Other, specify: | Result: Positive | Negative | Indeterminate

Resistance Mechanism for Carbapenemase Testing	Response
KPC	Detected | Not detected | Not tested | Invalid
NDM	Detected | Not detected | Not tested | Invalid
VIM	Detected | Not detected | Not tested | Invalid
IMP	Detected | Not detected | Not tested | Invalid
OXA-48-like	Detected | Not detected | Not tested | Invalid
OXA-23-like	Detected | Not detected | Not tested | Invalid
OXA-24/40-like	Detected | Not detected | Not tested | Invalid
OXA-58-like	Detected | Not detected | Not tested | Invalid
OXA-235-like	Detected | Not detected | Not tested | Invalid
Other, specify	Detected | Not detected | Not tested | Invalid

Clinical Lab Specimen ID (unique isolate No.): | Bureau of Labs Specimen ID: CL21-203398 | WGS Accession ID:

Tips for CPO Reporting

1. **Review the MDSS case information provided**
   - Person History tab may provide a list of prior reports
   - Notes tab may show lab reports attached
   - Lab Reports tab shows electronic reports and any manual lab entries
2. **Confirm the organism identification**
   - Enterobacterales organisms, *P. aeruginosa*, *Acinetobacter* spp.
   - Enterobacterales is an order of different types (genus) of bacteria which include *Escherichia*, *Klebsiella*, *Enterobacter*, *Salmonella*, *Shigella*, *Citrobacter* and *Yersinia* commonly, along with others.
3. **Review carbapenem Susceptibility testing MIC values**
   - Carbapenem-resistant Enterobacterales: Doripenem, imipenem, or meropenem ≥ 4 µg/ml; or ertapenem ≥ 2 µg/ml
   - Carbapenem-resistant *Pseudomonas aeruginosa*: MIC of ≥ 8 µg/mL to doripenem, imipenem, or meropenem AND an MIC of ≥ 16 µg/mL to cefepime OR ceftazidime
   - Carbapenem-resistant *Acinetobacter* spp.: MIC of ≥ 8 µg/mL for doripenem, imipenem, or meropenem
   - If there are no MIC values reported (e.g., “Resistant”) or no carbapenems reported in MDSS, call the laboratory and ask to speak to a bench technologist
   - If there are only MIC values reported, ensure isolate is submitted to BOL for confirmatory testing; if isolate was submitted, wait 7 days from submission date to check for electronic BOL lab report
4. **Check for phenotypic carbapenemase testing**
   - ‘Carbapenemase positive’ or ‘Carbapenemase negative’
   - Confirm the method used: mCIM, CarbaNP, MBL test, etc.
5. **Check for molecular carbapenemase testing for resistance mechanisms**
   - KPC, NDM, OXA-48, VIM, IMP “Detected” or “Not Detected”
   - Confirm the method used: PCR, Cepheid, etc. (BOL typically uses Cepheid Xpert Carba-R PCR)

CPO Case Status/Classification

1. **Confirmed CPO**
   - ✓ Any Enterobacterales*, P. aeruginosa, Acinetobacter* spp. organism or no organism recovered from a molecular carbapenemase screening specimen
   - ✓ Positive phenotypic test (e.g., mCIM, Carba NP, etc.) **OR**
   - ✓ Positive molecular test (e.g., PCR, Cepheid Xpert, etc.) – carbapenem resistance mechanism detected: KPC, NDM, VIM, IMP, OXA-48, etc. OR
   - ✓ Detection of carbapenemase gene by next generation sequencing (NGS)

2. **No Suspect or Probable case classification**

3. **Not a Case**
   - ✓Organism not Enterobacterales*, P. aeruginosa, Acinetobacter* spp.
   - ✓Negative for phenotypic and molecular tests, if conducted, regardless of MIC.

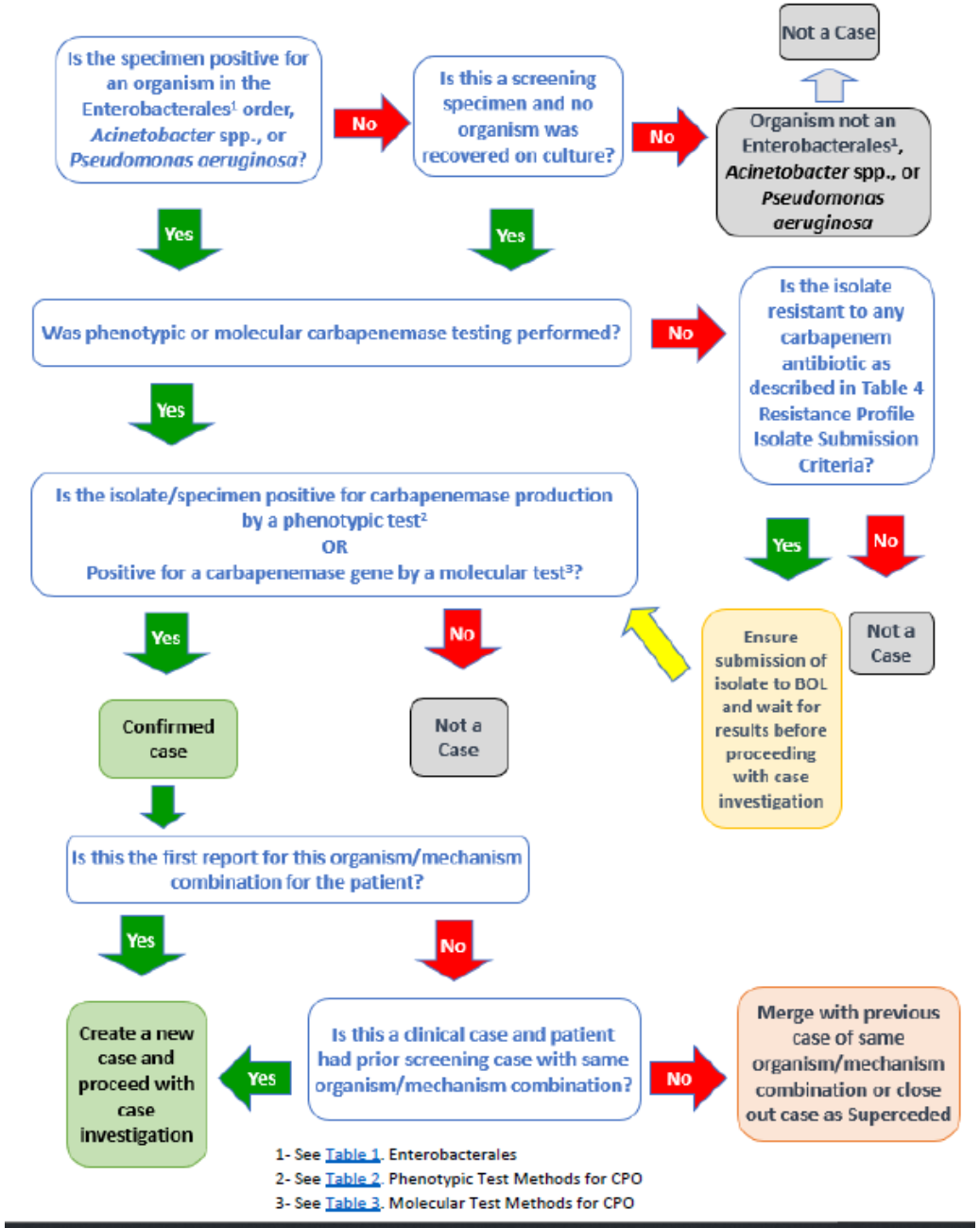
CDC/CSTE Case definition: [Carbapenemase-Producing Organisms (CPO)| CDC]

CPO Case Classification Flowchart

[CPO-Reporting-and-Investigation-Guide-2024-01-16-2024.pdf (michigan.gov)]

CPO Case Reporting and Investigation Guidance

Appendix A: MDSS Reporting and Case Status/Classification Flowchart



MDHHS BOL ELR Lab Report Interpretation – Confirmed CPO

Lab Results

Report Date	Test Name	Reported Test Name/Test Result		Specimen	Collection Date
(mm/dd/yyyy)					*(mm/dd/yyyy)*
01/06/2021	Culture Results	Bacteria identified/null	Klebsiella pneumoniae///	Other	12/20/2020
01/06/2021	Antimicrobial Susceptibility Results	Doripenem/null Ertapenem/null Imipenem/null Meropenem/null	///> 2 ///> 4 ///> 8 ///> 8		12/20/2020
01/06/2021	Modified Carbapenem Inactivation Method	Carbapenemase/null	Positive///		12/20/2020
		bla(KPC) gene/null	KPC (bla-KPC) gene DNA Not Detected///		
		Bacterial carbapenem resistance blaNDM gene/null	NDM-1 (bla-NDM-1) gene DNA Detected///		
01/06/2021	PCR Result	Bacterial carbapenem resistance blaOXA-48-like gen/null Bacterial carbapenem resistance blaVIM gene/null	OXA-48 (bla-OXA-48 like) gene DNA Not Detected/// VIM (bla-VIM) gene DNA Not Detected///		12/20/2020
01/06/2021	IMP PCR Result	Bacterial carbapenem resistance blaIMP gene/null	IMP (bla-IMP) gene DNA Not Detected///		12/20/2020
01/06/2021	Carbapenem resistance genes	Carbapenem resistance genes/ARC	Klebsiella pneumoniae///		12/20/2020
01/05/2021	Culture Results	Bacteria identified/	Klebsiella pneumoniae///	Other	12/20/2020
01/05/2021	PCR Result	bla(KPC) gene/ Bacterial carbapenem resistance blaNDM gene/ Bacterial carbapenem resistance blaOXA-48-like gen/ Bacterial carbapenem resistance blaVIM gene/	KPC (bla-KPC) gene DNA Not Detected/// NDM-1 (bla-NDM-1) gene DNA Detected/// OXA-48 (bla-OXA-48 like) gene DNA Not Detected/// VIM (bla-VIM) gene DNA Not Detected///		12/20/2020

Antimicrobial Resistance Confirmation (ARC)

Gram Stain

Gram negative bacilli

Culture Results

Confirmed Identification by MALDI-TOF - Klebsiella pneumoniae

Antimicrobial Susceptibility Results

	Klebsiella pneumoniae	
	MIC - Interpretation	
Aztreonam	>16	R
Cefepime	>16	R

Modified Carbapenem Inactivation Method

Positive

Modified Carbapenem Inactivation Method (mCIM) screen positive - this isolate demonstrates carbapenemase production. The clinical efficacy of the carbapenems has not been established for treating infections caused by Enterobacteriaceae and Pseudomonas aeruginosa that test carbapenem susceptible but demonstrate carbapenemase production in vitro. ISOLATES THAT ARE mCIM POSITIVE SHOULD BE CONSIDERED RESISTANT TO ALL CARBAPENEMS REGARDLESS OF MIC. MIC REPORTED FOR EPIDEMIOLOGIC PURPOSES ONLY.

PCR Result

KPC (bla-KPC) gene DNA Not Detected

NDM-1 (bla-NDM-1) gene DNA Detected

IMP PCR Result

IMP (bla-IMP) gene DNA Not Detected

16S rRNA Sequencing, PCR, and MALDI-TOF tests were developed and their performance characteristics determined by the Michigan Department of Health and Human Services (MDHHS). They have not been cleared or approved by the U.S. Food and Drug Administration (FDA). The FDA has determined that such clearance or approval is not necessary if performance characteristics are verified at the testing laboratory.

Initial screening for carbapenemase genes performed using Cepheid GeneXpert which has been FDA approved for this testing.

MDHHS BOL ELR Lab Report

Interpretation – Not a Case, CPO

Date Collected	07/22/2021	**Patient Last Name**	[redacted]
Time Collected	1014	**Patient First Name**	[redacted]
Date Received	07/29/2021	**Patient DOB**	[redacted]
Specimen Type	SPUTUM	**Submitter Patient ID**	[redacted]
		Gender	[redacted]
		Physician	[redacted]
		Submitter Identifier	P51690
		Reason for Test	DIAGNOSIS

TEST RESULTS

Antimicrobial Resistance Confirmation (ARC)

Gram Stain

Direct Gram Stain Not Done

Culture Results

Confirmed Identification by MALDI-TOF - Enterobacter cloacae complex

Modified Carbapenem Inactivation Method

Negative

Modified Carbapenem Inactivation Method (mCIM) screen negative - not all carbapenemase-producing isolates of Enterobacteriaceae and Pseudomonas aeruginosa are mCIM positive.

16S rRNA Sequencing, PCR, and MALDI-TOF tests were developed and their performance characteristics determined by the Michigan Department of Health and Human Services (MDHHS). They have not been cleared or approved by the U.S. Food and Drug Administration (FDA). The FDA has determined that such clearance or approval is not necessary if performance characteristics are verified at the testing laboratory.

Initial screening for carbapenemase genes performed using Cepheid GeneXpert which has been FDA approved for this testing.

Lab Reports Help

Date Received	Collection Date	Test Name (* Case Associated)	Result	Electronic	
08/11/2021	07/22/2021	Culture Results	Enterobacter cloacae complex	Yes	View
08/11/2021	07/22/2021	Modified Carbapenem Inactivation Method	Negative	Yes	View
08/11/2021	07/22/2021	Carbapenem resistance genes	Enterobacter cloacae complex	Yes	View

No Carbapenem resistance genes tested because mCIM is negative.
Result shows the Culture Results - organism identification

CPO Case Counting: Duplicate Report?

If a person is first classified as a clinical case, and later screening reports the **same organism/carbapenemase combination**, they are counted only once.

Scenario 1:

Laboratory Results	Interpretation	Action
Sputum culture 1/12/2023 KPC+ Klebsiella pneumoniae	New Confirmed CP-CRE case for Patient A, **case #1**	Report as a Confirmed clinical case Organism: K. pneumoniae Gene: KPC
Rectal swab 2/13/2023 KPC+ by PCR KPC+ Klebsiella pneumoniae by subsequent culture	Positive screening for **same organism/mechanism as case #1,** initial clinical case. **Not a new case for Patient A.**	Enter new lab info in the Lab Reports tab and Merge with case #1 or close out as Superceded

CPO Case Counting, con't

A person first classified as a screening case can be later counted as a clinical case with the same organism/carbapenemase combination. **This is the only scenario that the same organism/carbapenemase combination can be counted twice for the same person.**

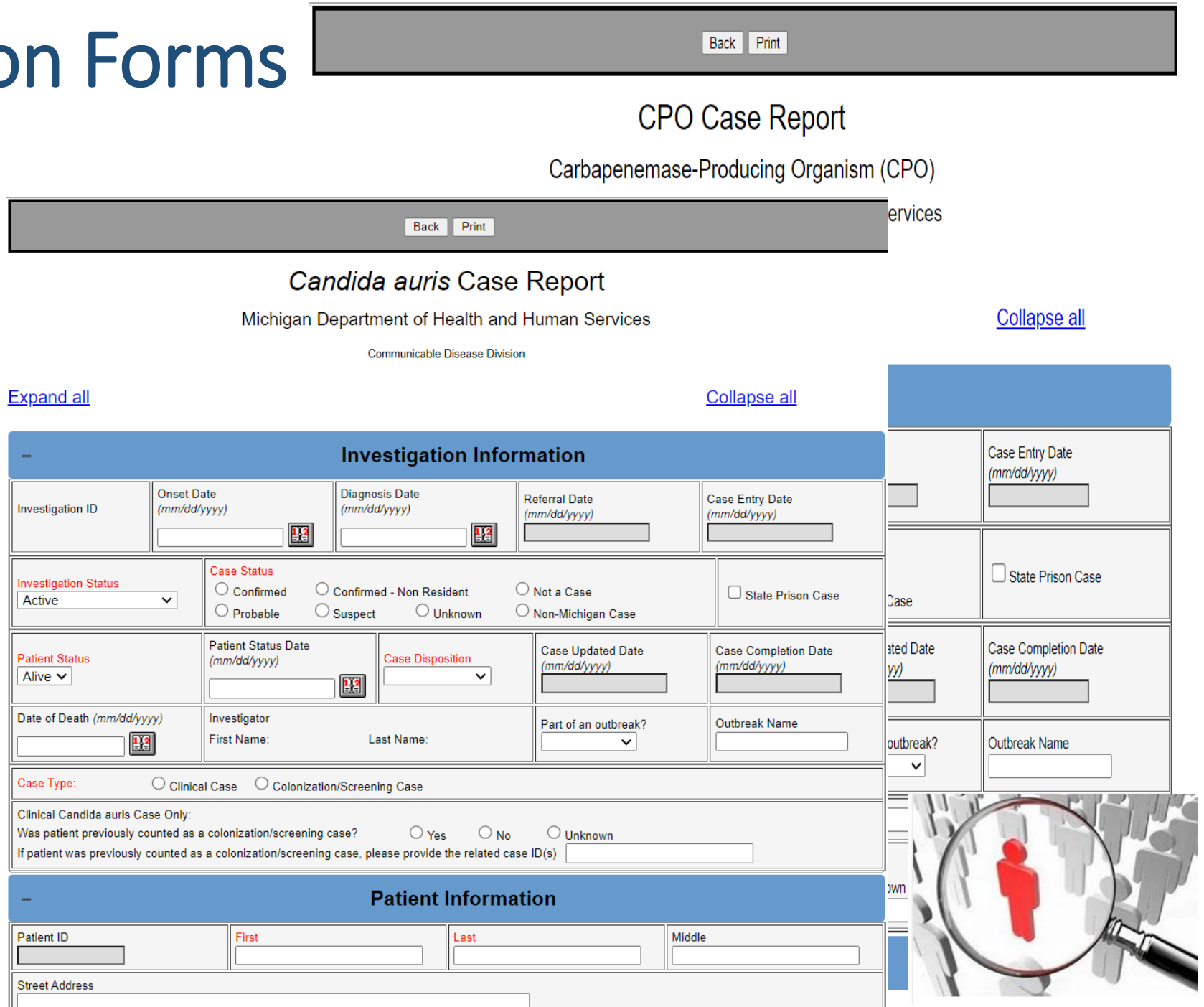
Scenario 2:

Laboratory Results	Interpretation →	Action
Rectal swab 1/10/2023 KPC+ Escherichia coli	New Confirmed CP-CRE **case #1**	Report as a Confirmed Screening Case Organism: E. coli Gene: KPC
Blood culture 2/12/2023 KPC+ Escherichia coli	Positive clinical specimen for same organism/carbapenemase as case #1. New Confirmed CP-CRE **case #2**	Report as a Confirmed Clinical Case Organism: E. coli Gene: KPC

Case Investigation Forms

"Case Report Form (CRF)" or "Case Detail Form", or "Case Investigation Form"

- **Sections**
  - Investigation Information
  - Patient Information
  - Demographics
  - Referral Information
  - Laboratory Testing and Microbiology Information
  - Clinical Information
  - Other Information
  - Case Notes
  - Lab Results



Case Walk and Infection Prevention

Electronic lab reports from BOL or Facility

Monitors in the back or assists as needed, depending on the case.

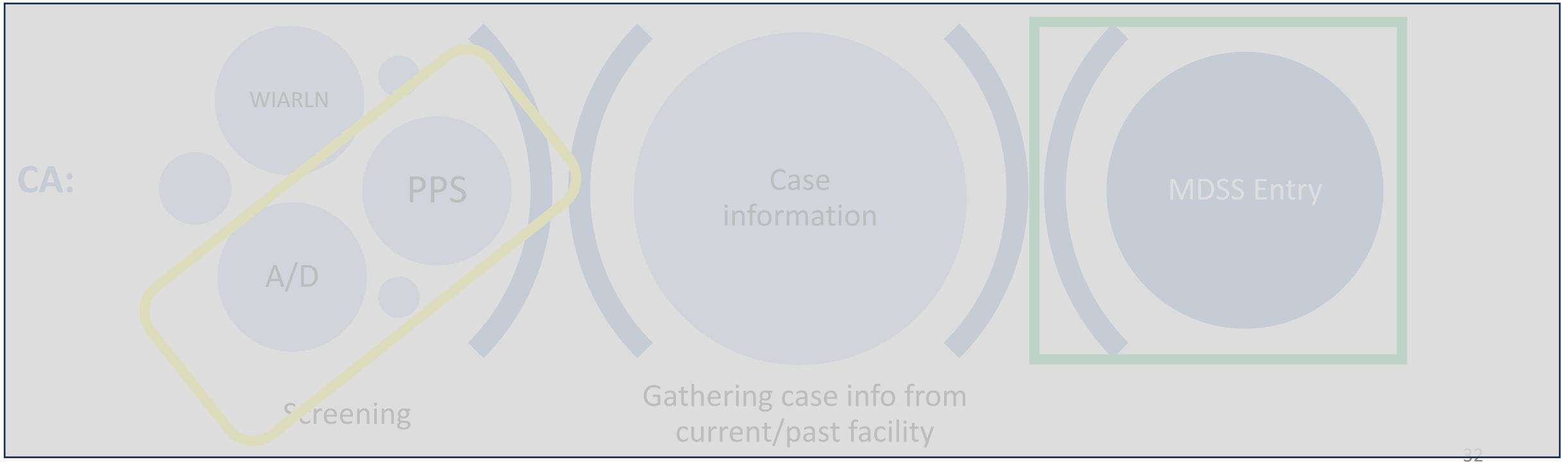
CPOs:

LHD investigate cases that pop up on their radar

LHD investigate and close as appropriate.

MDSS:

CA:

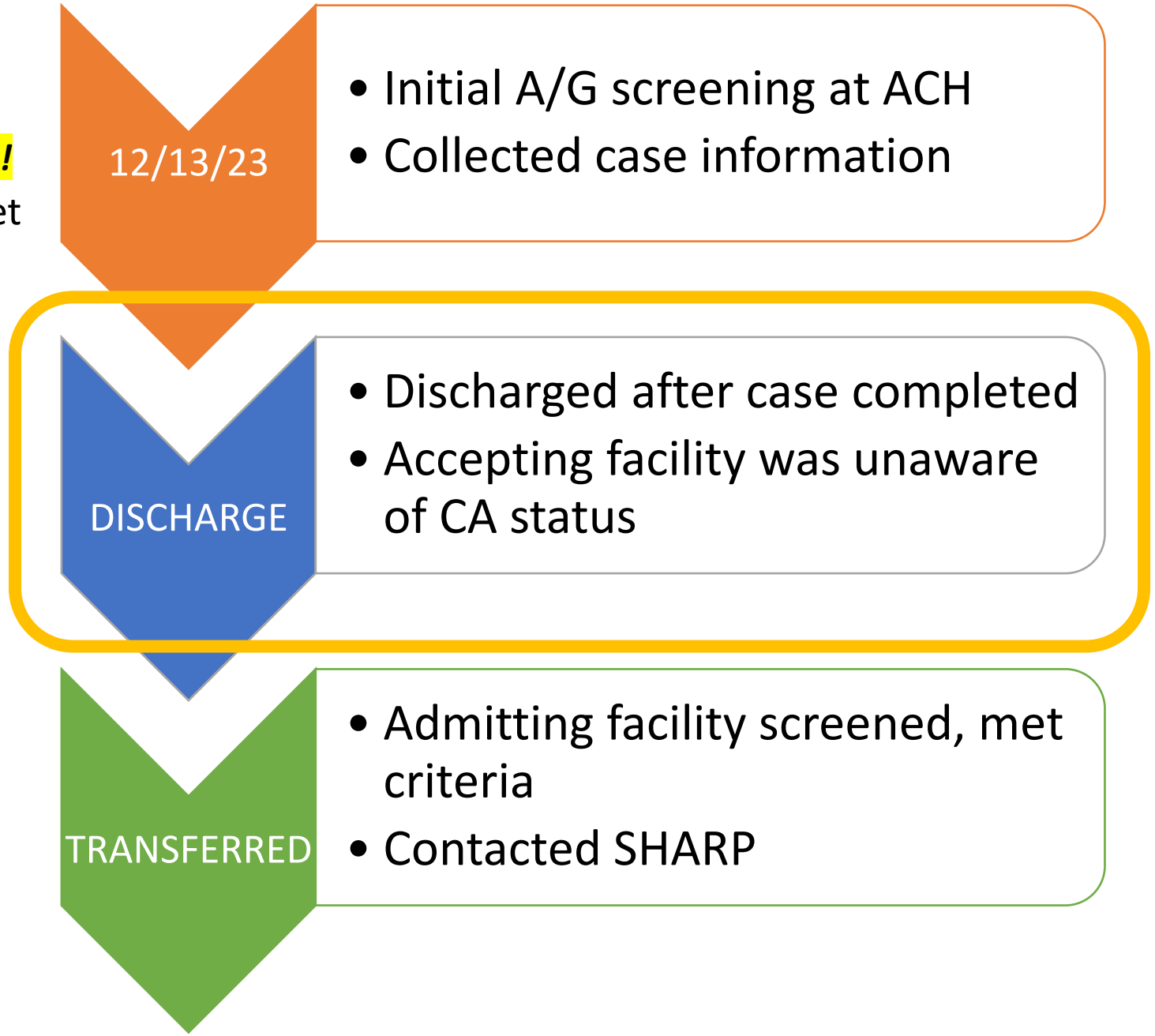


Case Walk

1. Call from **facility #1**
    1. **Case Identified – *but a previous case, phew!***
    2. Collect case information, provide IPC, set up PPS
    3. Identified transferring facility

3. Call **facility #2**
    1. Left message
    2. Return call, left message
    3. Return call, collect case information, provide education/IPC
        1. Facility was **UNAWARE** of status
        2. Identify need for PPS
        3. Identify a 3rd facility within 30-day window

4. Call **facility #3**
    1. Facility was aware of CA status, pt in precautions, proper cleaner was being used
    2. Declined PPS



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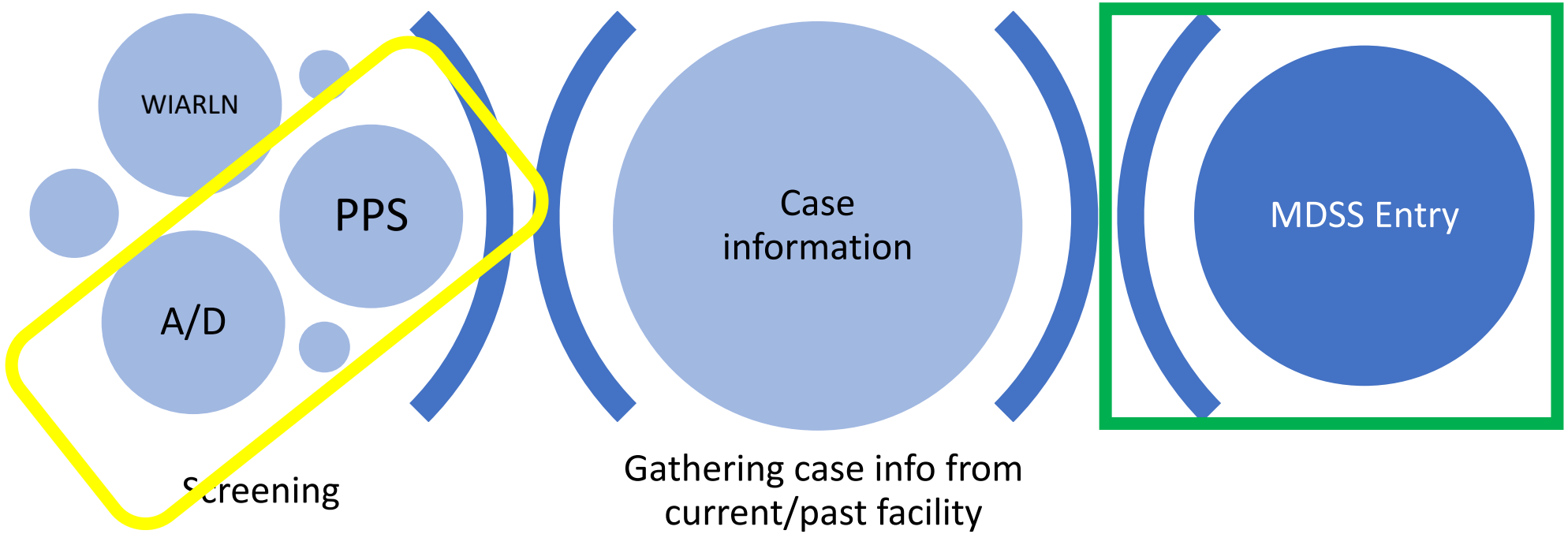


Screening

Gathering case info from current/past facility

MDSS

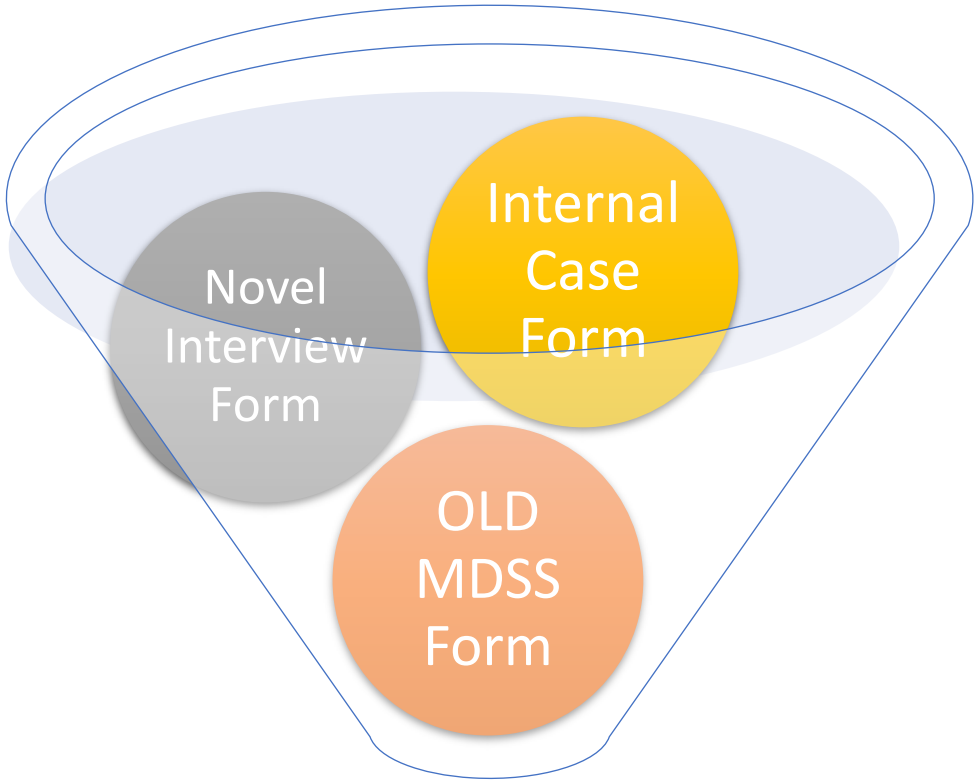
- ONE -- ACH, LTACH, SNF
- CP date
- Medical Hx
- L/D/T
- Procedures

Internal Case Form

- Multiple -- ACH, LTACH, SNF
- Multiple CP dates
- Medical Hx.
- Dialysis Status
- L/D/T
- Procedures
- Wounds
- Roommates
- Outpatient settings
- Bed History
- Other CA Screenings

Adjustments to MDSS

GOAL – to collect and document more complete case investigations



New MDSS Case Investigation Form

2/23/2024

NEW Case Form

- Multiple Admissions -- ACH, LTACH, SNF
- Multiple CP dates for each admission
- Medical History
- Dialysis Status & locations
- Lines/Drains/Tubes
- Procedures
- Roommates for EACH location
- Outpatient settings
- Bed Trace History for each admission
- Heath care Services and Shared Resources

Needed Case Information

*Leave a case note

History & Physical

Demographic Page

Positive Lab Report (if applicable)

Discharge note (if applicable)

Current ID note (if applicable)

Pt Name **DOB**

*** Please also send **H&P, updated progress note, and Demographic/face sheet** along with this completed form*

Admitted on **Admitted from**

Discharged on **Discharged to**

Bed History (room numbers, dates in each room)

Roommates: Name/DOB/location now?

Procedures (Date/Name)

Precautions in place-- type & dates

HD? **Yes or No** **How often?**

Pertinant Medical History

COPD?
DM?
Cancer? Hx or current? Where?
Renal failure/ESRD ?
Cardiovascular?
Transplant?

MDROs?

Lines/Drains/Tubes (date range/name)

PEG
TRACH
VENT
FOLEY
Central Line
Midline
HD catheter

Cultures (dates/results)

Wounds (location/stage/draining?)

Antifungals (name/dose/route/date range (if possible)

Working Together

- Collect and upload case information
- Start entering on the new MDSS case investigation form
- Leave notes to MDHHS along the way
- EDRS – complete and close

- **MDHHS** will document when IPC recs or screening recs were provided and case is in “review”
- **MDHHS** will also fill-in/complete case investigation form

Resources

Patient/Resident Transfers

- **As with any MDRO,** decisions to transfer a patient/resident from one level of care to another should be based on:
  - Clinical criteria
  - Ability of the accepting facility to provide the appropriate level of care
  - **Not** on the presence or absence of *C. auris* infection or colonization

All facilities need to be prepared to implement setting-appropriate precautions

Infection Prevention Recommendations:

Hand Hygiene

- ABHS
- Location of ABHS
- Audits

PPE

- Gowns and Gloves
- High-contact resident care
  - SNF: CP or EBP
  - ACH: CP

EVS

- EPA List P cleaner/ disinfectant
- Cleaner location & frequency

Communication

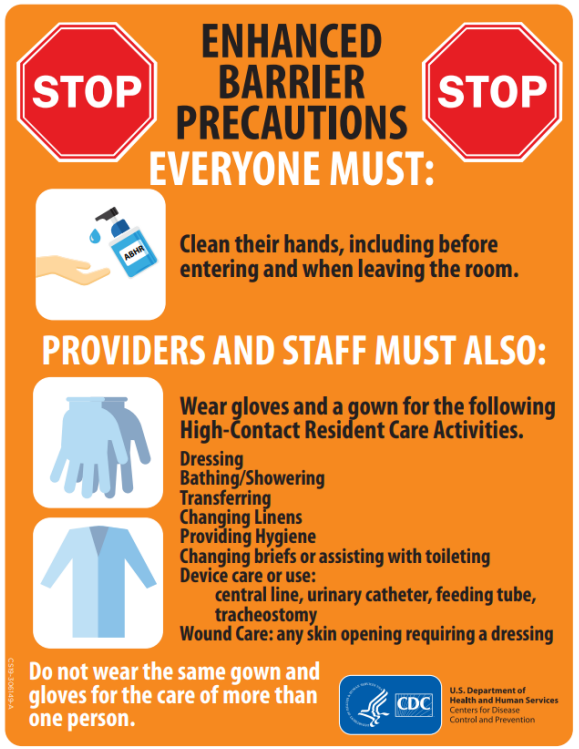
- C auris Transfer Form
- Pending labs/cultures
- Screenings
- Precautions used

List P: Antimicrobial Products Registered with EPA for Claims Against Candida Auris | US EPA
Frequently Asked Questions (FAQs) about Enhanced Barrier Precautions in Nursing Homes | HAI | CDC
Inter-Facility Infection Control Transfer Form for States Establishing HAI Prevention Collaboratives (cdc.gov)
enhanced barrier precautions final rev3 (cdc.gov)

Infection Prevention Precautions for *C. auris*

Skilled Nursing Facilities and Nursing Homes

Enhanced Barrier Precautions



- Known MDRO
- Indwelling device or wound
- Used for resident's entire length of stay

OR

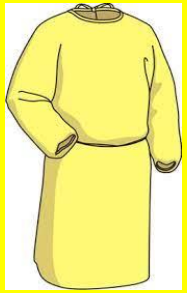
Contact Precautions

- Acute diarrhea
- Uncontained draining wounds, secretions or excretions
- Other infections (Appendix A)
- Limited to infectious period

CDC Infection Prevention for *C. auris*

Frequently Asked Questions (FAQs) about Enhanced Barrier Precautions in Nursing Homes | HAI | CDC

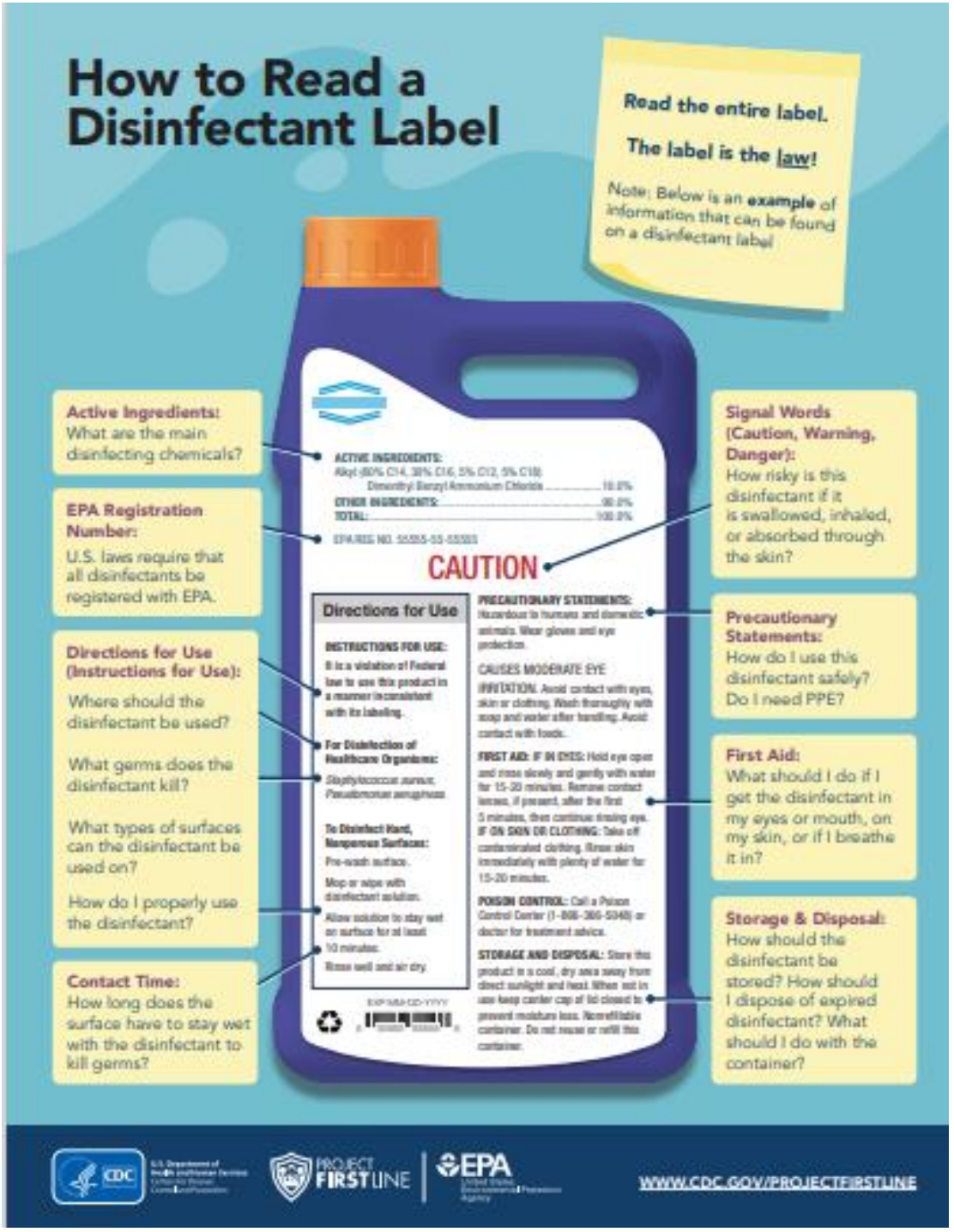
Personal Protective Equipment (PPE)

Type of Precaution	PPE	When	What Care
	 	Before high-contact resident care	• Dressing • Bathing/showering • Transferring • Providing hygiene • Changing linens • Changing briefs or assisting with toileting • Indwelling device care or use • Wound care
	 	Before any room entry	• Any care

Safe and Effective Disinfectant Use

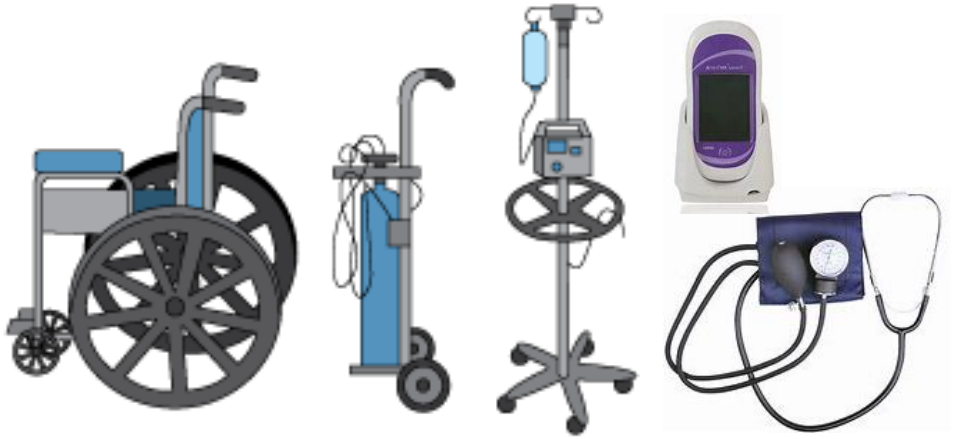
- **EPA-approved hospital-grade disinfectant →List P**
- **Read the directions**
  - What types of surfaces?
  - What precautions are needed?
- **Pre-clean** if surfaces are soiled or directions require
- Follow the **contact time**
  - time a disinfectant must remain wet on a surface to be effective

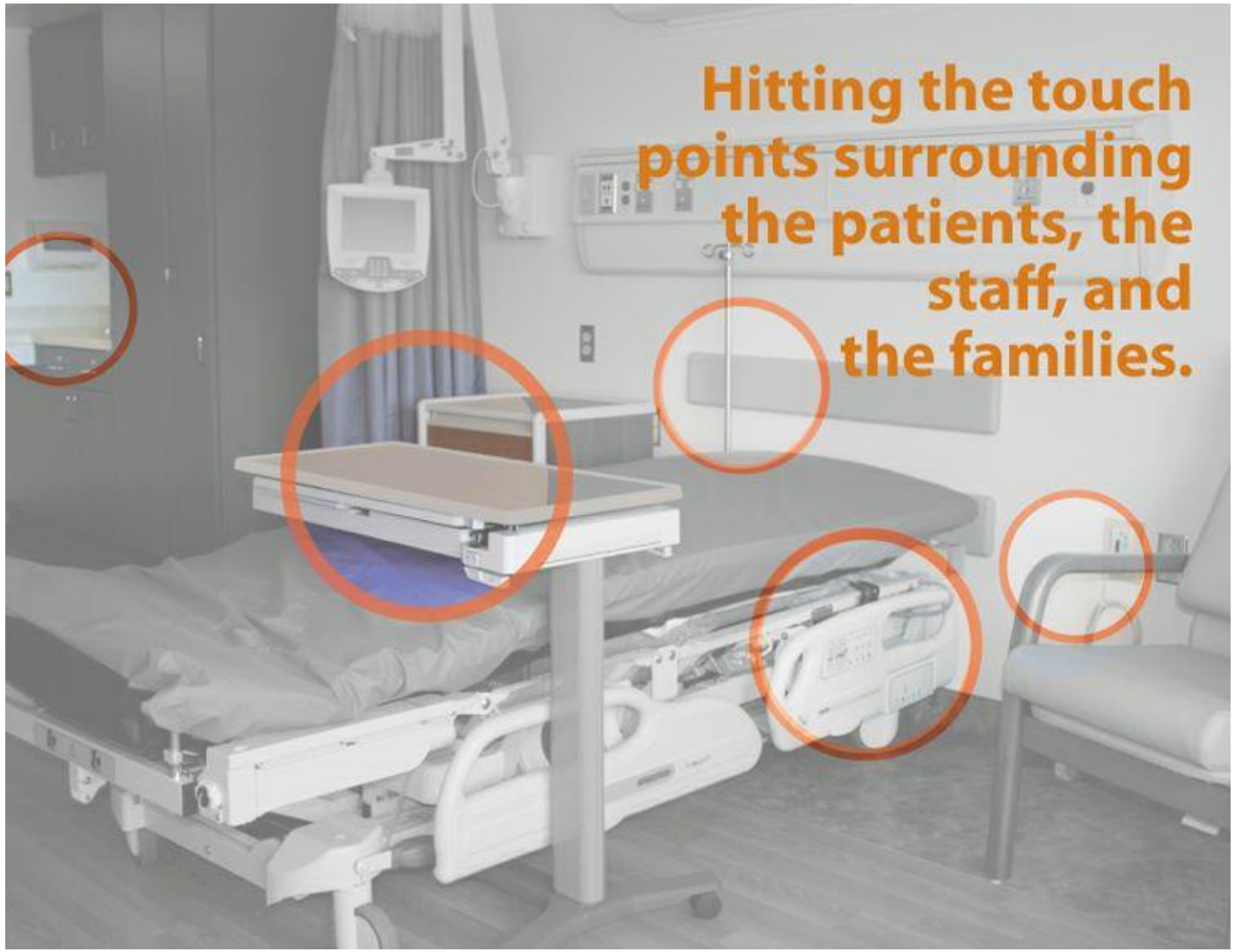
Michigan.gov/ProjectFirstline



Cleaning & Disinfection Plan for C. *auris*

- Clean C auris rooms last
- Increase cleaning frequency of high-touch surfaces
- Clean shared medical equipment





And . . . . . Screening for CA or CPO

CPO	*C. auris*
Rectal	Axilla/Groin
Supplies & Lab Req forms	
BOL/WIARLN/In-house	
UPS Shipping	FedEx Shipping

Healthcare-Associated Infections

Surveillance for Healthcare-Associated & Resistant Pathogens (SHARP) Unit

Contact Information:

Website: Michigan.gov/HAI *

Phone: **517-335-8165** (Mon. - Fri. 8am - 5pm)

Email: MDHHS-SHARP@michigan.gov

Fax: **517- 335-8263**

SHARP Staff Contact Information

*Subscribe to the SHARP Unit's Listserv