Antimicrobial Resistance Testing: Public Health Laboratory Testing Updates, and Recommendations for Isolate Submission and Reporting

California Antimicrobial Resistance Lab-Epi Alliance

October 6, 2021

California Department of Public Health Microbial Diseases Laboratory (MDL) and Healthcare-Associated Infections (HAI) Program
Objectives

• Summarize 2019-2021 MDL carbapenemase testing, *Candida* species confirmation testing, and whole genome sequencing (WGS) results.

• Provide updates on MDL and regional AR Lab Network testing capabilities for *Candida* and carbapenem-resistant organisms.

• Summarize AR testing capabilities of clinical laboratories reported via the National Healthcare Safety Network (NHSN).

• Present HAI AR case and cluster investigation data, including for recent multi-jurisdictional outbreaks.

• Review public health recommendations for AR isolate submission and reporting by laboratories, including proposed Title 17 changes.
Emerging Antimicrobial Resistance (AR) Threats

- Bacteria and fungi resistant to many or all antimicrobials tested
- Few treatment options, higher morbidity and mortality
- Uncommon in geographic area or the U.S.
- Highly transmissible within and between healthcare facilities, cause outbreaks
- Early and aggressive containment can limit spread
- Examples include *Candida auris*, carbapenemase-producing organisms
Candida auris

- Multidrug-resistant yeast
  - 90% fluconazole
  - 30% amphotericin B
  - <5% echinocandins
  - Can be resistant to all 3 antifungal classes
- Difficult to identify with standard lab methods
- Easily transmissible in the healthcare environment
- Can cause serious, invasive infections with 30-60% mortality
Carbapenem-resistant Organisms (CRO)

- **Carbapenems** are “last resort” antibiotics (doripenem, ertapenem, imipenem, meropenem)

- **Carbapenem-resistant organisms** (CRO) include:
  - Enterobacterales (CRE), e.g., *E. coli*, *Klebsiella* species
  - *Pseudomonas aeruginosa* (CRPA)
  - *Acinetobacter baumannii* (CRAB)

- **Carbapenemase** enzymes are primary mechanism for carbapenem resistance; CRO produce carbapenemases, which inactivate carbapenems, other β-lactam antibiotics.
Carbapenemase-producing Organisms (CPO)

• **Carbapenemases** include:
  • KPC, NDM, IMP, VIM, OXA (e.g., OXA-48-like, OXA-23-like)

• Many **carbapenemase genes** are on mobile genetic elements (plasmids), and can “jump” between/within species
  • E.g., NDM-producing *E. coli* → NDM-producing *A. baumannii*

• **Carbapenemase testing methods**:
  • **Phenotypic** tests for carbapenemase production
  • **Molecular/Genotypic** tests detect specific carbapenemase gene

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KPC=*Klebsiella pneumoniae* carbapenemase; NDM=New Delhi metallo-beta-lactamase; IMP=Imipenemase; VIM=Verona integron-encoded metallo-beta-lactamase; OXA=Oxacillinase
Antibiotic Resistance (AR) Lab Network

- Supports nationwide lab capacity for emerging AR pathogens
- Early detection to enable timely response

CDC Lab Network
(www.cdc.gov/drugresistance/laboratories.html)
Regional AR Lab Network Testing

- *Candida auris* colonization testing
- Non-*albicans Candida* spp. identification, antifungal susceptibility testing on isolates
- Carbapenemase colonization testing
  - *KPC, IMP, NDM, OXA-48-like, VIM* if CRE, CRPA, CRAB
  - *OXA-23-, OXA-24/40-, OXA-58-like* if CRAB
- Identification, carbapenemase and antimicrobial susceptibility testing (AST) on CRAB, CRE, CRPA isolates
- Expanded AST (highly-resistant CRE isolates)
- Targeted surveillance (CRAB, CRPA, non-*albicans Candida* isolates)

[WA AR Lab Network Test Menu](www.doh.wa.gov/ForPublicHealthandHealthcareProviders/PublicHealthLaboratories/ARLNLabTestMenu)
WA Regional AR Lab Network Lab Testing for CA*
Jan 2019 – Jul 2021

<table>
<thead>
<tr>
<th>Type</th>
<th># Positive for <em>C. auris</em> (%)</th>
<th>Total Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. auris</em> swabs</td>
<td>724 (5.6%)</td>
<td>13,009</td>
</tr>
<tr>
<td><em>Candida</em> isolates</td>
<td>272 (43%)</td>
<td>630</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th># Positive for carbapenemase (%)</th>
<th>Total Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPO swabs (including Cepheid and culture)</td>
<td>135 (3.9%)</td>
<td>3,500</td>
</tr>
<tr>
<td>CRO/CPO isolates</td>
<td>156 (26%)</td>
<td>600</td>
</tr>
<tr>
<td>CRPA</td>
<td>4 (7.7%)</td>
<td>52</td>
</tr>
<tr>
<td>CRAB</td>
<td>115 (70%)</td>
<td>165</td>
</tr>
<tr>
<td>CRE</td>
<td>37 (9.7%)</td>
<td>383</td>
</tr>
</tbody>
</table>

*Includes Pasadena and Long Beach, excludes Los Angeles local health jurisdictions
AR Testing at CDPH: Microbial Diseases Laboratory (MDL)

• Bacterial Diseases Section (BDS)
  • ID confirmation, carbapenemase testing on isolates
    • CRE, *E. coli*, *Klebsiella* and *Enterobacter* spp.
    • CRPA, non-susceptible to cefepime or ceftazidime

• Molecular Characterization Unit (MCU)
  • Whole genome sequencing (WGS) for CRE, CRPA, CRAB isolates (uncommon or outbreak-related)

• Mycobacterial, Mycotic and Parasitic Diseases Section
  • *Candida* isolate species identification and confirmation
Carbapenemase Testing at MDL
Bacterial Diseases Section (BDS)
Where to submit CRO samples

• Routine surveillance samples should be submitted to your local public health lab and subsequently forwarded to BDS as per the MDL Expanded-Carbapenemase Testing FAQ Sheet.

• If your sample is part of an outbreak investigation or other enhanced testing offered by ARL Lab Network you may be directed to submit to another AR Lab Network lab or directly for WGS here at CDPH.

Please use MDL form ‘Antimicrobial Susceptibility Testing-AST’ to submit samples for routine CRO testing. The most updated submission form and instructions can be found in our test FAQ on the MDL website. (www.cdph.ca.gov/Programs/CID/DCDC/Pages/MDLSubmissionInstructionsandForms.aspx)
What happens when MDL identifies a carbapenemase, other genes of interest?

- Results are reported back to the submitting lab and to AR Lab Network. The CDPH HAI Program is notified. Isolate may be sent for further testing at AR Lab Network regional or CDC labs as appropriate.

- If we identify a molecular-negative and phenotypic-positive isolate, the results are considered discordant. These isolates are forwarded for further testing as appropriate (AR Lab Network regional or CDC labs, or MCU for WGS).

- If you find a particular gene/pathogen that we do not routinely test for is causing problems in your facility we can usually arrange for you to submit (either through us or send directly) to AR Lab Network regional or CDC labs as appropriate.
AR Lab Network CRO Testing offered at BDS

- Workflow ‘Option 1’: *P. aeruginosa* (CRPA) and Enterobacterales (CRE) with previous genotypic testing.

MALDI=matrix assisted laser desorption ionization; mCIM=modified carbapenem inactivation method
Workflow ‘Option 2’: Enterobacterales (CRE) without previous genotypic testing and *P. aeruginosa* (CRPA) with previous phenotypic testing.

MALDI = matrix assisted laser desorption ionization; mCIM = modified carbapenem inactivation method
CRO submissions have been increasing from 2018 – Jul 2021
Workflow ‘Option 1’: *P. aeruginosa* (CRPA) and Enterobacterales (CRE) with previous genotypic testing.

MALDI=matrix assisted laser desorption ionization; mCIM=modified carbapenem inactivation method
Number of mCIM tests on CRPA done have been increasing from Jan 2019 – Jul 2021

<table>
<thead>
<tr>
<th>Year</th>
<th>% Positive by mCIM</th>
<th>Total # of isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>10</td>
<td>150</td>
</tr>
<tr>
<td>2020</td>
<td>3.5</td>
<td>200</td>
</tr>
<tr>
<td>2021</td>
<td>2.4</td>
<td>258</td>
</tr>
</tbody>
</table>
CRPA Xpert Results by Year, Jan 2019 – Jul 2021

<table>
<thead>
<tr>
<th>Year</th>
<th>Total % Positive</th>
<th>% IMP Positive</th>
<th>% NDM Positive</th>
<th>% VIM Positive</th>
<th>Total # of isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>71</td>
<td>0.0</td>
<td>0</td>
<td>71</td>
<td>14</td>
</tr>
<tr>
<td>2020</td>
<td>100</td>
<td>0.0</td>
<td>29</td>
<td>71</td>
<td>7</td>
</tr>
<tr>
<td>2021</td>
<td>100</td>
<td>9.1</td>
<td>0</td>
<td>27</td>
<td>11</td>
</tr>
</tbody>
</table>
Workflow ‘Option 2’: Enterobacterales (CRE) without previous genotypic testing and *P. aeruginosa* (CRPA) with previous phenotypic testing.

MALDI=matrix assisted laser desorption ionization; mCIM=modified carbapenem inactivation method
CRE Xpert Results by Year, Jan 2019 – Jul 2021

<table>
<thead>
<tr>
<th>Year</th>
<th>Total % Positive</th>
<th>% IMP Positive</th>
<th>% KPC Positive</th>
<th>% NDM Positive</th>
<th>% NDM/KPC Positive</th>
<th>% NDM/OXA-48 Positive</th>
<th>OXA-48 Positive</th>
<th>% VIM Positive</th>
<th>Total # of isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>55</td>
<td>0.0</td>
<td>35</td>
<td>13</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>128</td>
</tr>
<tr>
<td>2020</td>
<td>55</td>
<td>0.5</td>
<td>42</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>195</td>
</tr>
<tr>
<td>2021</td>
<td>36</td>
<td>0.9</td>
<td>20</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>110</td>
</tr>
</tbody>
</table>
CRE mCIM Results by Year, Jan 2019 – Jul 2021

<table>
<thead>
<tr>
<th>Year</th>
<th>% Positive by mCIM</th>
<th>Total # of isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>13</td>
<td>190</td>
</tr>
<tr>
<td>2020</td>
<td>13</td>
<td>176</td>
</tr>
<tr>
<td>2021</td>
<td>16</td>
<td>125</td>
</tr>
</tbody>
</table>
Whole Genome Sequencing (WGS) at MDL

• The following slides contain data from isolates sequenced by WGS at MDL.
• This is a selection of a mix of reference isolates from outbreaks and others. This is not a representative sample.
  • Includes isolates from 2017 through July 2021
• Additional testing including WGS is done at ARLN regional and CDC labs. That data is not presented here.
KPC variants from CRO 2017 – Jul 2021

![Bar Chart]

- **KPC-2**: 7 isolates
- **KPC-2/MCR-9**: 1 isolate
- **KPC-3**: 27 isolates

# of isolates vs. KPC variant
NDM variants from CRO (including CRAB) 2017 – Jul 2021

<table>
<thead>
<tr>
<th>NDM Variants</th>
<th>No. of isolates tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDM-1</td>
<td>41</td>
</tr>
<tr>
<td>NDM-1/OXA-23</td>
<td>10</td>
</tr>
<tr>
<td>NDM-1/OXA-23-2</td>
<td>8</td>
</tr>
<tr>
<td>NDM-1/OXA-23-66</td>
<td>2</td>
</tr>
<tr>
<td>NDM-5</td>
<td>41</td>
</tr>
<tr>
<td>NDM-5/OXA-181</td>
<td>2</td>
</tr>
<tr>
<td>NDM-5/OXA-232</td>
<td>3</td>
</tr>
<tr>
<td>NDM-7</td>
<td>2</td>
</tr>
<tr>
<td>NDM-7/KPC-2</td>
<td>4</td>
</tr>
</tbody>
</table>
OXA variants from CRO (including CRAB) 2017 – Jul 2021

![Bar chart showing the number of isolates tested for different OXA variants from 2017 to July 2021. The chart includes OXA-109 (12), OXA-181 (6), OXA-23 (8), OXA-232 (5), OXA-237 (1), OXA-24 (1), OXA-252 (7), OXA-65 (1), and OXA-66 (13).]
IMP and VIM variants from CRO 2017 – Jul 2021

**IMP Variants in CRO**

- IMP-62: 1 isolate

**VIM variants in CRO**

- VIM-2: 38 isolates
- VIM-2/OXA-488: 1 isolate
Other Carbapenemases and Genes of interest to ARLN Found in CA

- Isolates with the SME and IMI carbapenemase genes.
- IMP variants that are not detected by Xpert (IMP-27).
- OXA variants that are not detected by Xpert.
- Isolates that test KPC+ by molecular tests but are phenotypically sensitive to carbapenems.
- We are in the process of validating a new PCR test (Streck ARM-D Kits) which will expand our capability to detect IMP and OXA variants.

Other genes of interest:
- detected MCR-9 and 10 variants in WGS data – not recommended for routine screening but still reported to AR Lab Network when we identify.
  - We follow ‘Alert’ reporting guidance that is updated by AR Lab Network periodically. We can provide this to anyone who is interested.
New Tests in 2022

• Sensititre GNX2F panel for CRO organisms
• Etest for *Neisseria gonorrhoeae*

BDS works on many other organisms in addition to CRO and routinely submits isolates/specimens for testing at CDC and other AR Lab Network labs. Please contact us if there are other tests and services you would like access to.
Whole Genome Sequencing at MDL
Molecular Characterization Unit (MCU)
Whole Genome Sequencing (WGS)

- WGS on non-PulseNet organisms, HAI organisms, Mycobacterium, etc.
- HAI organisms include:
  - CPO (n=259): *Acinetobacter baumannii*, *Enterobacter cloacae*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*
  - Non-CPO (n=191): *Serratia marcescens*, *Staphylococcus aureus*, *Corynebacterium striatum*, *Stenotrophomonas maltophilia*
WGS Summary of AR organisms, Nov 2019 – Jul 2021 (n=259)

- **Other**: 3 (Associated), 6 (WGS)
- **Enterobacter**: 3 (Associated), 15 (WGS)
- **E.coli**: 1 (Associated), 45 (WGS)
- **Pseudomonas**: 10 (WGS), 49 (WGS)
- **Klebsiella**: 4 (Associated), 57 (WGS)
- **Acinetobacter**: 9 (Associated), 87 (WGS)
<table>
<thead>
<tr>
<th>Organism</th>
<th>WGS performed</th>
<th>Genes detected</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acinetobacter</td>
<td>87</td>
<td>blaNDM-1</td>
<td>blaOXA-109, blaOXA-252, blaOXA-23, blaOXA-66, blaOXA-99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Klebsiella</td>
<td>57</td>
<td>blaNDM-1, blaNDM-5, blaNDM-7</td>
<td>blaOXA-1, blaOXA-9, blaOXA-232, blaOXA-515, blaOXA-181, blaOXA-252; blaKPC-2, blaKPC-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>49</td>
<td>blaNDM-1</td>
<td>blaOXA-50, blaOXA-488, blaOXA-396</td>
<td>blaVIM-2</td>
<td></td>
</tr>
<tr>
<td>E.coli</td>
<td>45</td>
<td>blaNDM-1, blaNDM-4, blaNDM-5, blaNDM-7</td>
<td>blaOXA-1, blaOXA-9, blaOXA-181</td>
<td>blaKPC-2, blaKPC-3</td>
<td></td>
</tr>
<tr>
<td>Enterobacter</td>
<td>15</td>
<td>blaNDM-7</td>
<td></td>
<td>blaKPC-2</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>blaNDM-1</td>
<td>blaOXA-1, blaOXA-10, blaOXA-181</td>
<td>blaKPC-2</td>
<td></td>
</tr>
</tbody>
</table>
WGS Submission Requirements

• Isolates from patients being investigated as part of an outbreak or containing novel resistance mechanisms
• Approval required by HAI Program or MCU
• Isolates should be submitted with completed submission form (WGSR form for WGS) (www.cdph.ca.gov/Programs/CID/DCDC/Pages/MDLSsubmissionInstructionsandForms.aspx)
• Pure isolates are accepted; mixed cultures will not be tested
• Isolates must be identified by the submitter
WGS Report

• Reports are used for epidemiology/surveillance purpose and by infection control program for outbreak investigations
• Official report is provided
• Report includes:
  • *In-silico* Multi-Locus Sequence Typing information
  • Predicted AR genes
  • Phylogenetic tree and single-nucleotide polymorphisms (SNP) matrix to compare isolates for relatedness
Candida Testing at MDL Mycobacterial, Mycotic and Parasitic Diseases Section
Current testing capacities

Yeast identification, including *Candida* spp.

- **Methods**: MALDI-TOF MS, Sanger sequencing (18S rRNA and ITS regions)
- **Current status**: validated in 2016
- **Number of isolates tested per month**: ~20-35
- **Number of facilities sending isolates per month**: 4-5 county laboratories (representing unknown number of clinical facilities)

**Referral:**

All *Candida* spp. except for *C. albicans* sent to WA AR Lab Network lab for antifungal susceptibility testing.
Candida Isolate Testing, Sep 2019 – Jul 2021

<table>
<thead>
<tr>
<th>Species Identified</th>
<th># Isolates</th>
<th>% Isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Candida auris</td>
<td>193</td>
<td>48.37%</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>57</td>
<td>14.29%</td>
</tr>
<tr>
<td>Candida glabrata</td>
<td>42</td>
<td>10.53%</td>
</tr>
<tr>
<td>Candida parapsilosis*</td>
<td>41</td>
<td>10.28%</td>
</tr>
<tr>
<td>Candida tropicalis</td>
<td>25</td>
<td>6.27%</td>
</tr>
<tr>
<td>Candida lusitaniae*</td>
<td>9</td>
<td>2.26%</td>
</tr>
<tr>
<td>Candida dubliniensis</td>
<td>8</td>
<td>2.01%</td>
</tr>
<tr>
<td>Candida orthopsilosis</td>
<td>7</td>
<td>1.75%</td>
</tr>
<tr>
<td>Candida krusei</td>
<td>4</td>
<td>1.00%</td>
</tr>
<tr>
<td>Candida kefyr</td>
<td>2</td>
<td>0.50%</td>
</tr>
<tr>
<td>Candida blankii</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida bracarensis</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida catenulata</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida duobushaemulonii*</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida fermentati</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida lambica</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida metapsilosis</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida oleophila</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida palmioleophila</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida sake*</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Candida vulturna</td>
<td>1</td>
<td>0.25%</td>
</tr>
</tbody>
</table>

Total Candida Isolates Tested: 399

*Candida auris can be misidentified as these species when using traditional phenotypic methods for yeast identification*
Candida Isolate Testing, Sep 2019 – Jul 2021

# Candida Isolates

<table>
<thead>
<tr>
<th>Month</th>
<th>Non C. auris Candida spp.</th>
<th>Candida auris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep-19</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Oct-19</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Nov-19</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Dec-19</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Jan-20</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Feb-20</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Mar-20</td>
<td>5</td>
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</tr>
<tr>
<td>Apr-20</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>May-20</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Jun-20</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Jul-20</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Aug-20</td>
<td>15</td>
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<td>Sep-20</td>
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<td>Oct-20</td>
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<td>Nov-20</td>
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<td>Dec-20</td>
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<td>Jan-21</td>
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<td>Mar-21</td>
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<tr>
<td>Apr-21</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>May-21</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>Jun-21</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Jul-21</td>
<td>6</td>
<td>6</td>
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</tbody>
</table>
### Candida Isolate Testing, Sep 2019 – Jul 2021

<table>
<thead>
<tr>
<th>Submitter</th>
<th># Isolates</th>
<th>% Isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange</td>
<td>196</td>
<td>49.12%</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>112</td>
<td>28.07%</td>
</tr>
<tr>
<td>Monterey</td>
<td>48</td>
<td>12.03%</td>
</tr>
<tr>
<td>Alameda</td>
<td>15</td>
<td>3.76%</td>
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<tr>
<td>Sacramento</td>
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<td>2.76%</td>
</tr>
<tr>
<td>Butte</td>
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</tr>
<tr>
<td>San Bernardino</td>
<td>3</td>
<td>0.75%</td>
</tr>
<tr>
<td>Ventura</td>
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<td>0.75%</td>
</tr>
<tr>
<td>Napa-Solano-Yolo-Marin-Mendocino</td>
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<td>0.50%</td>
</tr>
<tr>
<td>San Mateo</td>
<td>2</td>
<td>0.50%</td>
</tr>
<tr>
<td>Long Beach</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>San Diego</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Sonoma</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>TPMG Regional Laboratory</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td><strong>Total Candida Isolates Tested</strong></td>
<td><strong>399</strong></td>
<td></td>
</tr>
</tbody>
</table>
Upcoming Testing

*Candida auris* colonization screening

- **Methods**: BD-Max PCR (Bio-GX), CHROMagar, MALDI-TOF MS
- **Current status**: in process of validation (new staff recruited in the past month, specimens received from WA state public health lab, validation plan written, staff training in process)
- **Expected number of isolates tested per month**: ~300 (more with additional funding and staffing)
- **Expected timeline**: Plan to start receiving swabs by end of 2021
MDL Testing and Submission Instructions

• For more information on testing and submission instructions please visit the [MDL website and test menu](https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/MDLServicesAndTestCatalog.aspx)
AR Cases Reported to CDPH, January 2019 – July 2021
Antimicrobial-Resistant (AR) Cases

- *Candida auris*
- Carbapenemase-producing organisms (CPO)
  - CRAB, CRE, CRPA
- Incident colonization/screening and clinical cases
  - Clinical *C. auris* case may also be counted as prior screening case
- All local health jurisdictions *excluding* Los Angeles
- January 1, 2019 – July 31, 2021
- Only include cases reported to CDPH
Percent Clinical Isolate vs. Colonization/Screening Cases by AR Organism (n=1735)

- **Candida auris**: 170 clinical, 945 screening
- **CRAB**: 165 clinical, 58 screening
- **CRPA**: 56 clinical, 19 screening
- **CRE**: 233 clinical, 26 screening
- **None/Unknown**: 3 clinical, 60 screening
**C. auris** Cases by Testing Lab* (n=1115)

*All clinical isolates tested at MDL are forwarded to Regional AR Lab Network for further characterization*
CPO Cases by Testing Lab (n=620)

- Clinical: 59%
- Screening: 2%

Legend:
- Other Lab
- Regional AR Lab Network
- MDL
CPO Cases by Resistance Mechanism (n=620)
Dual Mechanism CPO Cases (n=17)
mCIM-positive only Cases (n=27)

- **P. aeruginosa**: 8
- **S. marcescens**: 1
- **Enterobacter spp.**: 9
- **Klebsiella spp.**: 9
CPO Cases by CA Local Health Officer Region
AR Outbreaks
AR Cases by Pathogen: Outbreak vs. Non-Outbreak

![Bar chart showing AR cases by pathogen in outbreak vs. non-outbreak scenarios. The chart indicates 86% of cases in the outbreak scenario, primarily due to Candida auris.](chart.png)
Number of Outbreaks by Pathogen, Year (n=92)
C. auris resurgence during COVID-19 pandemic
C. auris Cases by LHJ through Sep 2021 (N=1960)
C. auris Screening vs. Clinical Cases

- Screening: 83%
- Screening then Clinical: 10%
- Clinical: 7%

Bar chart showing clinical specimen types:
- Blood: 35%
- Urine: 22%
- Respiratory: 21%
- Wound: 13%
- Other/Unknown: 7%
- Tissue: 2%
- Abscess: 0.3%

Number of reported cases (n=329)
NDM CRAB epi curve by LHJ through Sep 2021 (N=165)
NDM CRAB

Pan-Nonsusceptible (NS)
- Non-Pan-NS: 93%
- Pan-NS: 7%

Case Type
- Clinical: 67%
- Screening: 33%

Facility Type
- SNF: 41%
- ACH: 37%
- vSNF: 16%
- LTACH: 6%

ACH=acute care hospital; LTACH=long-term ACH; SNF=skilled nursing facility; vSNF=ventilator-equipped SNF
AR Lab Network Targeted Surveillance

• Access to advanced lab testing and resources
• Free shipping
• Enables early detection of novel organisms/resistance mechanisms (e.g., C. auris, NDM CRAB)
• CRAB, CRPA, non-\textit{albicans} \textit{Candida}

• \textbf{Targeted surveillance flyer} (PDF)
  (www.cdph.ca.gov/Programs/CHCQ/HAI/CDPH\%20Document\%20Library/CDPH_ARLN_TargetedSurveillanceDescription_052521.pdf)

• Contact \texttt{HAIProgram@cdph.ca.gov} for more information
National Healthcare Safety Network (NHSN) Data: AR Testing Capacity
Laboratory Practices to Identify Antimicrobial Resistant Pathogens

- California acute care hospitals annually complete the NHSN Annual Survey
  - Infection Control Practices
  - Microbiology Methods
  - Antimicrobial Stewardship Policies
- CDC uses information to track hospital characteristics and practices over time
*Respondents indicate they speciate Candida only for specific wounds or tissue specimens

[Source](www.cdc.gov/nhsn/forms/57.103_pshospsurv_blank.pdf)
Type of Carbapenemase Test by Year, 2014 – 2020

Laboratory Performs a Test for Presence of Carbapenemase

- Test for Presence Only
- Carbapenemase Identification
- No Carbapenemase Tests
Access to Carbapenemase Testing Among 365 Short Stay & Long-Term Acute Care Hospitals, 2020

*Facilities report using a lab with phenotypic test only
**Facilities report using a lab with PCR and/or a commercial molecular test

NHSN Annual Survey, 2020 (PDF)
(www.cdc.gov/nhsn/forms/57.103_pshospsurv_blank.pdf)
### Types of Reported Carbapenemase Tests, 2014 – 2020

<table>
<thead>
<tr>
<th>Carbapenemase Test</th>
<th>Examples</th>
<th>Identify Carbapenemase Type or Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCR-based</td>
<td>Lab-developed PCR Commercial Tests (e.g., Cepheid, BioFire array, Verigene®)</td>
<td>✔️</td>
</tr>
<tr>
<td>Phenotypic</td>
<td>Modified Hodge Test* E Test CIM/mCIM Carba NP Rapid CARB Blue</td>
<td>✗</td>
</tr>
<tr>
<td>Phenotypic + Carbapenemase Identification</td>
<td>BD Phoenix CPO detect NG-Test® CARBA 5 MBL Screen</td>
<td>✔️</td>
</tr>
<tr>
<td>Other</td>
<td>Send Out, Screens</td>
<td></td>
</tr>
</tbody>
</table>

*Not recommended*
Title 17 Proposed Changes
Carbapenemase-Producing Organisms (CPO)

Replace carbapenemase-producing (CP)-CRE with CPO reportable condition

- **Simplify reporting** by excluding carbapenem-resistant organisms not tested for carbapenemase
- **Expand to include other epi-relevant CPO** (e.g., *Acinetobacter, Pseudomonas, Citrobacter*)
- Keep as **lab-reportable** within 1 working day with **no** submission, **susceptibility testing requirements**

- **CSTE/CDC** currently revising CP-CRE position statement
- Will not override local reporting/submission requirements
Candida auris

• Nationally notifiable to CDC; reportable in some counties

• **Laboratories** report detection of *C. auris* from any body site using either a culture or a non-culture-based test (e.g., PCR) within 1 working day.
  • Submit isolates from sterile sites within 10 working days
  • ~8% of *C. auris* reported to CDPH is from a sterile site

• **Healthcare providers** submit a report including:
  • Patient demographic factors
  • Facility & lab information
  • Epi information (e.g., risk factors)
Key Messages

• Identify *Candida* isolates to the species level
• Perform or obtain carbapenemase testing on all CRE, CRAB, and CRPA*
  • Identification of specific carbapenemase is preferred
• Public health resources are available!
  • **Regional Lab**: Targeted surveillance (CRPA, CRAB, non-albicans Candida)
  • **MDL**: CRE, CRPA, all pan-resistant CRO, *Candida* isolates
  • **Local public health labs**: varies
  • **HAI**: AR containment and response support

*CDPH Algorithm for Prioritizing Carbapenemase Testing (PDF)
Resources

- **CDPH Antimicrobial Resistance Resources landing webpage**
  (www.cdph.ca.gov/Programs/CHCQ/HAI/Pages/AntimicrobialResistanceLandingPage.aspx)
- **CDPH CPO Webpage**
  (www.cdph.ca.gov/Programs/CHCQ/HAI/Pages/CRE_InfectionPreventionStrategies.aspx)
- **CDPH *C. auris* Webpage**
  (www.cdph.ca.gov/Programs/CHCQ/HAI/Pages/Candida-auris.aspx)
- **CDPH Algorithm for Prioritizing Carbapenemase Testing** (PDF)
- **CDPH *C. auris* and CPO Screening Decision Tree** (PDF)
  (www.cdph.ca.gov/Programs/CHCQ/HAI/CDPH%20Document%20Library/Tier2_Pathogen_Screening_Decision_Tree_Oct2020.pdf)
- **AR Lab Network Targeted Surveillance Program** (PDF)
  (www.cdph.ca.gov/Programs/CHCQ/HAI/CDPH%20Document%20Library/CDPH_ARLN_TargetedSurveillanceDescription_052521.pdf)
- **MDL Submission Instructions and Forms**
  (www.cdph.ca.gov/Programs/CID/DCDC/Pages/MDLSubmissionInstructionsandForms.aspx)
- **MDL Carbapenemase Testing Services FAQ** (PDF)
  (www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/MDL_Expanded-Carbapenemase_Testing_FAQ-Sheet.pdf)
Questions?

For more information, contact:

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