The Clinical Microbiology Laboratory: a Fundamental Resource for Infection Preventionists!

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At the conclusion of this program, you will be able to:

- Describe the primary role of a clinical microbiology laboratory; focus on bacteriology.
- Explain how improperly collected specimens can contribute to misleading results.
- List examples where bacteria reported may NOT be contributing to an infection.
- Discuss tests used to determine if a bacterium is susceptible or resistant to an antimicrobial agent.
- Describe a cumulative antibiogram and how this report can be used to guide empiric therapy and monitor % of bacteria susceptible (%S) to specific antimicrobial agents.
Scenario:
Physician sends a specimen to the microbiology lab. What does he/she want to know?

- Does the specimen contain pathogens? What type? How many?
- What are the antimicrobial susceptibility profiles of the pathogens in the specimen?
Scenario:
IP practitioner / epidemiologist reviews microbiology laboratory reports.

What does he/she want to know?

Could the pathogens isolated have been acquired while the patient was in the facility?

What can be done to prevent further spread of the pathogens?

= some key messages!
Examining Patient Specimens for Microorganisms
Instructions for collecting / transporting specimens for microbiology tests...

Processing specimens in a biological safety cabinet
Perform / Report **Direct** Gram Stain for Bacteria

- Report results within a few hours
- Quick insight into possible cause of an infection
Gram Reactions for Select Bacteria

**Gram positive**
- Staphylococcus
- Streptococcus

**Gram negative**
- E. coli
- Klebsiella
- Pseudomonas
- Neisseria

- Cocci in clusters
- Cocci in chains
- Cocci
- Rods
Direct Gram stain (pus from wound): Gram-positive cocci in clusters + white blood cells
Direct Gram stain (urethral discharge): Gram-negative diplococci (gonorrhoeae) within white blood cells
Place inoculated plates in incubator…

Should I identify these bacteria? Should I perform antimicrobial susceptibility tests on them?

next day
Criteria Used to Identify Bacteria

Traditional methods:
♦ Gram stain and microscopic exam
♦ Growth rate and colony appearance on various types of agar media
♦ Reactivity with various chemicals / reagents

Modern (molecular) methods:
♦ DNA / RNA content of microorganisms
♦ Protein profile (MALDI-TOF) of microorganisms

MALDI-TOF = Matrix-assisted laser desorption ionization – time of flight mass spectrometry
Sick Patient!

- 85 year old
- Sick for 3 days; getting progressively worse
  - Shortness of breath
  - Fever, chills, sweats, productive cough
- Temperature of 102°F
  - Sputum cultures
  - Blood cultures

Send sputum NOT saliva; send 2 blood cultures; appropriate volumes!
Direct Gram Stain
Assess Sputum Specimen Quality

♦ If saliva vs. sputum collected, may NOT recover “pathogens”
♦ Prepare direct Gram stain (put specimen on slide)
♦ Count number of squamous epithelial cells (SEC)

<table>
<thead>
<tr>
<th># SEC / low power field</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>No significant “mouth” contamination</td>
</tr>
<tr>
<td>≥10</td>
<td>Indicates poorly collected specimen</td>
</tr>
</tbody>
</table>

GOOD!
Direct Gram Stain Results

Many WBCs
Many Gram-positive cocci in clusters
Moderate normal oral flora

Physician thinks staphylococcus!
When *Staphylococcus* suspected…

♢ Questions:

- Is this *Staphylococcus aureus*?
  • If yes, is this methicillin-resistant *S. aureus* (MRSA) or methicillin-susceptible *S. aureus* (MSSA)?

- Is this another species of *Staphylococcus*, typically lumped into “coagulase-negative staphylococci” (CoNS) group?
  • Often contaminant; less clinically significant than MRSA or MSSA
For serious infections....

**MSSA**

**Usual Therapy**

**Oxacillin*** or **Nafcillin***

**MRSA**

**Vancomycin**

*Methicillin very similar but no longer available*
Common Lower Respiratory Tract Pathogens

♦ Community-acquired pneumonia (CAP)
  - *Streptococcus pneumoniae*
  - *Haemophilus influenzae*
  - *Moraxella catarrhalis*
  - “Atypicals” – *Mycoplasma pneumoniae*, *Chlamydophila pneumoniae*, and *Legionella pneumophila*
    - Often more difficult to recover / identify

♦ Hospital-acquired pneumonia (HAP); most often ICU or ventilator-associated
  - *Klebsiella pneumoniae*
  - *Pseudomonas aeruginosa*

♦ Either CAP or HAP
  - *Staphylococcus aureus* (MRSA or MSSA)

Yeast uncommon cause of pneumonia or other respiratory tract infection unless present in large quantities and/or immunosuppressed.
Blood specimen for bacterial culture: blood is injected directly into bottle of broth at bedside and sent to the lab.

Timing – collect before antibiotics given
Volume – check instructions; 2 sets!
Bottles are placed in blood culture instrument and continuously monitored. If bacteria are present, they multiply, react with “indicator” and sound an alarm when a threshold is reached.
“Positive” blood cultures are Gram stained, subcultured and subjected to other “tests”!

Gram stain: gram-positive cocci in clusters
Blood “Traditional” Culture Workup (1)

Sheep’s Blood Agar Medium

Colonies show:
Staphylococcus spp.
Perform coagulase test to determine if S. aureus

Blood Culture 16-20 hours

Gram Stain

Pos Blood Culture 15 Min.
Blood “Molecular” Culture Workup (2)

Molecular Assay Results:
MSSA or MRSA or CoNS

www.bd.com/geneohm

Pos Blood Culture

Gram Stain

Pos

15 Min.

1-2 hours

www.bd.com/geneohm
Sick Patient (Blood Culture)

**Gram Stain:**
Gram-positive cocci in clusters

**Culture:**

*Staphylococcus aureus* (MRSA)
- Clindamycin: R
- Daptomycin: S
- Linezolid: S
- Oxacillin: R
- Vancomycin: S

“MRSA isolated. Please check infection control policies.”
Blood Culture Contaminants

- Coagulase-negative staphylococci (CoNS)
- Diphtheroids
- Bacillus spp.
- Propionibacterium spp.
- Viridans streptococcus
- Micrococcus spp.

Usually, for these bacteria to be considered as causing infection, two sets of blood cultures must be positive PLUS patient must show specific signs and symptoms of bloodstream infection.
Urine Collection / Transport

- **Must test within 2 hours of collection** if stored at room temp
- **Must test within 24 hours** if refrigerated
- **Must test within 2 days** if in boric acid preservative

- If UTI symptoms – send for culture!
- Best if culture performed ONLY on specimens with significant pyuria (auto-reflex to culture); e.g., IF positive for leukocyte esterase and/or nitrite tests which suggest infection, THEN culture.
Most Common Pathogens
Urinary Tract Infections

♦ Community acquired
  – *E. coli* most common
  – *Klebsiella*, other
  – Enterobacteriaceae
  – *Staphylococcus saprophyticus*

♦ Hospital acquired
  – *E. coli*, *Klebsiella*, other
  – Enterobacteriaceae
  – *Pseudomonas aeruginosa*
  – Enterococci; staphylococci

Spot indole test (positive) = *E. coli*
Surveillance Cultures (vs. Diagnostic Cultures)

♦ Lab processes differently
♦ Must order as “surveillance culture”
♦ Must send appropriate specimen
♦ Only tested for “targeted” pathogen (e.g. MRSA)

CRE = carbapenem-resistant Enterobacteriaceae
Tests to Detect Antimicrobial Susceptibility
When do we do antimicrobial susceptibility tests (ASTs)?

♦ If 1 or 2 potential pathogens isolated from culture
♦ If it is likely that the bacteria are causing an infection
♦ If bacteria have a susceptibility pattern that is unpredictable
Urine Culture

Report:

$> 10^5 \text{CFU/ml } E. coli$

Significant quantity of potential pathogen. 
*E. coli* common pathogen in urinary tract infections. 
No contaminants.

Perform AST!
Urine Culture

Report:

$>10^5$ CFU/ml *Corynebacterium spp.*
40,000 CFU/ml *E. coli*
10,000 CFU/ml *Yeast*
10,000 CFU/ml *Lactobacillus spp.*

Likely contaminated culture. (high numbers of species that are unlikely pathogens).
Do NOT perform AST!

Encourage new specimen if UTI suspected!
Sputum Culture

Gram Stain:
- Many oral flora
- Many Gram positive diplococci
- Many WBCs

Culture:
- Many Normal Flora
- Many *Streptococcus pneumoniae*

Good correlation of Gram stain with culture.
Significant quantity of potential pathogen.
*S. pneumoniae* relatively common pathogen in respiratory tract infections.

Perform AST!
Foot Wound Culture

Gram Stain:
Many Gram positive cocci in clusters
Many pleomorphic Gram positive rods
No WBCs

Culture:
Many coagulase-neg staphylococci
Many diphtheroids
Few *E. coli*-like colonies
Few *Proteus*-like colonies

Poor correlation of Gram stain with culture.
Small quantity of potential pathogens.
“Skin flora” suggests likely contaminated culture.
Do NOT perform AST!

Send “pus”
Throat Culture

Many Group A Streptococcus

“Group A Streptococcus is always susceptible to penicillin.”

Not necessary to perform AST on bacteria that are always (predictably) susceptible to the antimicrobial agents typically prescribed.
Why do we **NOT** do susceptibility tests on every potential pathogen isolated?

♦ AST results on a report suggest that bacteria are causing an infection

♦ Reporting results when NOT needed may lead to:
  - Unnecessary or inappropriate therapy
    - Selection of resistant bacteria
    - Put patient at risk for *Clostridium difficile*
  - Failure to look further to identify true cause of the patient’s problem
Antimicrobial Susceptibility Tests

Disk diffusion (Kirby Bauer)

Broth microdilution

MIC = minimal inhibitory concentration (lowest concentration of drug that inhibits growth of the test bacteria)

Reported results:

♦ Susceptible (S) – drug likely to work providing it can get to the infection site

♦ Resistant (R) – drug won’t work

♦ Intermediate (I) – drug may or may not work depending on site of infection and patient’s status
## Zone Diameter “Breakpoints” (mm) for Enterobacteriaceae

<table>
<thead>
<tr>
<th>Drug</th>
<th>S</th>
<th>I</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>≥21</td>
<td>16-20</td>
<td>≤15</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>≥15</td>
<td>13-14</td>
<td>≤12</td>
</tr>
</tbody>
</table>

CLSI, Clinical and Laboratory Standards Institute

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**Table 2A. Enterobacteriaceae (Continued)**

<table>
<thead>
<tr>
<th>Test Strip Group</th>
<th>Antimicrobial Agent</th>
<th>Interpretable Categories and Zone Diameter Breakpoints, measured whole mm</th>
<th>Interpretive Categories and MBC Breakpoints, µg/µl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S ≤100 µg</td>
<td>I 101-150 µg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.3-7</td>
<td>7.1-9.5</td>
</tr>
</tbody>
</table>

Notes:
- **S**: Sensitive
- **I**: Intermediate
- **R**: Resistant
- **MBC**: Minimal Bactericidal Concentration
- **CLSI**: Clinical and Laboratory Standards Institute
- **MDR**: Multi-Drug Resistant
MIC “Breakpoints” (µg/ml) Enterobacteriaceae

<table>
<thead>
<tr>
<th>Drug</th>
<th>S</th>
<th>I</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>≤1</td>
<td>2</td>
<td>≥4</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>≤4</td>
<td>8</td>
<td>≥16</td>
</tr>
</tbody>
</table>

- **MIC Testing**

- **MIC “Breakpoints” (µg/ml)**

- **Drug**
  - Ciprofloxacin
  - Gentamicin

- **Breakpoints**
  - **S**: Susceptible
  - **I**: Intermediate
  - **R**: Resistant

- **Colours and Concentrations**
  - **Orange**:
    - 1 µg/ml
    - 64 µg/ml
    - >64 µg/ml

- **Legend**:
  - **+**:
    - Positive
  - **-**:
    - Negative
Commercial Antimicrobial Susceptibility Test Systems

- Etest
- Vitek 2
- MicroScan
- Sensititre
- Phoenix
### Lab Report

Review of S, I, R most important for IP
For MIC tests, must report S, I, R with or without MIC value.

<table>
<thead>
<tr>
<th>Susceptibility</th>
<th>Morganella morganii $^{iso1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MIC (MCG/ML)</td>
</tr>
<tr>
<td>Amikacin</td>
<td>R</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>R</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>&lt;=1</td>
</tr>
<tr>
<td>Cefepime</td>
<td>S</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>&gt;=4</td>
</tr>
<tr>
<td>Ceftazidime/Avibactam</td>
<td></td>
</tr>
<tr>
<td>Ceftolozane/ Tazobactam</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>&lt;=0.5</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>&gt;=4</td>
</tr>
<tr>
<td>Colistin</td>
<td>I</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>&lt;=1</td>
</tr>
<tr>
<td>Imipenem</td>
<td>S</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td></td>
</tr>
<tr>
<td>Meropenem</td>
<td></td>
</tr>
<tr>
<td>Minocycline</td>
<td></td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td></td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>64</td>
</tr>
<tr>
<td>Oral Cephalosporins</td>
<td></td>
</tr>
<tr>
<td>Piperacillin + Tazobactam</td>
<td>&lt;=4</td>
</tr>
<tr>
<td>Tobramycin</td>
<td></td>
</tr>
<tr>
<td>Trimethoprim/Sulfamethoxazole</td>
<td>&gt;=320</td>
</tr>
<tr>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Agent</td>
<td>#1</td>
</tr>
<tr>
<td>----------------</td>
<td>----</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>S</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>S</td>
</tr>
<tr>
<td>Cefepime</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td></td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>S</td>
</tr>
<tr>
<td>Ertapenem</td>
<td></td>
</tr>
<tr>
<td>Gentamicin</td>
<td>S</td>
</tr>
<tr>
<td>Meropenem</td>
<td></td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>S</td>
</tr>
<tr>
<td>Piper-tazo</td>
<td></td>
</tr>
<tr>
<td>Trimeth-sulfa</td>
<td>S</td>
</tr>
</tbody>
</table>

"Typical" *E. coli* - NO "R"!

Acquired "R" to all PO agents. Request fosfomycin – usually not tested routinely!

2 urine *E. coli* isolates

Broad Spectrum drug results suppressed when “S” to narrow spectrum drugs!
<table>
<thead>
<tr>
<th>Agent</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Cefepime</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Ertapenem</td>
<td>S</td>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Meropenem</td>
<td>S</td>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Piper-tazo</td>
<td>S</td>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Trimeth-sulfa</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

Potential outbreak?

3 more *E. coli* isolates ALL CRE!

CRE = carbapenem-resistant Enterobacteriaceae

CRE = R to doripenem, ertapenem, imipenem OR meropenem
Bacterial Culture Urine (Edited)

40,000 CFU/mL Morganella morganii (A)
Susceptibility Setup Date: 01/18/2018

<10,000 CFU/mL Klebsiella pneumoniae (A)
Susceptibility Setup Date: 01/20/2018

Carbapenem Resistant Enterobacteriaceae (CRE).

This organism is positive for the KPC Carbapenemase. Infectious diseases consult strongly suggested. This patient requires contact precautions, consult HSIC 002.

<table>
<thead>
<tr>
<th></th>
<th>Morganella morganii</th>
<th>Klebsiella pneumoniae</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MIC (MCG/ML)</td>
<td>MIC (MCG/ML)</td>
</tr>
<tr>
<td>Amikacin</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>&gt;32</td>
<td>%</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td>Cefepime</td>
<td>&gt;32</td>
<td>R</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>&lt;=2</td>
<td>S</td>
</tr>
<tr>
<td>Ceftazidime/Avibactam</td>
<td>&lt;=2</td>
<td>S</td>
</tr>
<tr>
<td>Cefotaxime/Tazobactam</td>
<td>&gt;32</td>
<td>R</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>&gt;=4</td>
<td>R</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>&lt;=2</td>
<td>WT</td>
</tr>
<tr>
<td>Colistin</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td>Ertapenem</td>
<td>&lt;=0.5</td>
<td>S</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>&gt;16</td>
<td>R</td>
</tr>
<tr>
<td>Imipenem</td>
<td>&gt;=4</td>
<td>R</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>&gt;8</td>
<td>R</td>
</tr>
<tr>
<td>Meropenem</td>
<td>&gt;16</td>
<td>R</td>
</tr>
<tr>
<td>Minocycline</td>
<td>16</td>
<td>R</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>&gt;8</td>
<td>%</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>64</td>
<td>I</td>
</tr>
<tr>
<td>Oral Cephalosporins</td>
<td>256</td>
<td>R</td>
</tr>
<tr>
<td>Piperacillin +</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td>Tazobactam</td>
<td>&gt;128</td>
<td>R</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>16</td>
<td>R</td>
</tr>
<tr>
<td>Trimethoprim/Sulfamet Hoxazole</td>
<td>&gt;320</td>
<td>R</td>
</tr>
</tbody>
</table>

Nitrofurantoin should not be used in patients with impaired renal function (Creatinine Clearance <60 mL/min) or in patients with suspected or confirmed pyelonephritis.

This Klebsiella Pneumoniae has unusual Carbapenem results; Infectious Disease consult suggested.
The Cumulative Antibiogram Report

Antibiogram = report that lists percent of isolates of common species susceptible (%S) to individual antimicrobial agents.

♦ Analyzes data from routine antimicrobial susceptibility tests performed in the clinical laboratory
♦ Separate report prepared for each healthcare facility
♦ Primarily used to guide empiric therapy
♦ Sometimes used to monitor resistance
  – Changes in %S from year to year
♦ Highly impacted by culturing practices
  – If cultures only done when patients fail therapy, antibiogram will...
    • not be representative of all isolates causing infection in a facility
    • overestimate “resistant” bacteria causing infection in a facility
Recommendations
Preparation of Cumulative Antibiogram

- Analyze/present data at least annually
- Include only species with ≥ 30 isolates of each species
- Include diagnostic (not surveillance) isolates
- Include the 1st isolate/patient; no duplicate patient isolates

Often difficult to get 30 isolates in LTCFs
### “Routine” Cumulative antibiogram

Generally...all isolates from a facility

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**Appendix E1. Cumulative Antimicrobial Susceptibility Report Example – Antimicrobial Agents Listed Alphabetically (Hypothetical Data)**

<table>
<thead>
<tr>
<th>Gram-Negative Organisms</th>
<th>Amikacin</th>
<th>Amoxicillin</th>
<th>Aztreonam</th>
<th>Cefazolin</th>
<th>Ceftaroline</th>
<th>Cefotaxime</th>
<th>Ceftazidime</th>
<th>Ciprofloxacin</th>
<th>Gentamicin</th>
<th>Nitrofurantoin</th>
<th>Cefepime</th>
<th>Meropenem</th>
<th>Piperacillin-tazobactam</th>
<th>Tobramycin</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acinetobacter baumannii</em></td>
<td>32</td>
<td>80</td>
<td>R</td>
<td>R</td>
<td>34</td>
<td>52</td>
<td>51</td>
<td>-</td>
<td>60</td>
<td>80</td>
<td>46</td>
<td>58</td>
<td>59</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Citrobacter freundii</em></td>
<td>49</td>
<td>100</td>
<td>R</td>
<td>R</td>
<td>72</td>
<td>67</td>
<td>90</td>
<td>78</td>
<td>100</td>
<td>99</td>
<td>67</td>
<td>67</td>
<td>100</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Enterobacter aerogenes</em></td>
<td>31</td>
<td>100</td>
<td>R</td>
<td>R</td>
<td>68</td>
<td>69</td>
<td>92</td>
<td>85</td>
<td>91</td>
<td>99</td>
<td>74</td>
<td>95</td>
<td>91</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>543</td>
<td>99</td>
<td>R</td>
<td>R</td>
<td>72</td>
<td>91</td>
<td>92</td>
<td>84</td>
<td>74</td>
<td>94</td>
<td>95</td>
<td>86</td>
<td>94</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Morganella morganii</em></td>
<td>44</td>
<td>100</td>
<td>R</td>
<td>R</td>
<td>85</td>
<td>81</td>
<td>99</td>
<td>R</td>
<td>100</td>
<td>99</td>
<td>64</td>
<td>75</td>
<td>100</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Proteus mirabilis</em></td>
<td>88</td>
<td>100</td>
<td>87</td>
<td>80</td>
<td>99</td>
<td>89</td>
<td>89</td>
<td>R</td>
<td>90</td>
<td>100</td>
<td>70</td>
<td>73</td>
<td>93</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>397</td>
<td>97</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Salmonella spp.</em></td>
<td>32</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Serratia marcescens</em></td>
<td>50</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Shigella spp.</em></td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>64</td>
<td>100</td>
<td>100</td>
<td>95</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>84</td>
<td>69</td>
<td>CLSI M39-A4.</td>
</tr>
<tr>
<td><em>Stenotrophomonas maltophilia</em></td>
<td>72</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>63</td>
<td>6</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>-</td>
<td>98</td>
<td>R</td>
<td>CLSI M39-A4.</td>
<td></td>
</tr>
</tbody>
</table>
**E. coli - % Susceptible**

<table>
<thead>
<tr>
<th>Category</th>
<th>N</th>
<th>Cip</th>
<th>FM</th>
<th>T-S</th>
<th>CZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>All isolates</td>
<td>4167</td>
<td>77</td>
<td>93</td>
<td>71</td>
<td>92</td>
</tr>
<tr>
<td>18-40 yo female outpatient urine</td>
<td>797</td>
<td>90</td>
<td>95</td>
<td>79</td>
<td>96</td>
</tr>
<tr>
<td>&gt;65 yo outpatient urine</td>
<td>1260</td>
<td>70</td>
<td>91</td>
<td>68</td>
<td>92</td>
</tr>
</tbody>
</table>

1 First isolate/pt (CLSI M39-A4)

Cip, ciprofloxacin
FM, nitrofurantoin
T-S, trimethoprim-sulfamethoxazole
CZ, cefazolin as surrogate for cephalexin (oral cephalosporins)
### Routine Cumulative Antibiogram % Susceptible

<table>
<thead>
<tr>
<th>Organism</th>
<th>N</th>
<th>Amp</th>
<th>P-T</th>
<th>Ceftriax</th>
<th>Ertapenem</th>
<th>Meropenem</th>
<th>Amikacin</th>
<th>Gentamicin</th>
<th>Ciprofloxacin</th>
<th>T-S</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>K. pneumoniae</em></td>
<td>450</td>
<td>R</td>
<td>88</td>
<td>85</td>
<td>95</td>
<td>98</td>
<td>98</td>
<td>92</td>
<td>88</td>
<td>82</td>
</tr>
</tbody>
</table>

- Meropenem = carbapenem
- 98% “S”
- ≈ 2% CRE

CRE = carbapenem-resistant Enterobacteriaceae
Examine all isolates (not just first isolate/patient).
Number of Enterobacteriaceae/year tested = approximately 5000 isolates.

CRE = carbapenem-resistant Enterobacteriaceae
# 2015 LOS ANGELES COUNTY ACUTE CARE HOSPITAL ANTIBIOTIC SUSCEPTIBILITY REPORT

## Gram-Negative Organisms

<table>
<thead>
<tr>
<th>Percent Susceptible (Number of Isolates Tested)</th>
<th>Penicillins</th>
<th>Cephalosporins</th>
<th>Carbapenems</th>
<th>Aminoglycosides</th>
<th>Quinolone</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin/Clavulanate</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piperacillin/Tazobactam</td>
<td></td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceftaroline</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aztreonam</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ertapenem</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mipromide</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amikacin</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gentamicin</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tobramycin</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ciprofloxacin/Levofoxacin</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telithromycin/OMEPRAZOLE</td>
<td>53 (1,561)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LA County Antibiogram 2015**  
Composite Data from Antibiograms from Acute Care Hospitals
Toolkit 3. The Nursing Home Antibiogram Program Toolkit: How To Develop and Implement an Antibiogram Program

Overview of the Toolkit
What Is an Antibiogram and Why Use One?

Antibiograms provide a report of the susceptibility of microorganisms isolated from patients to various antibiotics. They are used in daily patient care to assist with clinical decision-making. Antibiograms can also be used to identify patterns of antibiotic use and resistance, which can inform infection control policies. Antibiograms can also be used to identify patterns of antibiotic use and resistance, which can inform infection control policies.

AUTHORS
Ahi Associates Inc., and Brigham and Women’s Hospital prepared the Comprehensive Antibiogram Toolkit and presented it to the Agency for Healthcare Research and Quality in June 2012 under ACTION Contract No. HHSA2501200620111, Task Order No. 12.

Society of Infectious Diseases Pharmacists &
American Society of Consultant Pharmacists

Recommendations for Antibiogram Development
Long-Term Care Facility (LTCF) Addendum

The ability to generate an accurate annual cumulative susceptibility report (antibiogram) according to CLSI M39 guidelines is challenging for many LTCF due to selective culturing practices, small numbers of isolates, and ambiguity with regard to who should be responsible for antibiogram development for each LTCF (e.g., the LTCF contracted lab, the LTCF medical director, the LTCF consultant pharmacist, etc.). Similar to acute care hospitals, the first step in the process of antibiogram development for LTCFs is to have a multidisciplinary planning meeting with all of the stakeholders in the LTCF in order to discuss and formulate a plan to meet the needs of each individual LTCF. For LTCF antibiogram development, this multidisciplinary group should be comprised of LTCF leadership, the LTCF medical director, LTCF consultant pharmacist, the LTCF lab provider, and representatives from the LTCF Antibiotic Stewardship Committee and local hospital, if applicable. Areas that should be addressed at the planning meeting include identification of:

1) the person responsible for preparing the antibiogram
Assessment of patient’s clinical symptoms together with reliable clinical microbiology laboratory results are essential for accurate diagnosis of infections.

- Reliable clinical microbiology laboratory results are dependent on:
  - appropriate collection and transport of specimens.
  - accurate identification and antimicrobial susceptibility testing.
  - good communication between healthcare providers and lab.

Review of clinical microbiology laboratory results is key to identification of potential nosocomial transmission of microbes.

Additional clinical microbiology laboratory tests may be needed for epidemiological investigations.

A local cumulative antibiogram can help guide empiric therapy decisions and monitor “%S” for antimicrobial agents appropriate for common pathogens.
Thank You!