Guardians of the Antibiotics
Microbiology’s role in Stewardship

MARGIE MORGAN, MT(ASCP), PHD, D(ABMM)
PROFESSOR OF PATHOLOGY AND LABORATORY MEDICINE
SCIENTIFIC DIRECTOR MICROBIOLOGY
CEDARS-SINAI MEDICAL CENTER
What is Stewardship?

Duties of a steward is to oversee and protect something considered worth caring for and preserving

We (microbiologists) have the responsibility to collaborate with our pharmacy and physician leaders to care and preserve antibiotics

- Use the right antibiotic at the right time at right dose for the right duration
- Optimize clinical outcomes while minimizing unintended consequences of antimicrobial use, including toxicity, the selection of pathogenic organisms, and the emergence of resistance¹

¹ The White House national action plan for combating antibiotic resistant bacteria/ IDSA and SHEA
Why is “Antimicrobial use” such an issue?

Increasing global antimicrobial resistance over the last two decades

Decreasing number of antibiotics introduced into the pipeline over this time
It is Significant on the National Level!

Antibiotics are among the most commonly prescribed drugs used in human medicine
- 50% are not necessary or not optimally prescribed

Annual impact of antibiotic resistant infections
- 2 million illnesses
- 23,000 deaths
- 8 million additional hospital days
- $25-35 billion excess direct healthcare costs
- Up to $35 billion societal costs²

² PCAST Congressional report on antibiotic resistance
CDC Report: Antibiotic Resistance Threats

**Urgent:**
- Clostridium difficile – increasing rates
- Carbapenem resistant Enterobacteriaceae (CRE)
- Drug resistant Neisseria gonorrhea

**Serious**
- MDR Acinetobacter and Pseudomonas
- ESBLs, VRE, MRSA
- Resistant Campylobacter and Strep pneumonia
- Fluconazole resistant Candida spp and MDR TB

**Concerning**
- Vancomycin Resistant Staphylococcus aureus
- Erythromycin resistant Strep pyogenes and Clindamycin resistant Strep agalactiae
Antimicrobial Stewardship Standard

Joint Commission announced a new Medication Management Standard for Hospitals effective 1/1/2017

- Participated in the White House Forum on Antibiotic Stewardship June 2015
- Subsequently developed the Antimicrobial Stewardship Standard for Hospitals, critical care access hospitals and nursing care centers

This standard states that Hospital administrations establish Antimicrobial Stewardship as an organizational priority

Re-stated core elements originally developed by Centers for Disease Control (CDC) for the design of Stewardship programs
National Reportable Events

This became means to monitor through data collection and reporting the quality of care and the success (or lack thereof) of your Stewardship Program.

Two reportable events that effect microbiology practices:

1. Catheter Associated Urinary Tract Infection (CAUTI) and Non-catheter Associated urinary Tract Infections
2. Clostridium difficile rates

Hospitals Rates are benchmarked and published on websites in some states.

Monetary fines issued to Hospitals with rates above benchmark by withholding Medicare payment.
Core Elements of Hospital Stewardship
What we are expected to do!

Leadership – Formal statement of intent to improve antibiotic use

Accountability – Medical Staff, Pharmacy, Infection Prevention, and Microbiology (multidisciplinary and collaborative approach)

Drug Expertise – Stewardship pharmacists on board

Action – Execute actions to improve ABX usage

Tracking – Track ABX prescribing and resistance with data

Reporting - Develop proper antibiogram(s), monitor practices and outcome

Education – MDs educated about optimal prescribing and institutional resistance data
Call to Action: Proper use of tests

Targeted testing

- Eliminate duplicate test orders
  - Computer alerts – often times ignored
  - Laboratory hard stops with permission
- Encourage the best test for a diagnosis
  - Sounds so simple, but……demands education and consultation
  - Leads to more rapid diagnosis with more targeted therapy (Stewardship!!)
- Discourage the shot gun ordering approach of times past
  - For example, everyone has a routine Urinalysis and a urine culture
Proper use of tests: Urine Cultures

There is over ordering of urine cultures without true symptoms of UTI

UTI symptoms = fever, urgency, frequency, dysuria, suprapubic tenderness

Urinalysis (UA) can be used as a screening test to predict the usefulness of a urine culture with a high negative predictive value

- Absence of WBCs in a UA is excellent predictor of a negative urine culture
- Criteria can be applied to urines collected from midstream and catheterized specimens

Preventing the performance of an unnecessary urine culture on a patient without symptoms could prevent unnecessary treatment with antibiotics and assist with antimicrobial stewardship efforts
Proper use of tests: Urine Cultures

Reported that >=50% of patients with urine tests ordered in the ED and by General Medicine do not have symptoms consistent with a urinary tract infection (UTI)

An attempt should be made to streamline and improve urine culture algorithms due to the high volume of urine specimens cultured and the low number that are considered significant – beneficial to microbiology laboratories and core patient care

Potentially over diagnosis of UTI leads to overuse of antibiotics (Stewardship)

Urine cultures become a large burden in the microbiology laboratory
- Plating media
- Identification methods
- Susceptibility testing
- Labor to interpret cultures and perform tests

Yin, P. JAMA 175: 1711-1713 2015
Humphries, R. J. Bard, JCM 54(2) 2016
The Reflex Urine Culture

Urinalysis first performed - and based on findings

Culture is reflexed (ordered and performed) only if one or more of the screening methods are positive
  ◦ Nitrate positive,
  ◦ Leukocyte esterase >1,
  ◦ Bacteria present,
  ◦ WBC >10/hpf

Institutions may vary somewhat in reflex criteria

The negative predictive value using these criteria is >98%

Should be coupled with an ongoing QM program to access program effectiveness and safety

Urine cultures without reflex order are restricted to urology & OB (where a sterile urine is necessary) and neutropenic and pediatric patients

Humphries, R, J. Bard, JCM 54(2) 2016
Results of Reflex Urine Protocol

Reflex protocols have led to decreases in the number of urines ordered for culture – reports of 30% - 69% decrease*  
\* Decrease % will depend on individual institution patient demographics and enforcement of policy

Catheter-Associate Urinary Tract Infection (CA-UTI) reflex inclusion will decrease NHSN reporting of catheter related infections from patients that do not truly have CA-UTI – NHSN reporting

Promotes Antimicrobial Stewardship - less use of antibiotics will be prescribed to treat asymptomatic bacteriuria

Cost savings (materials and labor) in the microbiology laboratory

Proper use of tests:
Evaluate Testing Algorithm for C difficile

Toxin EIA

Liquid or soft stool

GDH EIA testing

IF POSITIVE

Do Toxin EIA or Molecular assay

Two Step reflex test

Molecular Testing

IF POSITIVE

Do Toxin EIA

Two step reflex test
Look more closely at The Patient

Careful selection of patients is needed before ordering C difficile testing
- This is nothing new (1980's) but we have not done a very good job

The few studies investigating this issue have found that 36% to 50% of hospitalized patients tested for *C difficile* do not have clinically significant diarrhea

20% to 44% of patients tested were on a laxative regimen.

Improving patient selection for testing (only test patients with clinically significant diarrhea, as well as stopping laxative use before testing) will improve the positive predictive value of any assay

Problem: Most patients had antibiotics or chemo in the last 60 days
- Nosocomial diarrhea following recent antibiotic therapy or chemo can have symptoms like that of C diff
The “Perfect” Stool Specimen

Algorithms following SHEA/IDSA 2010 guidelines

Soft or Liquid stool from patient is required
  ◦ Do not test formed stools unless from a paralytic ileus

Clean container – refrigerate to prevent toxin deterioration

Discourage repeat testing during the same episode of diarrhea
  ◦ Develop hard stop to prevent repeat testing within 7 days unless discussion with MD

Testing for cure is not recommended
  ◦ Molecular tests positive for 2-3 wks
  ◦ Even toxins can be shed for an extended time

High colonization rate in children – so do not routinely test infants <=3 yrs
Yes, I do this for a living!

Bristol stool chart

Visual examination

The Stick test

** Accepting stool rejection for viscosity has been our most challenging issue. Yes, doctor, the stool really is formed! Need to develop rejection criteria and be consistent with rejection.
Microbiology Action: Quality Specimens

**Proper specimen collection guidelines** available to health care partners
- Establish standard guidelines/Education

**Clearly expressed rejection criteria** for suboptimal specimens
- Routine and standardized rejection performed
- Poor sputum (Spit) using Gram stain criteria
- Old urines – exceeding 24 hours
- Incorrectly transported stool specimens
- Inadequate amount of blood collected in blood culture bottles

**Trash in Trash out**
- The better the specimen the better the result
Microbiology Action: Antibiogram

Antibiogram – the good

- At least annually, including only the first isolate per patient in the period analyzed, and including only organisms for which ≥30 isolates were tested in the period analyzed.
- Help guide the clinician and pharmacist in selecting the best empiric antimicrobial treatment in the event of pending microbiology culture and susceptibility results.
- Trends in resistance can be identified and investigated.
- Help in preparing empiric guidelines.

Antibiogram – the bad

- Minimum inhibitory concentrations (MICs) are not included; as a result subtle trends below the resistance threshold (known as “MIC creep”) are not reflected.
- Generalizing health system wide data to one specific patient.
Microbiology Action: Patient Specific Information

**Timely reporting** of “No Growth” so antibiotic therapy can be discontinued

**Identify pathogens in timely manner**
- MALDI-TOF is one advancement that provides rapid and accurate identification
- Timely and understandable preliminary reports

**Susceptibility testing in timely manner**
- Appropriate antimicrobial therapy
- Timely release of results
- Understandable reports – comments if interpretive information would be helpful

**Rapid pathogen identification/resistant marker/susceptibility from Positive Blood Cultures**
- Information can be an important piece of Antibiotic Stewardship Program for quality care and more appropriate use of antibiotics
Microbiology Action: Blood Cultures

Recent Advances in Rapid Identification Diagnostics

Significant recent advances in pathogen identification

Advances in resistance markers

- G+  mecA, vanA/B
- G-  KPC, IMP, VIM, OXA, NDM, & CTX-M
Rapid Pathogen Identification

**MALDI-TOF** (matrix assisted laser desorption/ionization – time of flight)
- Rapid identification of pathogens directly from positive blood culture bottles
- Somewhat better results with Gram negative > Gram positive
- @ 65 – 85% of pathogens identified
- Extraction method required to prepare blood obtained from positive blood culture bottle
- No resistance marker or susceptibility information
- Relatively inexpensive
Pathogen Detection – Day one

T2Candida® Panel delivers direct detection of pathogens from whole blood

Diagnostic panel prior to blood culture
- Identifies five clinically relevant species of Candida
- Accurate results in an average of 4.3 hours
  - 91% sensitivity
  - 99.4% specificity
- Run on the fully-automated T2Dx Instrument
- Magnetic Resonance technology
- Very simple to perform

Positive results are certainly helpful, but negative results are as well, leading to the possible discontinuation of costly prophylactic antifungal therapy
Select Pathogen Identification with Resistance Markers Detection

- **Biofire, Nanosphere, Great Basin**
  - Testing performed aliquot from positive blood cultures
  - Rapid identification of select Gram positive and negative pathogens (1 h–2 hr)
    - Great Basin tests for Staphylococcus spp
  - Rapid detection of genetic resistance markers (1 hr- 2hr)
  - Provide information to assist with
    - De-escalation or escalation of therapy
    - Dosing adjustments
    - Determine “contaminate” leading to discontinuation of therapy
    - **Rapid, direct communication to caregiver that can take action**
  - Easy to perform, varies in cost $$$ - $$ - $
Accelerate Pheno™ System
Antibiotic Susceptibilities Direct from Positive Blood Culture

High Speed
• Time to identification ~90 minutes
• Time to antibiotic susceptibilities ~7 hours

Clinically Actionable Information
• MICs to multiple antibiotics
• FDA/CLSI/EUCAST S,I,R interpretation

Fully Automated
• Simple operation ~ 2 min set up time
• Modular architecture provides scalability
Accelerate Pheno™ System

**System**
- 1-4 module(s)
- Control & Analysis PCs
- Touchscreen monitor

**Module**
- Automated pipetting robot
- Digital camera
- Custom microscope

**Kit**
- 48 flow-channel cassette
- Reagent cartridge
- Sample vial

Specimen Prep → Identification → MIC Susceptibility

RBC Lysis → Filtration → Immobilization

FISH Probes
Core Scientific Principle
Bacterial Phenotypic Observation via Microscopy Time Lapse

- Example: Two different blood culture bottles – Each positive with *E. coli*
- Images from two different instrument runs - ceftazidime channel (same antibiotic concentration)
- Morphokinetic Cellular Analysis algorithm compares phenotypic data to proprietary databank for MIC determination

*E. coli* resistant to ceftazidime (MIC = 32)

*E. coli* susceptible to ceftazidime (MIC = 2)
Simple Workflow – Accelerate Pheno™ System

Positive Blood Culture Bottle
BacT/Alert BACTEC™ VersaTrek

Aliquot 0.5mL into Sample Vial

Load Sample Vial Cassette and Cartridge
Press Start

Specimen Prep
Identification
Susceptibility

+BC Bottle
Three Step Specimen Preparation
Separate aliquots used for ID & AST pathways

1. Lysis
   - Buffers solubilize blood components and lyse red blood cells
   - Mixing performed by pipettor

2. Filtration
   - Separates bacteria from debris via electrical field manipulation

3. Immobilization:
   - Bacterial cells are captured on lower surface of cassette channel via electrical field
Identification by FISH

Fluorescence *in situ* Hybridization

**Monomicrobial Identification**
- Single target probe is positive with matching universal probe signal

**Polymicrobial Identification**
- Signals from target and universal probes are used to indicate polymicrobial specimen

**Example of *E. coli* Channel in Polymicrobial ID**
- Difference between signal of *E. coli* target probe and signal of universal probe indicates an additional organism present
**Positive Blood Culture Panel**

48 channel Cassette

### Identification Channels

**Gram-Positive**
- *S. aureus*
- *S. lugdunensis*
- CoNS spp.
- *E. faecalis*
- *E. faecium*
- *Streptococcus* spp.

**Gram-Negative**
- *E. coli*
- Klebsiella spp.
- Enterobacter spp.
- Proteus spp.
- Citrobacter spp.
- *S. marcescens*
- *P. aeruginosa*
- *A. baumannii*

**Fungi**
- *C. albicans*
- *C. glabrata*

### Antibiotics Available

**Gram-Positive**
- Ampicillin
- Ceftaroline
- Doxycycline
- Erythromycin
- TMP-SMX
- Daptomycin
- Linezolid
- Vancomycin

**Gram-Negative**
- Amp-Sulbac
- Pip-Tazo
- Cefazolin
- Cefepime
- Ceftazidime
- Ceftriaxone
- Ertapenem
- Meropenem
- Amikacin
- Gentamicin
- Tobramycin
- Ciprofloxacin
- Minocycline
- Aztreonam
- Colistin

**Resistance**
- MRSA (Cefoxitin)
- MLSb (Ery-Clind)

**Dynamic Dilution**

Calculates inoculum concentration for AST

Universal bacterial or eukaryotic probes in ID channels enables Polymicrobial Identification

ID determines Antibiotic tested
### Gram-Positive & Yeast Panel

<table>
<thead>
<tr>
<th></th>
<th>Ampicillin</th>
<th>Ceftaroline</th>
<th>Doxycycline</th>
<th>Erythromycin</th>
<th>TMP-SMX</th>
<th>Daptomycin</th>
<th>Linezolid</th>
<th>Vancomycin</th>
<th>Vancomycin-R (Cefoxitin)</th>
<th>MLSb (Eryth-Clinda)</th>
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<tr>
<td>S. aureus</td>
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<td>S. lugdunensis</td>
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<td>E. faecium</td>
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<td>Streptococcus spp.</td>
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- **IVD** (16 Abx, 5 R-test)
- **RUO** (11 Abx)

Results should be interpreted in conjunction with Gram stain.
# Gram-Negative Panel

<table>
<thead>
<tr>
<th></th>
<th>Amp-Sul</th>
<th>P/P-Tazo</th>
<th>Cefazolin</th>
<th>Cefepime</th>
<th>Cefazidime</th>
<th>Ceftriaxone</th>
<th>Ertapenem</th>
<th>Meropenem</th>
<th>Amikacin</th>
<th>Gentamicin</th>
<th>Tobramycin</th>
<th>Ciprofloxacin</th>
<th>Aztreonam</th>
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<th>Minocycline</th>
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<tbody>
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<td>E. coli</td>
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<tr>
<td>Klebsiella spp.</td>
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- **IVD** (79 Abx)
- **RUO** (13 Abx)

Results should be interpreted in conjunction with Gram stain.
## ID Performance Clinical Trial

<table>
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<tr>
<td><em>S. aureus</em></td>
<td>97.9</td>
<td>98.5</td>
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<td>Coag-negative Staph spp.</td>
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<table>
<thead>
<tr>
<th>Yeast</th>
<th>Sens.</th>
<th>Spec.</th>
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<tr>
<td><em>Candida albicans</em></td>
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<td><strong>Gram Negative Total</strong></td>
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<td><strong>99.6</strong></td>
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<table>
<thead>
<tr>
<th>All Identified Organisms</th>
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<tbody>
<tr>
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<td>97.4</td>
<td>99.3</td>
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# Antibiotic Susceptibility Performance

## Gram-Positive

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Antibiotic</th>
<th>EA%</th>
<th>CA%</th>
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<tbody>
<tr>
<td>Cephalosporin</td>
<td>Ceftaroline</td>
<td>94.9</td>
<td>99.5</td>
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<td>Cyclic Lipopeptide</td>
<td>Daptomycin</td>
<td>98.1</td>
<td>99.6</td>
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<td>Glycopeptide</td>
<td>Vancomycin</td>
<td>97.2</td>
<td>97.9</td>
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<td>Macrolide</td>
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<td>98.3</td>
<td>96.6</td>
</tr>
<tr>
<td>Oxazolidinone</td>
<td>Linezolid</td>
<td>98.9</td>
<td>99.6</td>
</tr>
<tr>
<td>Penicillin</td>
<td>Ampicillin</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Sulfonamide</td>
<td>TMP-SMX</td>
<td>96.0</td>
<td>96.0</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>Doxycycline</td>
<td>94.4</td>
<td>95.8</td>
</tr>
</tbody>
</table>

## Gram-Negative

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Antibiotic</th>
<th>EA%</th>
<th>CA%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoglycosides</td>
<td>Amikacin</td>
<td>93.8</td>
<td>93.8</td>
</tr>
<tr>
<td></td>
<td>Gentamicin</td>
<td>99.5</td>
<td>98.7</td>
</tr>
<tr>
<td></td>
<td>Tobramycin</td>
<td>96.3</td>
<td>96.0</td>
</tr>
<tr>
<td>Carbapenem</td>
<td>Ertapenem</td>
<td>98.8</td>
<td>98.5</td>
</tr>
<tr>
<td></td>
<td>Meropenem</td>
<td>96.7</td>
<td>96.9</td>
</tr>
<tr>
<td>Cephalosporin</td>
<td>Cefazolin</td>
<td>95.7</td>
<td>85.6</td>
</tr>
<tr>
<td></td>
<td>Cefepime</td>
<td>96.2</td>
<td>95.5</td>
</tr>
<tr>
<td></td>
<td>Ceftazidime</td>
<td>92.4</td>
<td>92.1</td>
</tr>
<tr>
<td></td>
<td>Ceftriaxone</td>
<td>94.7</td>
<td>96.4</td>
</tr>
<tr>
<td>Fluorquinolone</td>
<td>Cipro</td>
<td>98.4</td>
<td>98.4</td>
</tr>
<tr>
<td>Monobactam</td>
<td>Aztreonam</td>
<td>96.4</td>
<td>97.6</td>
</tr>
<tr>
<td>Penicillin-Inhibitor</td>
<td>Amp-Sulb</td>
<td>91.0</td>
<td>82.7</td>
</tr>
<tr>
<td></td>
<td>Pip-Taz</td>
<td>91.0</td>
<td>90.8</td>
</tr>
<tr>
<td>Polymixin</td>
<td>Colistin</td>
<td>94.9</td>
<td>97.6</td>
</tr>
</tbody>
</table>

### S. aureus (MRSA/MSSA Phenotype)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>n</th>
<th>CA</th>
<th>% CA</th>
<th>S</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefoxitin</td>
<td>184</td>
<td>183</td>
<td>99.5</td>
<td>86</td>
<td>98</td>
</tr>
</tbody>
</table>

VMJ | MAJ
0   | 1

One *S. aureus* identified as MSSA by reference was called MRSA by Pheno

EA  Essential Agreement (+/- one MIC dilution)
CA  Categorical Agreement (Correct S,I,R category)
Time to Results
Data from FDA clinical trial of Accelerte Pheno™ System

Time to ID Result
Average = 1hr 23m
90% of runs within 1hr 24m
95% of runs within 1hr 24m

Time to AST Result
Average = 6hr 41m
90% of runs within 6hr 54m
95% of runs within 7hr 5m

Times reported are from pressing start button to result
# Example Report – *E. coli* Bacteremia (9330011 from FDA Clinical Trial)

**Identification:** *E. coli*  
**Specimen Type:** Fresh

<table>
<thead>
<tr>
<th>Class</th>
<th>Antibiotic</th>
<th>Accelerate MIC</th>
<th>S I R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aminoglycosides</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amikacin</td>
<td>&lt;=4</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Gentamicin</td>
<td>16</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Tobramycin</td>
<td>4</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td><strong>Cephalosporins</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefazolin (RUO)</td>
<td>1</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Cefepime</td>
<td>&lt;=1</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>&lt;=2</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>0.5</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td><strong>Monobactam</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aztreonam</td>
<td>2</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td><strong>Carbapenems</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ertapenem</td>
<td>0.25</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Meropenem</td>
<td>&lt;=0.25</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td><strong>Penicillin/Inhib</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amp-Sulbactam</td>
<td>32</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Pip-Taz</td>
<td>&lt;=4</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td><strong>Quinolone</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cipro</td>
<td>&gt;=8</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td><strong>Polymixin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colistin (RUO)</td>
<td>&lt;=0.5</td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>

**Monomicrobial:** Sample positive for only one pathogen

Fast susceptibility results provide earlier opportunity clinicians to de-escalate antibiotics if identified organism is reported susceptible to a stewardship preferred agent.

Accelerate Pheno Results should be interpreted in conjunction with Gram stain.
**Example Report – *E. coli* (Multi Drug Resistant) 9290236 from FDA Clinical Trial**

**Identification:** *E. coli*  
**Specimen Type:** Challenge

---

<table>
<thead>
<tr>
<th>Class</th>
<th>Antibiotic</th>
<th>Accelerate MIC</th>
<th>S I R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoglycosides</td>
<td>Amikacin</td>
<td>&lt;=4</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Gentamicin</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Tobramycin</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td>Cephalosporins</td>
<td><strong>Cefazolin (RUO)</strong></td>
<td>&lt;=16</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Cefepime</td>
<td>&gt;=32</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Ceftazidime</td>
<td>&gt;=32</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Ceftriaxone</td>
<td>&gt;=8</td>
<td>R</td>
</tr>
<tr>
<td>Monobactam</td>
<td>Aztreonam</td>
<td>&gt;=32</td>
<td>R</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>Ertapenem</td>
<td>2</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Meropenem</td>
<td>&gt;=8</td>
<td>R</td>
</tr>
<tr>
<td>Penicillin/Inhib</td>
<td>Amp-Sulbactam</td>
<td>&gt;=64</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Pip-Taz</td>
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<td>R</td>
</tr>
<tr>
<td>Quinolone</td>
<td>Cipro</td>
<td>&gt;=8</td>
<td>R</td>
</tr>
<tr>
<td>Polymixin</td>
<td><strong>Colistin (RUO)</strong></td>
<td>&lt;=0.5</td>
<td>S</td>
</tr>
</tbody>
</table>

*Monomicrobial: Sample positive for only one pathogen*

---

Fast susceptibility results provide earlier opportunity for clinicians to escalate antibiotics if organism is reported resistant to empiric therapy.

Accelerate Pheno Results should be interpreted in conjunction with Gram stain.
Patients With Bacteremia/Sepsis
- Earlier effective antibiotic treatment with potential for fewer side effects

Antimicrobial Stewardship
- Fast antibiotic susceptibilities enable rapid stewardship de-escalation or escalation

Microbiology Laboratory
- Provide critical results to clinicians 1-2 days faster than traditional methods

Accelerate Pheno™ System
- Direct from positive blood culture
- Fast identification within 1½ hours
- Fast susceptibilities ~7 hours
Advantage of MIC testing over resistance marker detection

Particularly meaningful with the Gram negative bacilli

- Inability to detect new / emerging resistance mechanisms from panel target
- Possible false-positive results - detect inactive or incomplete resistance genes
- Multidrug resistance is due to many gene variants/mutations
  - Expression of extended-spectrum β-lactamases (ESBLs), carbapenemases, aminoglycoside-blocking 16S rRNA methylases, etc.
- More resistance genes can be detected in parallel, the higher the probability of an exact determination of a particular susceptibility pattern is. Current systems detect the presence of very few gene mutations
- Resistance mechanisms such as permeability alterations cannot be detected using resistance markers
In Summary

Antimicrobial stewardship is a priority for hospital/medical centers

Microbiology laboratories are an important part of the Stewardship team and collaboration with pharmacy, clinicians and administration is vital to Stewardship.

We all need to continue to work together to improve antibiotic usage and hopefully slow down antimicrobial resistance.