Know When Antibiotics Work

Presentation for Healthcare Workers

UNIVERSITY OF RHODE ISLAND
COLLEGE OF PHARMACY
These slides were developed by the University of Rhode Island School of Pharmacy with assistance from:

- The Rhode Island Department of Health
- The New England QIN-QIO
- Optum Healthcare
Objectives

1. Describe how microbes exist in our environment and in and on our bodies
2. Describe how microbes become resistant
3. Describe when antibiotics are helpful and when they are not
4. List the negative effects associated with antibiotics
Introduction

- Antibiotics are being over-prescribed
  - Antibiotic Resistance
  - *Clostridium difficile* diarrhea
- Know when antibiotics are really necessary
Germs aka microbes – organisms too small for the eye to see
- Found everywhere on earth

There are many types of microbes:
- bacteria
- viruses
- fungi
- parasites

Most microbes are harmless or even beneficial to living organisms
Beneficial Microbes: “The good bacteria”

- Bacteria live harmlessly in and on our bodies
- Live together in harmony and don’t cause infection
- These bacteria are unique to each of us
- Beneficial to our health
- Every time we take an antibiotic, we disrupt this delicate balance
Harmful Microbes: What make you sick

- Symptoms: how your illness presents itself on the outside → changes the way you feel when you’re sick

- Some microbes cause disease
  - Pathogens (aka germs or bugs)

- You get sick when pathogen gets somewhere it isn’t supposed to go, or when your ability to fight infection (your immune system) is weakened

- All can develop resistance to drugs created to destroy them
  - Drug-resistant organisms
Bacteria

**GRAM-NEGATIVE**
- Outer membrane
- Lipoproteins
- Peptidoglycan
- Periplasmic space
- Cytoplasmic membrane

**GRAM-POSITIVE**
- Outer membrane
- Lipoproteins
- Peptidoglycan
- Periplasmic space
- Cytoplasmic membrane

**Shapes:**
- *bacillus* (rod)
- *coccus* (sphere)
- *spirillus* (spiral)
<table>
<thead>
<tr>
<th>Categori</th>
<th>Gram Positive Bacteria</th>
<th>Gram Negative Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocci</td>
<td><strong>Enterococcus</strong></td>
<td><strong>Moraxella</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Peptostreptococcus</strong></td>
<td><strong>Neisseria</strong></td>
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<tr>
<td></td>
<td><strong>Staphylococcus</strong></td>
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<tr>
<td></td>
<td><strong>Streptococcus</strong></td>
<td></td>
</tr>
<tr>
<td>Rod</td>
<td><strong>Bacillus</strong></td>
<td><strong>Campylobacter</strong></td>
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<tr>
<td></td>
<td><strong>Erysipelothrix</strong></td>
<td><strong>Helicobacter</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Listeria</strong></td>
<td><strong>Bartonella</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Corynebacterium</strong></td>
<td><strong>Haemophilus</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Gardnerella</strong></td>
<td><strong>Vibrio</strong></td>
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<tr>
<td></td>
<td></td>
<td><strong>Escherichia</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Serratia</strong></td>
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<td></td>
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<tr>
<td>Anaerobic</td>
<td><strong>Lactobacillus</strong></td>
<td><strong>Bacteroides</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Propionibacterium</strong></td>
<td><strong>Prevotella</strong></td>
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<tr>
<td></td>
<td><strong>Actinomyces</strong></td>
<td><strong>Fusobacterium</strong></td>
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<tr>
<td></td>
<td><strong>Clostriudium</strong></td>
<td></td>
</tr>
<tr>
<td>Misc</td>
<td><strong>Chlamydia, Mycoplasmas, Mycobacterium</strong></td>
<td></td>
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<tr>
<td></td>
<td><strong>Spirochetes</strong></td>
<td></td>
</tr>
</tbody>
</table>
Culture & Sensitivity

- Should be taken BEFORE starting antimicrobial therapy – prior therapy may interfere with bacterial growth

- Types
  - Blood Cultures
  - Wound/abscess
  - Sputum
  - Urine (midstream, catheterized)
  - Stool

- Good resource for correct collection technique: https://www.cdc.gov/gets smart/healthcare/implementation/clinicianguide.html
Culture & Sensitivity

- Interpretation
  - MIC: minimum inhibitory concentration
  - Susceptible
  - Intermediate
  - Resistant

<table>
<thead>
<tr>
<th>ORGANISM</th>
<th>S. agalactiae</th>
<th>P. vulgaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMP/SULPHATIN</td>
<td>16/8</td>
<td>R</td>
</tr>
<tr>
<td>AMPICILLIN</td>
<td>&gt;16</td>
<td>R</td>
</tr>
<tr>
<td>CEFAZOLIN</td>
<td>&gt;16</td>
<td>R</td>
</tr>
<tr>
<td>CEFEPIME</td>
<td>&lt;=4</td>
<td>S</td>
</tr>
<tr>
<td>CAFTAZIDIME</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td>CEFTAXOONE</td>
<td>&lt;=0.25</td>
<td>S</td>
</tr>
<tr>
<td>CEFOXIN</td>
<td>2</td>
<td>I</td>
</tr>
<tr>
<td>CIPROFLOXINICIN</td>
<td>&lt;=0.06</td>
<td>S</td>
</tr>
<tr>
<td>CLINDAMYCIN</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td>ERTAPENEM</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td>ERYTHROMYCIN</td>
<td>&gt;0.5</td>
<td>R</td>
</tr>
<tr>
<td>GENTAMICIN</td>
<td>&lt;=4</td>
<td>S</td>
</tr>
<tr>
<td>IMIPENEM</td>
<td>&lt;=1</td>
<td>S</td>
</tr>
<tr>
<td>PENICILLIN</td>
<td>0.06</td>
<td>S</td>
</tr>
<tr>
<td>PIP/TAZOBACTAM</td>
<td>&lt;=16</td>
<td>S</td>
</tr>
<tr>
<td>TETRACYCLINE</td>
<td>&gt;4</td>
<td>R</td>
</tr>
<tr>
<td>TOBRAMICIN</td>
<td>&lt;=4</td>
<td>S</td>
</tr>
<tr>
<td>TRIMETH/ SULFA</td>
<td>&lt;=2/38</td>
<td>S</td>
</tr>
<tr>
<td>VANCOMICIN</td>
<td>0.5</td>
<td>S</td>
</tr>
</tbody>
</table>
Which of the following can make you sick?

A. Bacteria
B. Viruses
C. Fungus
D. Parasites
E. All of the above
Do microbes ALWAYS cause infection?

A. Yes
B. No
What is *Clostridium difficile*?

- *Clostridium difficile* (C. diff) is a bacteria that normally lives in your colon.
- In certain situations it can cause inflammation of the colon (Colitis)
  - Symptoms of infection include:
    - Watery diarrhea
    - Fever
    - Loss of appetite
    - Nausea
    - Abdominal pain and tenderness
- C. diff bacteria can form spores which allows them to live outside the body for very long periods of time, and makes it very difficult to kill.
- Once a patient becomes infected with C. diff it is very difficult to get rid of.
C. Diff Statistics

- Most common cause of acute infectious diarrhea in nursing home residents
- 26% of nursing home residents were found to have C. diff after 2 weeks of antibiotics

Up to **70%** of nursing home residents received **one or more** courses of systemic antibiotics in a year.

People on antibiotics are 7-10 times more likely to get *C. difficile* while on the drugs and during the month after.
CLOSTRIDIUM DIFFICILE

250,000 INFECTIONS PER YEAR
14,000 DEATHS

$1,000,000,000,000 IN EXCESS MEDICAL COSTS PER YEAR
True or False?

Antibiotic resistance occurs when your body becomes resistant to antibiotics and they no longer work as well.
FALSE!

- Don’t worry if you answered true, you’re not alone
- WHO conducted a survey in 2015, asking 9,772 people in 12 countries across the world about antibiotics
- 76% participants also answered true
Antibiotic Resistance

- **You** do not become resistant to antibiotics – the **bacteria** do!
- Bacteria are tiny living creatures, when something tries to hurt them – they fight back!
- Some bacteria can develop methods to fight back so that certain antibiotics aren’t able to harm them
- They can then pass these fighting techniques on to other bacteria, and these bacteria can travel to other surfaces and people
Antibiotic Resistance

• The inappropriate use of antibiotics may lead to unnecessary and sometimes dangerous side effects

• Each time a person takes an antibiotic they are more likely to carry resistant germs in their noses and throats

• First line antibiotics cannot kill these resistant germs once they become resistant

• Appropriate antibiotic use can help protect you and your loved ones
Antimicrobial Resistance
Global Report on surveillance 2014

The report is the most comprehensive picture to date, with data provided by 114 countries.

Looking at 7 common bacteria that cause serious diseases from bloodstream infections to gonorrhoea.

High levels of resistance found in all regions of the world.

Over the last 30 years, no major new types of antibiotics have been developed.

What does this mean?
Without urgent action we are heading for a post-antibiotic era, in which common infections and minor injuries can once again kill.
Deaths attributable to antimicrobial resistance every year by 2050

North America: 317,000
Latin America: 392,000
Europe: 390,000
Africa: 4,150,000
Asia: 4,730,000
Oceania: 22,000

Source: The Review on Antimicrobial Resistance
There is hope!

- A study done in Finland in the 90s found that when antibiotic use was restricted resistance levels went down
- National Plan to Combat Antibiotic Resistant Bacteria
  - Improve surveillance, fund new antibiotic efforts, fund more rapid diagnostic test
- CDC’s 7 Core Elements of Antimicrobial Stewardship
- IDSA Guidelines for Antimicrobial Stewardship
- Education to the public
Summary of Core Elements for Antibiotic Stewardship in Nursing Homes

- **Leadership commitment**: Demonstrate support and commitment to safe and appropriate antibiotic use in your facility.
- **Accountability**: Identify physician, nursing and pharmacy leads responsible for promoting and overseeing antibiotic stewardship activities in your facility.
- **Drug expertise**: Establish access to consultant pharmacists or other individuals with experience or training in antibiotic stewardship for your facility.
- **Action**: Implement at least one policy or practice to improve antibiotic use.
- **Tracking**: Monitor at least one process measure of antibiotic use and at least one outcome from antibiotic use in your facility.
- **Reporting**: Provide regular feedback on antibiotic use and resistance to prescribing clinicians, nursing staff and other relevant staff.
- **Education**: Provide resources to clinicians, nursing staff, residents and families about antibiotic resistance and opportunities for improving antibiotic use.
How can you be a champion at your facility?

By educating your patient to know when it is most likely that they or their loved ones would benefit from using antibiotics (and when they would not!)
Nursing Role in AMS

- Ensure pertinent information about antibiotics is available at the point of care
- Question antibiotic administration route
- Reassess antibiotic therapy in 2-3 days
- Review antibiotic therapy when your patient develops a new C. diff infections
- Reconcile antibiotics during all patient-care transitions
True or False?

If an antibiotic is found to be effective against a certain bacteria, it will ALWAYS work against that bacteria.
What are antibiotics?

- Antimicrobials – destroy disease-causing microbes
  - Antibiotics, antivirals, antifungals, antiparasitics
- Antibiotics – medications used to treat *bacterial* infections
- They kill the bacteria that cause the symptoms – they don’t treat the symptoms!
- Many different kinds of antibiotics
- Different antibiotics are better at treating different bacteria
- The more specific the antibiotic is, the better!
# Antibiotics

<table>
<thead>
<tr>
<th>Antibiotic Class</th>
<th>General Spectrum of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sulfonamides</strong></td>
<td>Gram + and Neg (inc MRSA)</td>
</tr>
<tr>
<td><strong>Fluroquinolones</strong></td>
<td>Enteric Gram Neg</td>
</tr>
<tr>
<td><strong>Nitrofuran</strong></td>
<td><em>E. Coli, Staphylococcus</em></td>
</tr>
<tr>
<td><strong>Penicillins</strong></td>
<td>Gram +</td>
</tr>
<tr>
<td><strong>Aminopenicillins</strong></td>
<td>Gram +</td>
</tr>
<tr>
<td><strong>Antipseudomonal Penicillins</strong></td>
<td>Gram +, <em>pseudomonas</em></td>
</tr>
<tr>
<td><strong>Cephalosporins</strong></td>
<td>Gram + (1st gen) add neg coverage as you go up in generation</td>
</tr>
<tr>
<td><strong>Carbapenems</strong></td>
<td>Gram +, Gram neg, <em>pseudomonas</em></td>
</tr>
<tr>
<td><strong>Monobactams</strong></td>
<td><em>Psuedomonas</em>, Gram neg</td>
</tr>
<tr>
<td><strong>Glycopeptides</strong></td>
<td>Gram +, MRSA, <em>C. diff</em></td>
</tr>
<tr>
<td><strong>Aminoglycosides</strong></td>
<td>Gram neg, <em>Psuedomonas</em></td>
</tr>
<tr>
<td><strong>Macrolides</strong></td>
<td>Atypical, Gram + and Gram neg</td>
</tr>
<tr>
<td><strong>Tetracylcines</strong></td>
<td>Atypical, MRSA</td>
</tr>
<tr>
<td><strong>Lincosamide</strong></td>
<td>Gram +, anaerobes, Gram neg</td>
</tr>
<tr>
<td>Drug</td>
<td>Coverage</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Ciprofloxacin | GOOD: Enteric GNRs, *Haemophilus influenzae* MODERATE: *Pseudomonas*, atypicals POOR: *Staphylococci, S. pneumoniae, anaerobes, enterococci* | • Dizziness  
• Confusion  
• Hallucinations  
• QT prolongation  
• Arthralgias  
• Tendon Rupture  
• Photosensitivity | Q12 H | • C/I in pregnancy + children  
• photosensitivity  
• Higher dosing is necessary for *Pseudomonas* infection  
• Space with calcium, antacids, milk, or multivitamins by 2 H before or 6 H after  
• Renal adjustments necessary (except moxi)  
• Moxifloxacin is not approved for treatment of UTIs  
• Elderly patients are more likely to experience CNS side effects  
• Elderly patients, young athletes, patients with poor renal function and patients taking corticosteroids are more likely to experience tendon rupture |
| Levofloxacin | GOOD: Enteric GNRs, *Haemophilus influenzae, S. pneumoniae, atypicals* MODERATE: *Pseudomonas (LEVO onlu)*, MSSA POOR: *anaerobes, enterococci* | • Dizziness  
• Confusion  
• Hallucinations  
• QT prolongation  
• Arthralgias  
• Tendon Rupture  
• Photosensitivity | Q 24 H |  
| Moxifloxacin | *moxifloxacin has moderate activity against anaerobes*                     |                                                                                   | Q 24 H |  

<table>
<thead>
<tr>
<th>Indication</th>
<th>Cipro</th>
<th>Levo</th>
<th>Moxi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap, sinusitis, AECB</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>UTI</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Intra-abdominal infection</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Systemic Gram-negative infections</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>SSTIs</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Pseudomonas infections (+/- beta-lactam)</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Treatment prophylaxis in bioterrorism scenarios (active vs. anthrax, plague, tularemia)</td>
<td>+</td>
<td>+</td>
<td>?</td>
</tr>
</tbody>
</table>

+ Approved/studied/makes sense for this indication
? Should work, no clinical data
- Suboptimal
### Sulfamethoxazole/Trimethoprim

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Frequency</th>
<th>Adverse Effects</th>
<th>Monitoring</th>
<th>Counseling points</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD:</td>
<td>Q 12 H</td>
<td>• Rash</td>
<td>• Check INR within 2-3 days of initiating therapy</td>
<td>• High resistance to E. Coli in some areas – check local antibiogram before initiating for empiric UTI treatment</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td></td>
<td>• SJS</td>
<td>• Renal function</td>
<td>• Drug interaction with warfarin (increases INR)</td>
</tr>
<tr>
<td>(including many MRSA strains), <em>Haemophilus influenzae</em>, <em>Stenotrophomonas maltophilia</em>, <em>Listeria</em>, <em>Pneumocystis jirovecii</em> (formerly known as <em>P. carinii</em>)</td>
<td></td>
<td>• Toxic epidermal necrolysis</td>
<td>• Serum potassium</td>
<td>• Highly insoluble, so it requires a lot of fluid – be careful when admin IV to fluid overloaded patients or patients with heart failure</td>
</tr>
<tr>
<td>MODERATE:</td>
<td></td>
<td>• Bone marrow suppression</td>
<td>• Pseudorenal failure (crystalluria, AIN)</td>
<td>• Patient must maintain adequate hydration during therapy to prevent crystalluria and renal stone formation</td>
</tr>
<tr>
<td>enteric GNRs, <em>S. pneumoniae</em>, <em>Salmonella</em>, <em>Shigella</em>, <em>Nocardia</em>, <em>Steptococcus pyogenes</em></td>
<td></td>
<td>• Renal failure</td>
<td>• Increase in SCr</td>
<td></td>
</tr>
<tr>
<td>POOR:</td>
<td></td>
<td>• Pseudorenal failure</td>
<td>• Hyperkalemia</td>
<td></td>
</tr>
<tr>
<td><em>Pseudomonas</em>, enterococci, anaerobes</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Good for treatment of: uncomplicated lower UTIs, prophylaxis of recurrent UTIs, treatment of listeria meningitis, treatment of and prophylaxis of *Pneumocystis jirovecii* pneumonia, and treatment of *Toxoplasma* encephalitis,
<table>
<thead>
<tr>
<th>Coverage</th>
<th>Dose/Frequency</th>
<th>Adverse effects</th>
<th>Monitoring</th>
<th>Counseling points</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD: MSSA, MRSA, streptococci (including multidrug-resistant <em>S. pneumoniae</em>), enterococci (including VRE), <em>Nocardia</em></td>
<td>600 mg Q12H</td>
<td>• Generally well tolerated</td>
<td>• CBC at 2 weeks for thrombocytopenia</td>
<td>• Weak inhib of MOA, can cause serotonin syndrome when admin with SSRIs</td>
</tr>
<tr>
<td>MODERATE: some atypicals, <em>Mycobacterium tuberculosis</em></td>
<td></td>
<td>• Bone marrow suppression</td>
<td></td>
<td>• Check elim half life of SSRIs before d/c and initiation therapy</td>
</tr>
<tr>
<td>POOR: all Gram-negatives, anaerobes</td>
<td></td>
<td>• Thrombocytopenia</td>
<td></td>
<td>• No renal or hepatic dose adjustments needed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Peripheral neuropathy</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Lactic acidosis</td>
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<td></td>
</tr>
</tbody>
</table>

Good for: resistant Gram + infections (MRSA, VRE)
## Daptomycin

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Dose/Frequency</th>
<th>Adverse Effects</th>
<th>Monitoring</th>
<th>Counseling points</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD: MSSA, MRSA, streptococci</td>
<td>Q 24 H</td>
<td>• Muscle pain or weakness</td>
<td>• Creatinine Kinase (CK) levels at baseline and weekly</td>
<td>• Adjust renally</td>
</tr>
<tr>
<td>MODERATE/GOOD: Enterococci, including VRE</td>
<td></td>
<td>• Rhabdomyolysis</td>
<td>• Renal function</td>
<td>• Resistance is rare but has been reported</td>
</tr>
<tr>
<td>POOR; all gram negative</td>
<td></td>
<td>• Drug fever</td>
<td></td>
<td>• Cannot be used to treat pneumonia because pulmonary surfactant binds to it and makes the drug inactive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Eosinophilic pneumonia</td>
<td></td>
<td>• Additive rhado effect with Statins?</td>
</tr>
</tbody>
</table>

Good for: Gram + SSTIs, staphylococcal bacteremia, right sided endocarditis, enterococcal bacteremia (not indicated or well studied)
<table>
<thead>
<tr>
<th>Drug</th>
<th>Coverage</th>
<th>Monitoring</th>
<th>Counseling points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Generation:</strong></td>
<td><strong>GOOD:</strong> MSSA, Streptococci</td>
<td></td>
<td>• Good alternative to anti-staph penicillins</td>
</tr>
<tr>
<td><strong>Cefazolin</strong></td>
<td><strong>MDE Rate:</strong> Some enteric GNR</td>
<td></td>
<td>• Cause less phlebitis</td>
</tr>
<tr>
<td><strong>Cephalexin</strong></td>
<td><strong>POOR:</strong> Enterococci, anaerobes, MRSA, Pseudomonas</td>
<td></td>
<td>• Infused less frequently</td>
</tr>
<tr>
<td>Cefadroxil</td>
<td></td>
<td></td>
<td>• Do not cross the BBB can should not be used in CNS infections</td>
</tr>
<tr>
<td>Cephalothin</td>
<td></td>
<td></td>
<td>• Cephalexin and cefadroxil only ones available PO</td>
</tr>
<tr>
<td><strong>Second Generation:</strong></td>
<td><strong>GOOD:</strong> Some enteric GNRs, <em>Haemophilis</em>, <em>Neisseria</em></td>
<td><strong>Check INR in 2-3 days</strong></td>
<td>• Can cause disulfiram-like reaction with co-administered with ethanol</td>
</tr>
<tr>
<td><strong>Cefuroxime</strong></td>
<td><strong>MODERATE:</strong> Streptococci, staphylococci, anaerobes (only cefotetan, cefoxitin, cefmetazole)</td>
<td></td>
<td>• Can inhibit Vitamin K production and increase INR</td>
</tr>
<tr>
<td><strong>Cefoxitin</strong></td>
<td><strong>POOR:</strong> Enterococci, MRSA, Pseudomonas</td>
<td></td>
<td>• Do not cross BBB well enough to treat CNS infections</td>
</tr>
<tr>
<td><strong>Cefotetan</strong></td>
<td></td>
<td></td>
<td>• Cefaclor, cefprozil and loracarbef – PO only</td>
</tr>
<tr>
<td><strong>Cefprozil</strong></td>
<td></td>
<td></td>
<td>• Cefuroxime – available IV and PO</td>
</tr>
<tr>
<td>Loracarbef</td>
<td></td>
<td></td>
<td>• All others IV only</td>
</tr>
<tr>
<td>Cefmetazole</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefonicid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefamandole</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefaclor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Third generation:</strong></td>
<td><strong>GOOD:</strong> streptococci, enteric GNRs, <em>Pseudomonas</em> (ceftazidime only)</td>
<td><strong>Check INR in 2-3 days</strong></td>
<td>• Strongest association with C. Diff diarrhea</td>
</tr>
<tr>
<td><strong>Ceftriazone</strong></td>
<td><strong>MODERATE:</strong> MSSA (except ceftazidime, which is poor)</td>
<td></td>
<td>• Cefpodoxime – increases INR</td>
</tr>
<tr>
<td><strong>Cefotaxime</strong></td>
<td><strong>POOR:</strong> enterococci, <em>Pseudomonas</em> (except ceftazidime), anaerobes, MRSA</td>
<td></td>
<td>• Ceftriazone, cefotaxime, and ceftazidime cross the BBB well and are good for CNS infections</td>
</tr>
<tr>
<td><strong>Ceftazidime</strong></td>
<td></td>
<td></td>
<td>• Ceftazidime – antipseudomonal</td>
</tr>
<tr>
<td><strong>Cefdinir</strong></td>
<td></td>
<td></td>
<td>• Induce resistance amount GNRs</td>
</tr>
<tr>
<td><strong>Cefpodoxime</strong></td>
<td></td>
<td></td>
<td>• Ceftazidime is excreted renally (penetration for UTIs)</td>
</tr>
<tr>
<td><strong>Cefixime</strong></td>
<td></td>
<td></td>
<td>• Ceftriazone is C/I in neonates</td>
</tr>
<tr>
<td><strong>Ceftibuten</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Cephalosporins

<table>
<thead>
<tr>
<th>Drug</th>
<th>Coverage</th>
<th>Monitoring</th>
<th>Counseling points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fourth generation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefepime</td>
<td>GOOD: MSSA, streptococci, <em>Pseudomonas</em>, enteric GNRs</td>
<td>• Hepatic/renal function</td>
<td>• Broad-spectrum agent, good for nosocomial infections but overkill for community acquired – make sure to deescalate if started empirically</td>
</tr>
<tr>
<td></td>
<td>MODERATE: <em>Acinetobacter</em></td>
<td>• PTT</td>
<td>• Induces less resistance in GNRs than third generation</td>
</tr>
<tr>
<td></td>
<td>POOR: enterococci, anaerobes, MRSA</td>
<td>• Serum-sickness</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fifth generation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceftaroline</td>
<td>GOOD: MSSA, MRSA, streptococci, enteric GNRs</td>
<td>• Anemia during and after treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MODERATE: <em>Enterococcus faecalis</em></td>
<td>• Renal function in elderly patients</td>
<td></td>
</tr>
<tr>
<td></td>
<td>POOR: <em>Pseudomonas aeruginosa, Enterococcus faecium, anaerobes</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Acinetobacter</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coverage</td>
<td>Dose/Frequency</td>
<td>Monitoring</td>
<td>Side Effects</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>--------------------------------------------------------------</td>
<td>--------------------------------------</td>
<td>-------------------------------</td>
</tr>
</tbody>
</table>
| GOOD: MSSA, MRSA, streptococci, *Clostridium difficile* | • 15 mg/kg x ABW  
• Dosing interval depends on kidney function | • Trough should be 15-20 mg/ml       | • Red man syndrome            | • For C. diiff – PO only                          |
| MODERATE: enterococci                |                                                               |                                      | • Otoxicity                   | • Does not kill MSSA as well as beta-lactams          |
| POOR: anything Gram-negative         |                                                               |                                      | • Nephrotoxicity              | • Needs to be specially dosed                        |

Good for: MRSA, gram + infections when patient has beta-lactam allergy
### Macrolides

<table>
<thead>
<tr>
<th>Drug</th>
<th>Coverage</th>
<th>Frequency</th>
<th>Monitoring</th>
<th>Side Effects</th>
<th>Counseling points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clarithromycin</strong></td>
<td><strong>GOOD:</strong> atypicals, <em>Haemophilus influenzae</em>, <em>Moraxella catarrhalis</em>, <em>Helicobacter pylori</em>, <em>Mycobacterium avium</em></td>
<td>BID</td>
<td>• EKG for QT prolongation&lt;br&gt;• Hepatic function</td>
<td>• Significant GI upset&lt;br&gt;• Hepatic events&lt;br&gt;• Prolongation of the QT interval</td>
<td>• Erythromycin is the worse for GI upset&lt;br&gt;• Interact with a lot of drugs&lt;br&gt;• 5 days of therapy probably adequate for azithromycin&lt;br&gt;• Bacteriostatic&lt;br&gt;• Good for CAP, but high levels of <em>S. pneumoniae</em> resistance</td>
</tr>
<tr>
<td></td>
<td><strong>MODERATE:</strong> <em>S. pneumoniae</em> (telithromycin &gt; macrolides), <em>S. pyogenes</em></td>
<td>QD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>POOR:</strong> staphylococci, enteric GNRs (azithromycin &gt; clarithromycin), anaerobes, enterococci</td>
<td>Q 6 H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>QD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Azithromycin</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Erythromycin</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Telithromycin</strong></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Good for:** Respiratory tract infections, chlamydia, atypical mycobacteria infections, travelers diarrhea (azithromycin). Clarithromycin in H. pylori
FDA Drug Safety Communication: Azithromycin (Zithromax or Zmax) and the risk of potentially fatal heart rhythms

Additional Information for Health Care Professionals

- Health care professionals should consider the risk of torsades de pointes and fatal arrhythmia when considering treatment options with azithromycin or alternative antibacterial drugs. Groups at higher risk include:
  - Patients with known prolongation of the QT interval, a history of torsades de pointes, congenital long QT syndrome, bradyarrhythmias, or uncompensated heart failure
  - Patients on drugs known to prolong the QT interval
  - Patients with ongoing proarrhythmic conditions such as uncorrected hypokalemia or hypomagnesemia, clinically significant bradycardia, and in patients receiving Class IA (quinidine, procainamide) or Class III (dofetilide, amiodarone, sotalol) antiarrhythmic agents.
- Elderly patients and patients with cardiac disease may be more susceptible to the effects of arrhythmogenic drugs on the QT interval.
**Coverage** | **Frequency** | **Side Effects** | **Counseling points**
---|---|---|---
GOOD: atypicals, rickettsia, spirochetes (e.g., B. burgdorferi, Helicobacter pylori), Plasmodium species (malaria) | Q 12 H | • Esophageal irritation  
• Photosensitvity  
• Discoloration of teeth in less than 8 year olds | • Patients should be instructed to take this with a full glass of water while standing up  
• Wear sunscreen, cover up from the sun  
• Do not take with calcium, iron, antacids, or multivitamins (space by 2 hours)
MODERATE: staphylococci (including MRSA), S. pneumoniae | | |
POOR: most GNRs, anaerobes, enterococci | | |

**Good For:** uncomplicated respiratory tract infections, acute exacerbations of chronic bronchitis, sinusitis, CAP, tick-bourne diseases
<table>
<thead>
<tr>
<th>Coverage</th>
<th>Frequency</th>
<th>Monitoring</th>
<th>Side Effects</th>
<th>Counseling points</th>
</tr>
</thead>
</table>
| Good: E. coli, Staphylococcus saprophyticus Moderate: Citrobacter, Klebsiella, Proteus, enterococci Poor: Acinetobacter | Crystalline formulation QID  
Macrocrystalline form w monohydrate BID | For C. diff  
EKG changes  
Hemolytic anemia  
Hepatic function  
Peripheral neuropathy  
Pulmonary function  
Renal function | Nausea / Vomiting  
Acute pneumonitis  
Chronic pulmonary fibrosis | Take with food to decrease N/V  
Only effective for UTI  
C/I in CrCl < 30 ml/min |
# Penicillins

<table>
<thead>
<tr>
<th>Drug</th>
<th>Coverage</th>
<th>Frequency</th>
<th>Monitoring</th>
<th>Side Effects</th>
<th>Counseling points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin</td>
<td>GOOD: <em>Treponema pallidum</em>, most streptococci, including <em>Streptococcus pneumoniae</em>&lt;br&gt;MODERATE: enterococci&lt;br&gt;POOR: almost everything else</td>
<td>Q 6-8 H</td>
<td></td>
<td>• Hypersensitivity reactions&lt;br&gt;• Seizures&lt;br&gt;• GI upset&lt;br&gt;• AIN</td>
<td>• Very short half life – frequency dosing&lt;br&gt;• Do not give procaine or benzicaine formulations IV – lethal&lt;br&gt;• Drug of choice for syphilis</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>GOOD: streptococci, enterococci&lt;br&gt;MODERATE: enteric GNRs, *Haemophilus&lt;br&gt;POOR: staphylococci, anaerobes, <em>Pseudomonas</em></td>
<td>Q 8 H</td>
<td>• Renal function</td>
<td>• Increased incidence of AIN</td>
<td></td>
</tr>
</tbody>
</table>
Respiratory Tract Infections

- An infection that occurs in your respiratory tract: mouth, nose, throat and lungs
- Most of these such as colds and sore throats are viral illnesses and antibiotics will not treat them
- Your body will fight viral illnesses that cause most upper respiratory tract infections
- You can help your immune system be at its strongest by staying up to date on your immunizations
<table>
<thead>
<tr>
<th>Infection</th>
<th>Common Pathogen</th>
<th>Symptoms</th>
<th>Antibiotics?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Otitis Media (Ear Infection)</td>
<td>Majority (40-75%): Viral pathogens Other common: <em>Streptococcus pneumoniae</em>, <em>Haemophilus influenzae</em>, and <em>Moraxella catarrhalis</em></td>
<td>Fever, Ear pain</td>
<td>Watch &amp; Wait</td>
</tr>
<tr>
<td>Sinusitis (Cold)</td>
<td>Majority: Viral Others: <em>Streptococcus pneumoniae</em>, <em>Haemophilus influenzae</em>, and <em>Moraxella catarrhalis</em></td>
<td>Purulent nasal discharge, nasal congestion or obstruction, facial congestion or fullness, facial pain or pressure, fever, headache, ear pain/pressure/fullness, halitosis, dental pain, cough, and fatigue</td>
<td>Watch &amp; Wait</td>
</tr>
<tr>
<td>Bronchitis</td>
<td>majority: Rhinovirus Coronavirus Influenza virus Adenovirus Other common: <em>Mycoplasma pneumoniae</em> <em>Chlamydia pneumoniae</em> <em>Bordetella pertussis</em></td>
<td>Increased Dyspnea Increased cough Increased sputum production/purulence Change in normal routine</td>
<td>Depends on severity of symptoms</td>
</tr>
<tr>
<td>Pharyngitis (sore throat)</td>
<td>Majority: rhinovirus, coronavirus, adenovirus, herpes simplex virus, influenza virus, parainfluenza virus, and Epstein-Barr virus Unlikely: group A beta-hemolytic <em>Streptococcus</em></td>
<td>A sore throat of sudden onset that is mostly self-limited Fever and constitutional symptoms resolving in about 3 to 5 days Clinical signs and symptoms are similar for viral causes and nonstreptococcal bacterial causes (See next slide for bacterial vs. viral signs + symptoms)</td>
<td>Depends on symptoms (see next slides)</td>
</tr>
<tr>
<td>Pneumonia (CAP)</td>
<td>Majority (75%): <em>Streptococcus pneumoniae</em> Other Common: <em>M. pneumoniae</em>, <em>Legionella species</em>, <em>C. pneumoniae</em>, <em>H. influenzae</em>, and a variety of viruses including influenza</td>
<td>Abrupt onset of fever, chills, dyspnea, and productive cough Rust-colored sputum or hemoptysis Pleuritic chest pain</td>
<td>Yes</td>
</tr>
<tr>
<td>Influenza (flu)</td>
<td>Influenza virus</td>
<td>rapid onset of fever, myalgia, headache, malaise, nonproductive cough, sore throat, and rhinitis.</td>
<td>NEVER</td>
</tr>
</tbody>
</table>
Strep Throat

- Antibiotics may indicated if 2 or more of the following are present:
  - Fever greater than 100.4°F
  - White patches on tonsils
  - **No cough**
  - Swollen and tender lymph nodes
  - Red blotchy rash

- If you do have these, get a strep test
Viral Sore Throat

- Antibiotics won’t help if the patient is exhibiting the following symptoms:
  - Red eyes
  - Cough
  - Running or congested nose
  - Diarrhea
  - Hoarseness
LRTI

Suspection of an AECB

Assess for cardinal symptoms
- Dyspnea, cough, sputum production/pureulence
- Change in patient’s “normal” routine

Assess for risk factors
- Age, COPD severity, >4 exacerbations/yr, cardiac disease
- Home oxygen use, antibiotic use in last 3 months
- Recent corticosteroid use

Minimal symptoms & no risk factors

Prominent symptoms & no risk factors

Prominent symptoms & risk factors

Treatment
- Rest
- Symptomatic treatment
- Observations

Simple CB

Complicated CB

Oral antibiotic therapy
- 2nd generation macrolide
- 2nd/3rd generation cephalosporin
- Other antibiotics (doxycycline, amoxicillin, TMP/SMX)

If inadequate response

Re-evaluate sputum culture

Hospitalization unlikely if
- ≥2 risk factors
- FEV₁ <50% predicted

Oral antibiotic therapy
- 2nd generation macrolide
- 2nd/3rd generation cephalosporin
- Other antibiotics (doxycycline, amoxicillin, TMP/SMX)

If inadequate response

Re-evaluate sputum culture

Hospitalization likely if
- ≥2 risk factors
- Severe symptoms
- Constant purulent sputum
- FEV₁ <35% predicted

Antibiotic therapy
- Fluoroquinolone
- β-lactam/β-lactamase inhibitor

If hospitalized, empiric IV antibiotic coverage for P. aeruginosa

Adjust antibiotics based on cultures

Source: Chapter 85. Lower Respiratory Tract Infections, Pharmacotherapy: A Pathophysiologic Approach, 9e
Citation: DiPiro JT, Talbert RL, Yee GC, Matzke GR, Wells BG, Posey L Pharmacotherapy: A Pathophysiologic Approach, 9e; 2014 Available at: http://accesspharmacy.mhmedical.com/ViewLarge.aspx?figid=45321016&gbosContainerID=0&gbosid=0 Accessed: February 17, 2017
Can the flu vaccine give you the flu?

- No, vaccinations do not contain an active form of the virus
- Low grade fever and muscle aches
  - Your body’s immune system is working to create antibodies against the flu!
- Some people experience flu-like symptoms because
  - They contracted a different infection with similar symptoms
  - The vaccination takes 2 weeks to produce immunity
  - They were exposed to a flu virus not contained in the vaccination
  - Patient had a previously weakened immune system
Watch & Wait

- AKA Delayed prescribing practices
- Patients are asked to wait 24-48 hours after a doctor visit to start antibiotics
- Many viral illnesses will have a resolve of symptoms in about 2 days from onset.
- Several studies found decreased antibiotic use without significantly increasing symptoms and/or complications in most cases when using the Watch & Wait method.
When to initiate empiric antibiotics for Urinary Tract Infections
**Urinary Tract Infection: No Catheter**

Either of the following:
1. Acute dysuria
2. Acute pain, swelling or tenderness of the testes, epididymis or prostate

OR

Either of the following:
1. Fever
2. Leukocytosis

AND

One or more of the following:
- Costovertebral angle pain or tenderness
- New or marked increase in suprapubic tenderness
- Gross hematuria
- New or marked increase in incontinence
- New or marked increase in urgency
- New or marked increase in frequency

TWO or more of the following:
- Costovertebral angle pain or tenderness
- New or marked increase in suprapubic tenderness
- Gross hematuria
- New or marked increase in incontinence
- New or marked increase in urgency
- New or marked increase in frequency

Either of the following:
1. A voided urine culture with $\geq 10^5$ CFU/ml of no more than 2 species of microorganisms
2. Positive culture with $\geq 10^2$ CFU/ml of any microorganisms from straight in/out catheter specimen
Urinary Tract Infection: Indwelling Catheter

ONE or more of the following with no alternate source:

- Fever
- Rigors
- New onset hypotension, with no alternate site of infection
- New onset confusion/functional decline AND Leukocytosis
- New costovertebral angle pain or tenderness
- New or marked increase in suprapubic tenderness
- Acute pain, swelling or tenderness of the testes, epididymis or prostate
- Purulent discharge from around the catheter

AND

Any of the following:

If urinary catheter removed within last 2 calendar days:
1. A voided urine culture with $\geq 10^5$ CFU/ml of no more than 2 species of microorganisms
2. Positive culture with $\geq 10^2$ CFU/ml of any microorganisms from straight in/out catheter specimen

If urinary catheter in place:
3. Positive culture with $\geq 10^5$ CFU/ml of any microorganisms from indwelling catheter specimen
True or False

1. Antibiotics will help cure all sinus infections
2. Antibiotics will help cure the flu
3. Antibiotics will help cure a sore throat with a runny nose and a cough
4. Antibiotics should be initiated in a patient who has cloudy urine and mental status changes
Symptomatic Treatment

- Good hand hygiene!

When you have a viral infection, there are a few things you can do to feel better in the meantime:
  - Increase fluid intake
  - Get plenty of rest
  - Use a cool mist vaporizer or nasal saline spray to relieve congestion
  - Soothe throat with ice chips, sore throat spray or lozenges
How antibiotics can be harmful

- C. diff diarrhea
  - Caused by using certain antibiotics such as Clindamycin, Ampicillin, Cephalosporins, and Flouroquinolones

- Side effects:
  - Nausea, vomiting, diarrhea, kidney dysfunction, heart dysfunction, tendon rupture, sensitivity to the sun, etc...

- Drug interactions
  - Warfarin
  - Dysglycemia

- Kidney dysfunction
  - Many antibiotics require adjustments in patients who had decreased kidney function
  - This can cause more drug in the body – which could mean more side effects
Contact Information

- Grace Mortrude – GraceMortrude@uri.edu
  - PharmD Candidate 2018

- Kerry LaPlante – KerryLaPlante@uri.edu
  - PharmD, FCCP
  - Professor of Pharmacy, University of Rhode Island, Kingston, RI
  - Adjunct Professor of Medicine, Brown University, Providence, RI
  - Director of the Rhode Island Infectious Diseases Research Program (RIID) and Infectious Diseases Pharmacotherapy Specialist, Providence Veterans Medical Center, RI
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THANK YOU!