Idaho Society of Health-System Pharmacists

What You Don't Know Could Kill You: An Infectious Disease Review

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Learning Objectives

- Identify most common bacteria associated with infections
- Review basic antibiotic drug classes
- Given an infection, be able to recognize most common antibiotics used to treat that infection
- Understand why antibiotic resistance needs to be prevented
- Apply infectious disease knowledge to a patient case

Disclosures

- Nothing to disclose

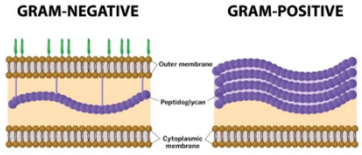
Tips for Learning Infectious Disease

- Categorization - organize as it makes sense to you
- Most side effects are antibiotic class effects, but learn the **EXCEPTIONS** in each class.

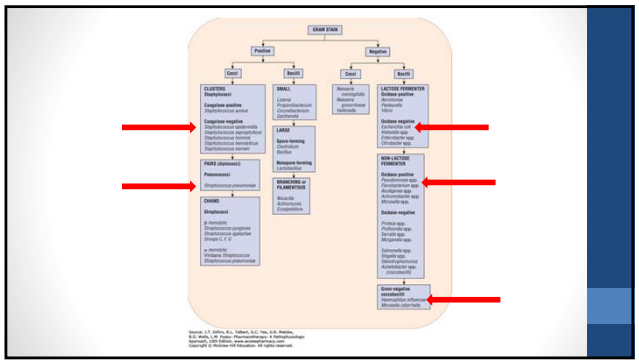
What's the big deal about bacteria?

Which is which?

- Gram staining is used to classify different bacteria
- Shape also plays a factor in differentiating bacteria
- These factors determine the selected therapy

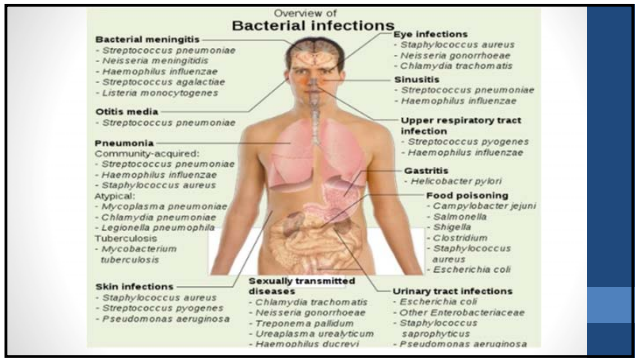


Berg, E.G. Chemical and Engineering News. 2018. https://cen.acs.org/articles/93/web/2015/04/New-Spin-Old-Gram-Stain.html



Common Infections

staphylococcal infection or "staph" infection	*Staphylococcus aureus*
Gastric ulcer	*Helicobacter pylori* or *H. pylori*
Urinary tract infection	*Escherichia coli, Klebsiella pneumoniae*
Community-acquired pneumonia	*Streptococcus pneumoniae* or "strep. pneumo"



Which microorganism is most commonly associated with Urinary Tract Infections (UTI)

a) Pseudomonas aeruginosa
b) Staphylococcus aureus
c) Helicobacter pylori
d) Escherichia coli

Antibiotic Selection

1. Where is the infection located?
2. What bacteria are likely to be in that location?
3. Which antibiotics cover the suspected bugs?

Additional Tips:

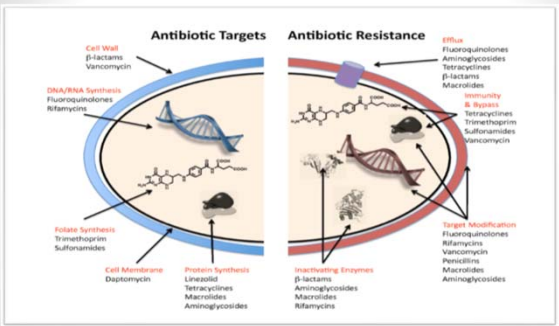
- Get cultures before starting antibiotics
- Look at individual factors: kidney function, drug interactions, allergies, past antibiotics

Leekha S, Terrell CL, Edson RS. General Principles of Antimicrobial Therapy. *Mayo Clinic Proceedings*. 2011;86(2):156-167. doi:10.4065/mcp.2010.0639.

Antibiotic Classes

Common Classes

Aminoglycosides	Beta-lactams	Fluoroquinolones	Fosfomycin
Glycopeptide	Lincosamide	Lipoglycopeptides	Macrolides
Metronidazole	Nitrofurantoin	Sulfonamides	Tetracyclines



https://mir-journal.org/issues/4/3/

Beta-lactams

Major Work Horses

- Penicillins
  - Natural penicillins
  - Aminopenicillins
  - Extended-spectrum penicillins
  - Antistaphylococcal penicillin
- Cephalosporins
  - 5 generations
- Monobactams
- Carbapenems
- MOA: Prevent cell wall synthesis

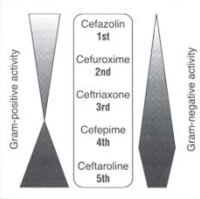
Penicillins

- Natural Penicillins
  - Penicillin (Pen-VK)
  - Penicillin G Benzathine
- Aminopenicillins
  - Amoxicillin
  - Ampicillin
- Extended-Spectrum Penicillins
  - Amoxicillin +Clavulanate (Augmentin)
  - Ampicillin + Sulbactam (Unasyn)
  - Piperacillin + Tazobactam (Zosyn)
- Antistaphylococcal Penicillins
  - Dicloxacillin
  - Nafcillin
  - Oxacillin

Cephalosporins

1st Generation	2nd Generation	3rd Generation	4th Generation	5th Generation
• **Cefazolin (Ancef, Kefzol)** • **Cephalexin (Keflex)** • Cefadroxil (Duricef)	• **Cefuroxime (Ceftin)** • Cefaclor • Cefoxitin • Cefotetan	• Ceftazidime (Fortaz) • Ceftazidime-avibactam (Avycaz) • **Ceftriaxone (Rocephin)** • Cefdinir (Omnicef)	• **Cefepime (Maxipeme)**	• Ceftaroline (Teflaro) Ceftolozane-tazobactam (Zerbaxa)

Cephalosporin Coverage



- Generally no cephalosporins cover *Enterococcus*
- Ceftaroline covers MRSA
- Cefepime and Ceftazidime cover *Pseudomonas*

Fig. 6-2 from *Antibiotics Simplified,* 34d Edition by J.C. Gallgher & C. MacDougall

Carbapenems

- Doripenem (Doribax)
- Imipenem-Cilastatin (Primaxin)
- Meropenem(Merrem)
- Ertapenem (Invanz)

Considered the "big-guns" because of their broad spectrum coverage. Typically reserved for multi-drug resistant gram negative organisms
Ex. *E. Coli, Klebsiella pneumoniae*

Exner M, Bhattacharya S, Christiansen B, et al. Antibiotic resistance: What is so special about multidrug-resistant Gram-negative bacteria? *GMS Hygiene and Infection Control*. 2017;12:Doc05. doi:10.3205/dgkh000290.

Beta-lactam Pearls

- Use with caution in Penicillin allergic patients
- Penicillin and cephalosporins are good drugs of choice in pregnancy
- Almost all have to be adjusted for poor kidney function (exception: ceftriaxone)
- Oral ampicillin and penicillin - take on an empty stomach
- Useful for a wide variety of infections
- Carbapenems typically reserved for use against organisms not susceptible to extended spectrum penicillin

Cephalexin is categorized as a _____.

a) aminoglycoside
b) penicillin
c) cephalosporin
d) sulfonamide

Aminoglycosides

- Gentamicin
- Tobramycin
- Amikacin

Prevents bacterial membranes from forming - destroys bacteria

Mnemonics Time

TANGS do **NOT** kill anaerobes.

- Aminoglycosides
  - **T**obramycin
  - **A**mikacin
  - **N**eomycin
  - **G**entamicin
  - **S**treptomycin
- Adverse Effects
  - **N**ephrotoxicity
  - **O**totoxicity
  - **T**eratogen

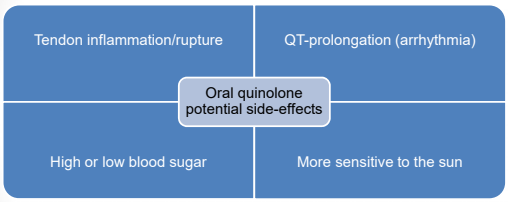
Aminoglycoside Pearls

- Monitor levels for toxicity
- Longer infusion times
- Good coverage of gram negatives
- Can be used with penicillins for synergy against Gram positives
- Post Antibiotic Effect

Quinolones

Ofloxacin	Norfloxacin
Ciprofloxacin (Cipro)	Levofloxacin (Levaquin)
Gatifloxacin (Zymaxid eye drop)	Moxifloxacin (Avelox)

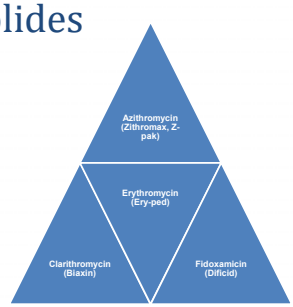
Quinolone Pearls



- Avoid calcium, iron, magnesium, zinc, multivitamins with minerals and antacids within 2 hours
- Potential for drug interactions - ciprofloxacin

https://www.fda.gov/Drugs/DrugSafety/ucm500143.htm

Macrolides

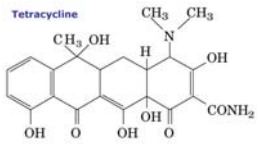


Macrolides Pearls

- QT-prolongation
- Drug interactions
  - Erythromycin
    - Increased levels of phenytoin, digoxin, anticoagulants
- Azithromycin - drug interactions uncommon
- Effective against G+ and some G-

Tetracyclines

- Doxycycline
- Minocycline
- Tetracycline



http://mmbr.asm.org/content/65/2/232/F1.expansion.html

Tetracycline Pearls

- NOT recommended for use in
  - Children < 8 years old
  - Pregnancy
  - Breastfeeding
- More sensitive to sun - use sunblock
- Avoid calcium, iron, magnesium, zinc, multivitamins with minerals and antacids within 2 hours
- Do not lie down for at least 30 minutes after taking

Sulfonamides

- Sulfamethoxazole-Trimethoprim (Bactrim DS, Septra DS)

Sulfonamide Pearls

- Don't use in "sulfa" allergic patients
- Potential to cause kidney stones
- Can decrease folate levels
- More sensitive to the sun - use sunblock
- Can increase potassium levels

Glycopeptide

- Vancomycin (Vancocin)

https://www.pinterest.com/pin/515873332300237154/?lp=true

Vancomycin

- Monitoring troughs
  - Range between 10-15 µg/mL or 15-20 µg/mL depending on indication
- Infusion reactions "Red-man syndrome"
  - Dependent on infusion rate, infuse slowere over longer period
- Kidney toxicity
- Ototoxicity - hearing loss
- Oral formulation only used for Clostridium difficile or C. diff infections

The only indication oral vancomycin has is for what organism?

a) Methicillin-resistant *Staphylococcus aureus*
b) *Enterococcus viridans*
c) *Clostridium difficile*
d) ALL of the ABOVE

Metronidazole (Flagyl)

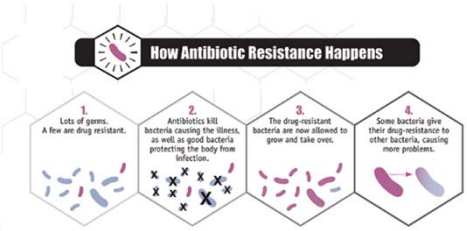
- Useful for anaerobes, *Trichomonas vaginalis*, *H. Pylori*, *Giardia lambia*, *C. diff*
- Disulfarim-like reaction – avoid alcohol
- **GOLD Standard** against anaerobes

https://www.pinterest.com/pin/161707442847167482/

Antimicrobial Stewardship

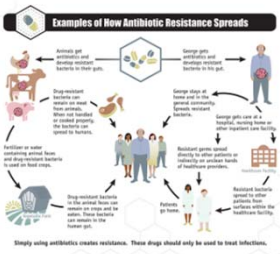
- What is it?
  - Overuse of antibiotics leads to mutations
  - Mutated bacteria continue to grow and spread
  - Drugs become less effective as the mutated bacteria spread
- CDC, NIH, and health systems/hospitals develop programs to reduce the overuse/overprescribing of antibiotics
- Goal is to use antibiotics more effectively and more targeted to the infection

Antimicrobial Stewardship



https://www.cdc.gov/drugresistance/about.html. 2018

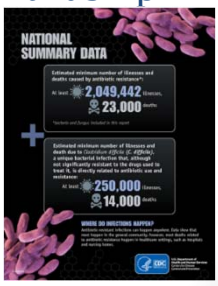
Antimicrobial Stewardship



https://www.cdc.gov/drugresistance/about.html. 2018

Antimicrobial Stewardship

- **Don't** use broad spectrum antibiotics for a long time
- **Don't** use antibiotics for viral infections/common cold
- Hygiene and sanitize **appropriately** to prevent the spread of infectious agents



https://www.cdc.gov/drugresistance/about.html. 2018

Why is it important to prevent antimicrobial resistance?

a) Resistance is futile
b) Treatments are becoming less effective
c) Alternative treatments may be less effective and/or more costly
d) A and C
e) B and C

Patient Case:

JK is a 23 year old male who presents to the ED with a fever and drowsiness. Additionally, 3 days ago he cut himself on the arm while working outside. His arm is now swollen and red. On examination, his blood pressure is low, his white blood cell count is high. Blood cultures were drawn and showed MRSA. Patient is allergic to sulfa drugs, penicillin, and red dye #40.

Which antibiotic therapy would you choose for this patient?

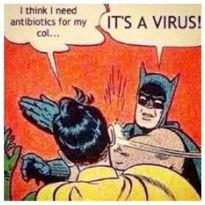
a) Amoxicillin
b) Sulfamathoxazole/Trimethoprim (Bactrim)
c) Oral Vancomycin
d) IV Vancomycin

Which side effects would you be concerned about?

a) Rash
b) Kidney injury
c) Hearing loss
d) All of the above

Summary

- Types of bacteria - Gram +/-, Anaerobes
- Antibiotic classes
- Antibiotic coverage
- Antimicrobial Stewardship
- Questions??



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- Centers for Disease Control. Antimicrobial/Antibiotic Resistance. 2018. https://www.cdc.gov/drugresistance/about.html. Accessed August 14, 2018.