OREGON HEALTH AUTHORITY

August 20, 2025

Eastern Oregon Infection Prevention & Control (IPC) Community of Care

Meet your OHA Team!

Pam Bruhn
IP
Regions
6, 7, and 9

Katie Cox
Epi
Regions
6 and 9

Dan Daniluk
Epi
Region 7

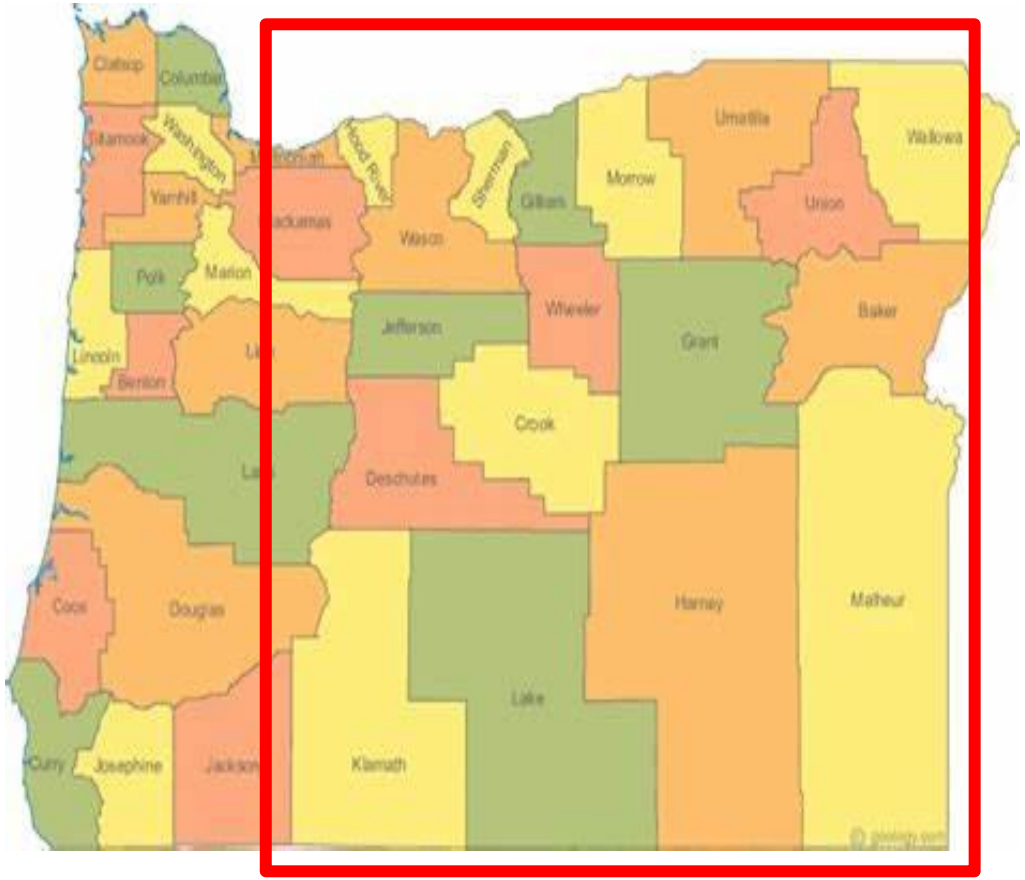
Elizabeth Johnson
MDRO IP Eastern Oregon

Purpose

Our time is intended to provide a space for infection preventionists and local public health personnel in Regions 6, 7 and 9 to come together to share ideas and stories and to learn about topic in infection prevention.

Our goal is to build community among a group of practitioners who are commonly isolated as the only one in their setting.

This time is **not** intended to provide specific recommendations for a facility. This space will provide a connection with the OHA or LPHA infection preventionists and epidemiologists who can provide that direct guidance.



Housekeeping

- Please turn off any AI recording/technology (against OHA policy)
- If you have questions during today's presentation, please feel free to raise your hand or type your question into the chat.

Agenda

- Presentation
  - The ABCs of Antibiotics
  - Presented by: Liz Breitenstein, PharmD, Antimicrobial Stewardship Pharmacist, OHA Acute & Communicable Disease Prevention
- Questions and Discussion
- Announcements

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08/20/2025

The ABCs of Antibiotics

Liz Breitenstein, PharmD

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Objectives

Review key points for major antibiotic classes

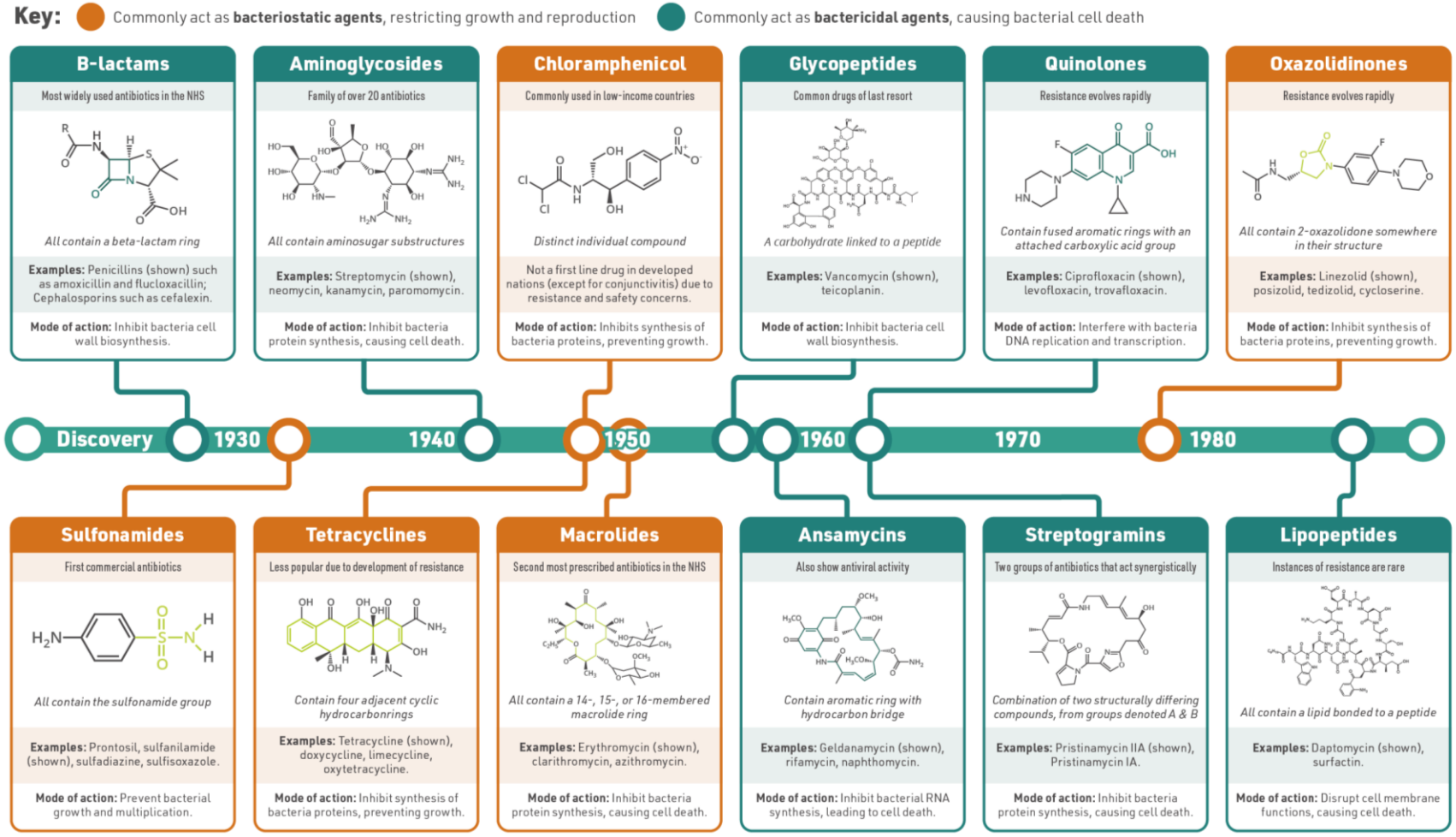
- Not a comprehensive review of all antibiotics
- Not a comprehensive review of each drug

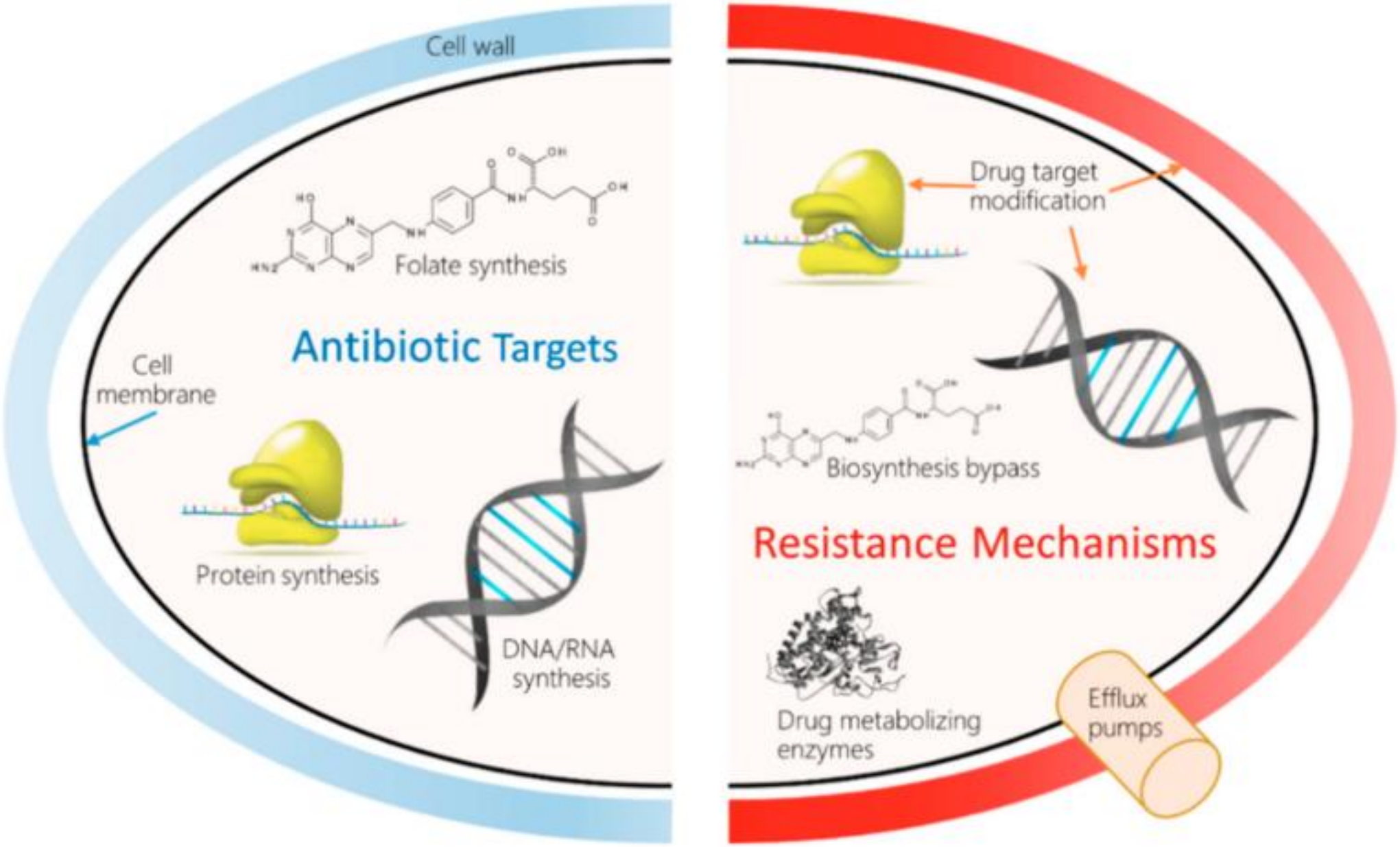
Discuss mechanisms of action and development of resistance

Highlight clinical pearls

Antibiotic Classes

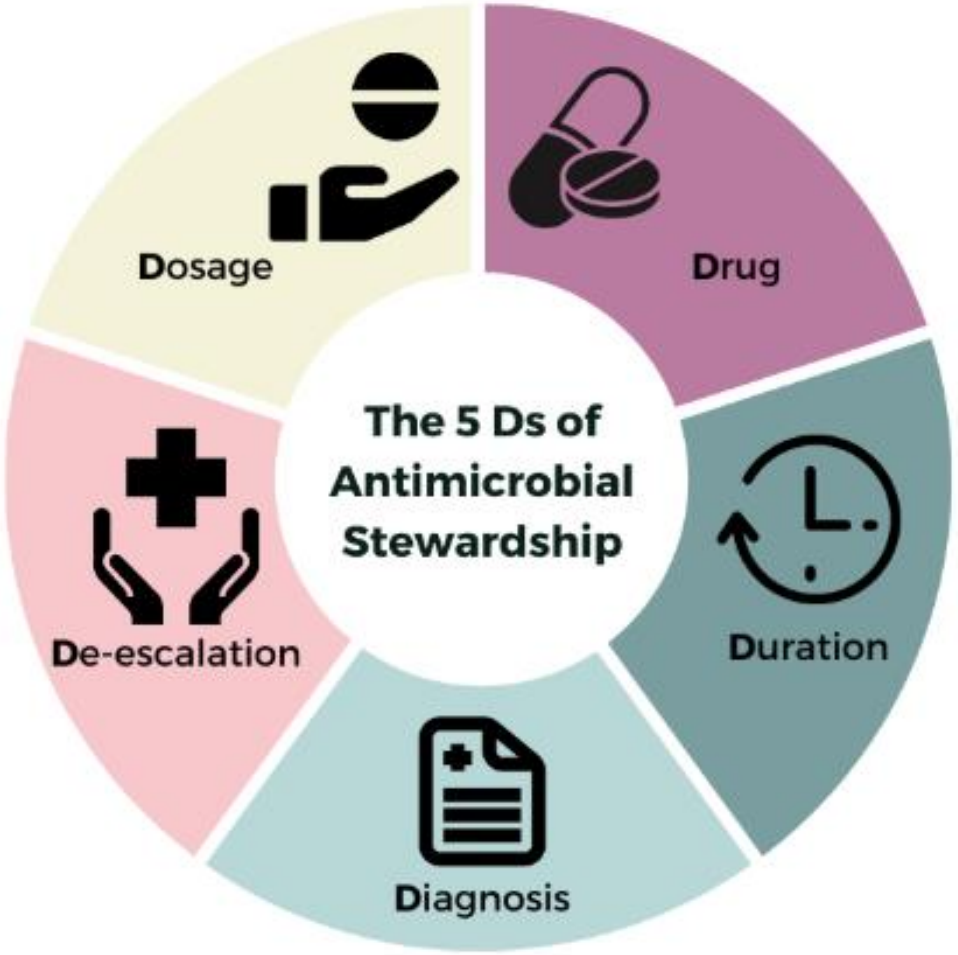
- Based on mechanism of action
- Generally similar properties within class



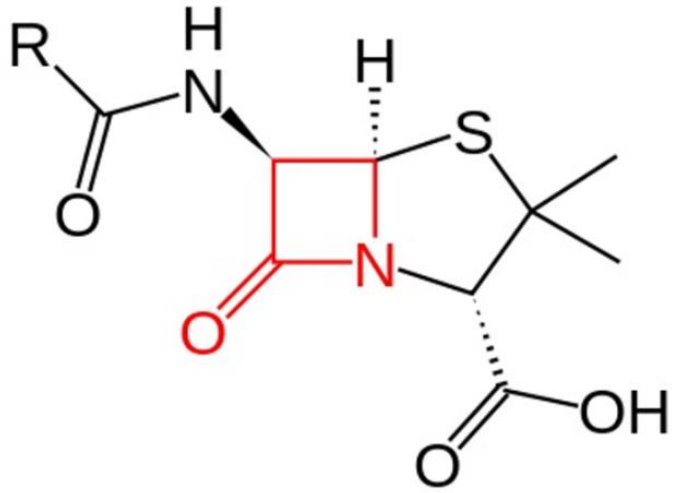

Cell wall
Folate synthesis
Antibiotic Targets
Cell membrane
Protein synthesis
DNA/RNA synthesis
Drug target modification
Biosynthesis bypass
Resistance Mechanisms
Drug metabolizing enzymes
Efflux pumps

Preventing Resistance

- Diagnosis: Only treat true bacterial infections – not viral infections, colonization
- Drug: Use the narrowest effective agent
- Dose: Use the correct dose
- Duration: Shortest effective course
- De-escalation: Based on susceptibilities



Beta-Lactams

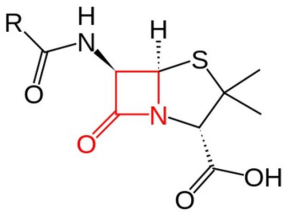


- Penicillins, cephalosporins, carbapenems
- Inhibit bacterial cell wall synthesis
- Generally well-tolerated; Adverse Reactions:
  - Allergic Reaction
  - GI upset or diarrhea
  - **Seizures at high doses – many require dose adjustment for renal function**
- **These antibiotics can be destroyed by beta-lactamases**
- Beta-lactamases are enzymes produced by bacteria that break open the beta-lactam ring, inactivating the beta-lactam antibiotic
  - There are many different types of beta-lactamases

Beta-Lactam Allergies

- Broad-spectrum antibiotics used as an alternative to penicillins are associated with higher healthcare costs, increased risk for antibiotic resistance, and suboptimal antibiotic therapy
- Correctly identifying those who are not truly penicillin-allergic can decrease unnecessary use of broad-spectrum antibiotics

Penicillins

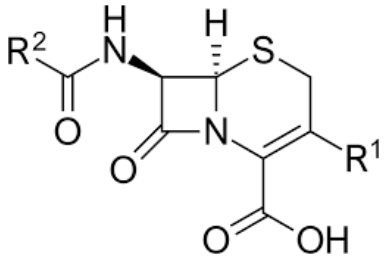


- Very short half-lives - must be dosed multiple times per day or by continuous infusion (except intramuscular)
  - **Natural Penicillins: Penicillin G, Penicillin V**
    - Spectrum: Streptococci and syphilis (*Treponema pallidum*)
    - Drug of choice for: Syphilis, strep throat
  - **Aminopenicillins: Amoxicillin, Ampicillin**
    - Spectrum: Same as natural penicillins + a few gram-negative organisms
    - Used for: Upper respiratory infections, otitis media
  - **Antistaphylococcal Penicillins: Nafcillin, Oxacillin, Dicloxacillin**
    - Spectrum: Similar to natural penicillins + Methicillin-Sensitive *Staphylococcus Aureus* (MSSA)
    - Used for: Drug of choice for MSSA infections: cellulitis, osteomyelitis, endocarditis, bacteremia

Penicillin/Beta-lactamase Inhibitor Combos

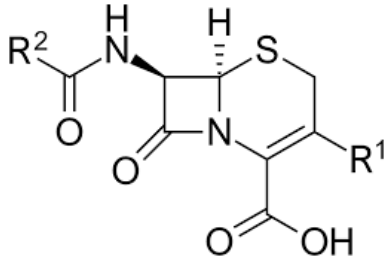
- Beta-lactamase inhibitors block the bacterial enzymes that destroy beta-lactam drugs. Addition of beta lactamase inhibitor = broader spectrum (MSSA, anaerobes)
  - **Amoxicillin/Clavulanate (Augmentin), Ampicillin/Sulbactam (Unasyn)**
    - Spectrum: Broadens overall spectrum, covers MSSA and gram-negative anaerobes associated with bite wounds
    - Used for: Sinusitis, respiratory infections, otitis media, bite wounds
  - **Piperacillin/Tazobactam (Zosyn)**
    - Spectrum: Broadest penicillin. Gram-positive, better overall gram-negative coverage, including *Pseudomonas aeruginosa*
    - Wide array of uses - respiratory, skin, abdominal, bloodstream and other infection types
    - Commonly started as empiric therapy before an organism is isolated and sensitivities are known

Cephalosporins



- **1st gen: Cefazolin (Ancef), cephalexin (Keflex)**
  - Spectrum: Gram-positive (MSSA and strep), a few gram-negative: “PEcK” – ***P****roteus,* ***E. c****oli,* ***K****lebsiella*
  - Used for: Skin/soft tissue infections, surgical prophylaxis (because MSSA lives on the skin)
- **2nd gen: Cefuroxime (Ceftin), Cefotetan (Cefotan)**
  - Spectrum: Same as first generation + a few additional gram negatives
- **3rd gen: Ceftriaxone (Rocephin), Cefdinir (Omnicef), Cefpodoxime (Vantin)**
  - Spectrum: Additional gram-negative coverage (but NOT *Pseudomonas*)
  - Wide array of infections, including UTI, endocarditis, meningitis, skin/soft tissue, bone/joint

Cephalosporins, cont.



- **4th gen: Cefepime (Maxipime)**
  - Spectrum: Gram-positive including MSSA, and gram-negative including *Pseudomonas aeruginosa*
  - Used for: Healthcare-associated infections (pneumonia, meningitis) and more
  - Susceptible, dose-dependent “SSD”
- **5th gen: Ceftaroline (Teflaro)**
  - Spectrum similar to ceftriaxone, but adds coverage of **MRSA (only cephalosporin with MRSA coverage)**
  - DOES NOT cover *Pseudomonas aeruginosa*
  - Approved for complicated skin/soft tissue infections and community-acquired pneumonia (CAP)
- **Cephalosporin/Beta-lactamase Inhibitor Combos: Ceftazidime/Avibactam (Avycaz), Ceftolozane/Tazobactam (Zerbaxa)**
  - Active against many multidrug-resistant gram-negatives, including *Pseudomonas aeruginosa*
  - No activity against MRSA or vancomycin-resistant Enterococci (VRE)
  - Hospital-acquired bacterial pneumonia and ventilator-associated bacterial pneumonia (HABP/VABP)

Carbapenems

- **Imipenem/Cilastatin (Primaxin), Meropenem (Merrem), Ertapenem (Invanz)**
- **Broad Spectrum**
  - Cover multi-drug-resistant *Acinetobacter baumannii, Pseudomonas aeruginosa* and *Klebsiella pneumoniae*
  - Drugs of choice for extended spectrum beta lactamase (ESBL)-producing organisms
  - DO NOT cover MRSA or VRE
    - **E**rtapenem is the **E**xception – lacks coverage for “APE” **A**cinetobacter, **P**seudomonas and **E**nterococci but does still cover ESBL. Main advantage is convenient once/day dosing for outpatient infusion.
- **Reserve for severe hospital-acquired infections or ESBL producers**
- May be used as empiric therapy in an ICU setting, de-escalate when possible

Carbapenem/Beta-lactamase Inhibitor Combos

- **Reserve for Carbapenem-resistant Enterobacterales (CRE) infections, or resistant infections when other options fail**
  - **Meropenem/Vaborbactam (Vabomere)**
    - Addition of vaborbactam inhibits many carbapenemases
    - Does not expand coverage to carbapenem-resistant *Acinetobacter* species or *Pseudomonas aeruginosa*
  - **Imipenem-cilastatin-relebactam (Recarbrio)**
    - FDA-approved 2019 **for patients with limited or no treatment options** for complicated infections
    - Covers **some** carbapenem-resistant *Pseudomonas aeruginosa*
    - Does not expand coverage to carbapenem-resistant *Acinetobacter* species

Macrolides

- Inhibit protein synthesis
- **Azithromycin (Zithromax), Clarithromycin (Biaxin), Erythromycin**
  - Spectrum: Atypical organisms (*Mycoplasma pneumoniae*, *Legionella* species, *Bordetella pertussis*), some gram-positives and gram-negatives
  - Used for: Commonly used for respiratory infections, CAP, Chlamydia, Gonococcal infections
    - Beware macrolide resistance in *Neisseria gonorrhoeae*
  - QTc-interval prolongation
  - **Generally Azithromycin preferred for fewer drug interactions and adverse effects**

Tetracyclines

- **Doxycycline**
- Inhibit protein synthesis
- Spectrum: Unusual pathogens including pathogens responsible for: Lyme disease, Tularemia, Vibrio, Malaria, Anthrax, Plague
- Good choice for mild-moderate skin/soft tissue infections due to community-acquired MRSA infection
- Adverse Effects:
  - **Esophagitis (take with plenty of water),**
  - Photosensitivity
  - Tooth discoloration
  - **Historically use restricted in children < 8 years of age due to inhibition of bone growth,** short-term doxycycline OK
  - Absorption decreased by aluminum, calcium, magnesium, iron
  - Expired Tetracycline can degrade and cause Fanconi syndrome (can result in severe kidney damage)

Modified Tetracyclines

- **Used for certain multi-drug-resistant organisms**
  - **Eravacycline (Xerava)** Activity against ESBL-producing and carbapenem-resistant *Acinetobacter baumannii*
  - **Omadacycline (Nuzyra)** activity against multidrug-resistant organisms including Klebsiella, Acinetobacter, and ESBLs
  - **Tigecycline (Tygacin)** Spectrum is broad, including multi-drug resistant gram-negative pathogens, some ESBL and carbapenemase-producing strains, VRE and MRSA.
    - **Overall increased risk of death** – FDA black box warning!
    - Tigecycline should be reserved for use in situations when alternative treatments are not suitable
    - NOT a good drug for blood infection, because it distributes rapidly to tissues

Clindamycin

- Inhibits protein synthesis
- Spectrum: Many *Staph aureus* strains (including MRSA), and some *Strep pneumoniae* and others.
- Used for skin/soft tissue infections, oral infections, Typically covers community-associated MRSA but not health care-associated MRSA
- Used for group A streptococcal and pneumococcal infections in penicillin-allergic patients
- Adverse effects:
  - **Clindamycin is more strongly associated with *C. difficile* colitis than other antibiotics.** Boxed Warning “Can cause severe and possibly fatal colitis”
  - Risk of esophagitis, take with plenty of water

Aminoglycosides

- **Tobramycin, Gentamicin (Garamycin), Amikacin**
  - Inhibit protein synthesis
  - Spectrum: Gram-negatives, but may be used for gram-positive synergy
  - Used for: serious gram-negative infections especially when Pseudomonas is suspected (pneumonia, bacteremia, UTI). Used with beta-lactams against gram-positive organisms for synergistic effect (endocarditis).
    - Inhaled formulations for cystic fibrosis.
    - Tobramycin sometimes mixed in cement and used during orthopedic surgery
  - **Nephrotoxicity (often reversible), Ototoxicity (often irreversible)**

    Increased risk with high or frequent doses, long duration (>3 days), older age
  - Narrow therapeutic range, **drug level should be monitored**

Fluoroquinolones

- Inhibit DNA synthesis
  - **Ciprofloxacin (Cipro)**
    - Spectrum: Gram-negatives, including *Pseudomonas aeruginosa*.
      - Not considered a “respiratory fluoroquinolone” because of its limited activity against *Streptococcus pneuamoniae*
    - Used for many infections including UTI, bone/joint, GI
  - **Levofloxacin (Levaquin)**
    - Spectrum: “Respiratory fluoroquinolone.” Has activity against *Streptococcus pneuamoniae*, the most common cause of community acquired pneumonia, good for atypicals like Legionella, Mycoplasma
    - Used for: CAP, UTI
  - **Moxifloxacin (Avelox)**
    - Spectrum: “Respiratory fluoroquinolone” - *Streptococcus pneuamoniae.*
    - CAP, **NOT for UTI**
- Calcium, Iron, Magnesium, Aluminum decrease oral absorption

Fluoroquinolones Adverse Effects

- FDA Warnings:
- **Serious side effects associated with fluoroquinolones may outweigh the benefits of fluoroquinolone use**
- Adverse Effects:
  - **Tendonitis**, Tendinopathy, including rupture of the Achilles tendon, especially with steroids – avoid vigorous exercise
  - QTc prolongation, cardiac arrhythmias
  - **Peripheral neuropathy** may occur soon after taking the fluoroquinolone and **may be permanent**
  - CNS effects: seizure, increased intracranial pressure, agitation, insomnia, nightmares, dizziness, confusion, altered mental health, suicidal thoughts
  - Hypoglycemia (including coma)
  - ***C. diff*–associated diarrhea has been strongly associated with fluoroquinolone use**

Sulfamethoxazole/Trimethoprim (SMX/TMP, Bactrim)

- Inhibits folate synthesis
- Spectrum: Wide spectrum including most community acquired MRSA
- Used for: Community-acquired MRSA skin infections, UTI, Pneumocystis pneumonia,
- Adverse Effects:
  - Hypersensitivity reactions: rashes, Stevens-Johnson syndrome, anaphylaxis, angioedema
  - Severe adverse reaction rate higher in patients with HIV and older adults
  - Hyperkalemia (high potassium), take care in kidney disease and with patients on ACEs or ARBs (common blood pressure meds)

Vancomycin

- Inhibits cell wall synthesis
- Spectrum: Activity against most all gram-positive organisms, except for the enterococci that have become resistant (VRE)
- Uses: MRSA infections, empiric use when MRSA is a concern, *C. difficile* colitis (oral only)
  - Poor oral absorption – administered **IV for systemic infections. Administer orally only for *C. diff.***
- **Too rapid infusion can lead to infusion reaction** (warm, flushed, hypotension) can be prevented by slowing infusion rate –NOT a true allergic reaction
- **Nephrotoxic** at higher doses, ototoxic (less common)
- **Requires individualized dosing, levels are frequently monitored to balance efficacy and toxicity**

Linezolid (Zyvox)

- Inhibits protein synthesis
- Spectrum: covers all Gram-positives including strep, **MRSA and VRE**
- Commonly used for VRE
- Adverse effects
  - Risk of serotonin syndrome with selective serotonin repute inhibitors (SSRIs) and monoamine oxidase inhibitors (MAOIs)
  - **Long term usage can lead to thrombocytopenia (low platelets), lactic acidosis, peripheral neuropathy, optic neuritis and blindness. In general, Linezolid is well tolerated for short-term, but not so much long-term.**

Daptomycin (Cubicin)

- Destroys cell membrane
- Spectrum: Active against many resistant gram-positive organisms, including **VRE** and **MRSA**.
- Uses: Skin and skin structure infections, bacteremia, endocarditis, and UTI caused by resistant gram-positive organisms.
- DO NOT use for pneumonia– it is inactivated by surfactant in the lung

Metronidazole (Flagyl)

- Disrupts DNA production in anaerobic bacteria and some protozoa
- Spectrum: Variety of organisms, including gram-negative, gram-positive, and protozoa
- Used for: Bacterial vaginosis, trichomoniasis, *H. pylori*
- Adverse Effects:
  - Metallic taste
  - Disulfiram-like reaction (flushing, headache, nausea, and vomiting) may occur **if alcohol is ingested within 3 days of use**
  - Dark brown to red urine

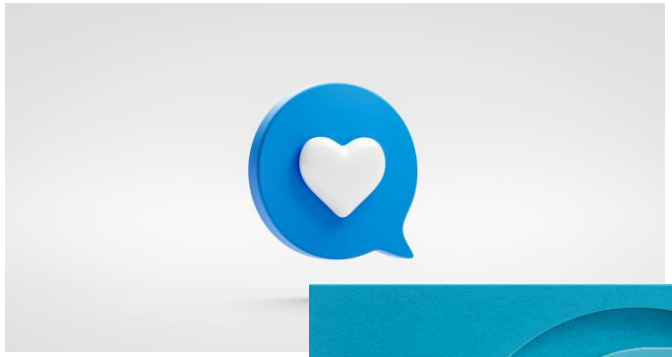
Urinary Tract Infection Antibiotics

- **Nitrofurantoin (Macrobid), Fosfomycin**
- **Ineffective for infections outside of the lower urinary tract**, use for uncomplicated lower UTIs only, do not use in pyelonephritis
  - Nitrofurantoin: Avoid for long-term use due risk of Chronic Pulmonary Fibrosis

Resources

- Merck Manual Antibacterial Medications
- IDSA Practice Guidelines
- CDC Penicillin Allergy Factsheet
- Antibiotic Pocket Guide UW Center for Stewardship in Medicine
  - A tool to guide prescribing based on Pacific NW resistance data and expert opinion.

Comments, Thoughts, Questions….



Next Meeting:

Date: September 17, 2025

Time: 1:00 pm – 2:00 pm

Session Topic: Respiratory Case Studies

Presenters: Pam Bruhn & Katie Cox

Announcements

- New meeting time
  - Next month, September 17, 2025, we will begin meeting at a new time: meetings will still be on the **3rd Wednesday of each month**, but we will now meet from **1:00 PM – 2:00 PM PT.**
  - The invitation to the new meeting series will be sent via email later this month.

Contacts

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Thank you!! 😊