Introduction to Clinical Pharmacology

Chapter 7 Antibacterial Drugs That Disrupt the Bacterial Cell Wall

Introduction to Penicillins

Group of antibiotics for treatment of susceptible pathogens

Actions: cell wall synthesis; DNA or RNA synthesis; protein synthesis

There are four groups of penicillins: (1) natural penicillins, (2) penicillinase-resistant penicillins, (3) aminopenicillins, and (4) extended-spectrum penicillins

Identifying the Appropriate Penicillin: Sensitivity and Resistance

Receive culture and sensitivity report

Select antibiotic to which the microorganism is sensitive

To minimize risk of bacteriostatic activity, ensure adequate blood level of penicillin in the body

Tracheal aspirate: *Pseudomonas aeruginosa*		
Antibiotic	**MIC**	**Interpretation**
Aztreonam	8	S
Ceftriaxone	> 32	R
Cefepime	2	S
Ciprofloxacin	≤ 1	I
Gentamicin	2	S
Meropenem	≤ 0.5	S
Piperacillin/Tazobactam	≤ 4/4	S

Uses

Used against infectious diseases

Used as initial therapy for any suspected staphylococcal infection

Prescribed as prophylaxis

- Potential secondary bacterial infection
- Potential infection in high-risk patients
- On a continuing basis to those with rheumatic fever or chronic ear infections

Resistance to Drugs

Drug resistance becomes an issue when:

- Antibiotics are regularly used by a patient
- A group of people live in close proximity

Bacteria: naturally resistant or acquired resistance to drug, such as MRSA

Emergence of a new resistance associated with bacteria that have both a natural and an acquired resistance ability

Adverse Reactions

Gastrointestinal reactions

Hypersensitivity reactions

- Anaphylactic shock
- Cross-sensitivity/cross-allergenicity
- Superinfections: bacterial; fungal

Hematopoietic changes

Contraindications and Precautions

Contraindicated in patients with history of hypersensitivity to penicillin or the cephalosporins

Use cautiously in patients with renal disease, asthma, bleeding disorders, gastrointestinal disease, pregnancy or lactation, history of allergies

Reason for caution: any indication of sensitivity

Interactions

Interactant drug	Effect of interaction with penicillin
Oral contraceptives	Decreased effectiveness
Tetracyclines	Decreased effectiveness
Anticoagulants	Increase bleeding risks
Beta-adrenergic blocking drugs	May increase the risk for an anaphylactic reaction

Introduction to Cephalosporins

Effective in the treatment of all strains of bacteria affected by penicillins and some strains resistant to penicillins

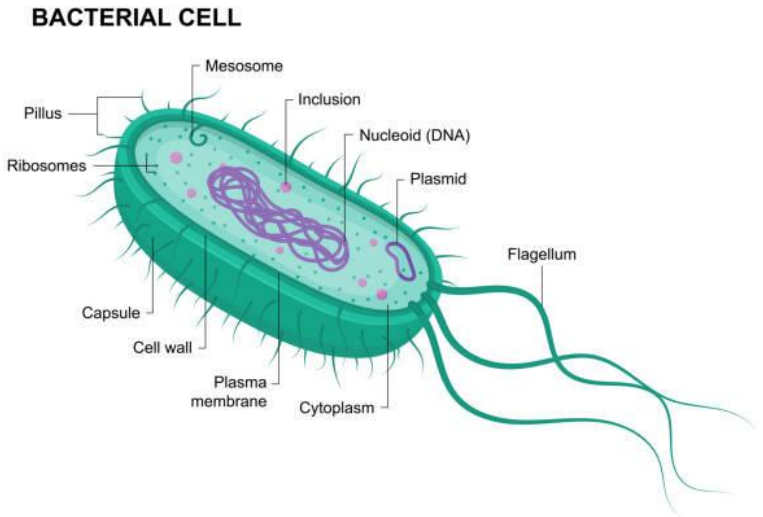
Classification: divided into first-, second-, third-, and fourth-generation drugs

Uses: treat urinary tract, bone/joint, and respiratory infections; otitis media

Cephalosporins: Actions

Exert bactericidal effect:

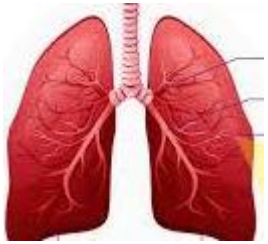
- Have a beta-lactam ring
  - Targets the bacterial cell wall, making it defective and unstable



Cephalosporins: Uses

Used to treat infections caused by bacteria:

- Respiratory
- Ear
- Bone/joint
- Genitourinary tract



Culture and sensitivity tests: help determine best antibiotic to control an infection

Used throughout perioperative period

Cephalosporins: Adverse Reactions #1

Gastrointestinal reactions:
- nausea; vomiting; diarrhea

Administration route reactions:
- intramuscularly and intravenously

Other body system reactions:
- Headache; dizziness; malaise; heartburn; fever; nephrotoxicity; hypersensitivity; aplastic anemia; toxic epidermal necrolysis
- Nursing alert:
  - Allergy: approximately 10% of people allergic to penicillin are also allergic to cephalosporins

Cephalosporins: Contraindications and Precautions

Contraindicated in patients:

- Allergic to cephalosporins or penicillins

Used cautiously in patients with:

- Renal disease; hepatic impairment; bleeding disorder; pregnancy; known penicillin allergy

Cephalosporins: Interactions #1

Drug	Common use	Effect of interaction
Aminoglycosides	Anti-infective	Increased risk for nephrotoxicity
Oral anticoagulants	Blood thinner	Increased risk for bleeding
Loop diuretics	Hypertension, reduce edema	Increased cephalosporin blood level

Cephalosporins: Interactions #2

Nursing alert:

- Disulfiram-like reaction: if alcohol consumed within 72 hours
  - Symptoms: flushing; throbbing; respiratory problems; vomiting; sweating; chest pain; hypotension
  - Severe reaction: arrhythmias and unconsciousness

Carbapenems and Miscellaneous Drugs That Inhibit Cell Wall Synthesis

Carbapenems—inhibit synthesis of the bacterial cell wall

Vancomycin—inhibits bacterial cell wall synthesis and increases cell wall permeability

Monobactam—inhibits bacterial cell wall synthesis

Carbapenems: Action and Uses

Inhibit synthesis of the bacterial cell wall and cause the death of susceptible cells

Meropenem: used for intra-abdominal infections; bacterial meningitis

Imipenem-cilastatin: used to treat serious infections; endocarditis; septicemia

Ertapenem: used to treat serious infections; bacterial community-acquired pneumonia

Carbapenems: Adverse Reactions

Common adverse reactions:

- Nausea
- Vomiting
- Diarrhea
- Rash
- Abscess, tissue sloughing, or phlebitis at the injection site

Carbapenems: Contraindications, Precautions, and Interactions

Contraindicated in patients who are allergic to cephalosporins and penicillins; patients with renal failure; children younger than 3 years; pregnant/lactating women

Used cautiously in patients with CNS disorders; seizure disorders; renal or hepatic failure

Excretion of carbapenems: inhibited with probenecid

Preadministration Assessment

- Obtain general health history
- Record vital signs
- Obtain description of signs and symptoms
- Assess infected area
- Note patient's general appearance
- Obtain culture and sensitivity test results

Susceptibility, Anaerobic, MIC AB

SOURCE: BLOOD, BLOOD, CLOSTRIDIUM TERTIUM
SUSCEPTIBILITY, ANAEROBIC, MIC FINAL
CLOSTRIDIUM TERTIUM
Organism identified by client.
There are no established interpretive guidelines for agents reported without interpretations.

Organism	CLOSTRIDIUM TERTIUM	
Antibiotic	MIC (mcg/mL)	Interpretation
Penicillin	<=0.5	S
Pip/Taz	<=32/4	S
Ceftriaxone	<=16	S
Ertapenem	<=4	S
Ciprofloxacin	<=1	
Clindamycin	>4	R
Metronidazole	<=8	S

S=SUSCEPTIBLE I=INTERMEDIATE R=RESISTANT
N=NOT SUSCEPTIBLE D=SUSCEPTIBLE DOSE DEPENDENT

Ongoing Assessment

Evaluate patient daily

Notify primary health care provider if signs and symptoms worsen

Ensure that additional culture and sensitivity tests are performed

Conduct urinalysis, complete blood count, renal and hepatic function tests at intervals

Observe patient closely for hypersensitivity

Nursing Diagnoses

Impaired Skin Integrity

Risk for Impaired Gas Exchange

Impaired Urinary Elimination

Diarrhea

Impaired Oral Mucous Membranes

Impaired Comfort: increased Fever

Planning

The expected outcome includes an optimal response to therapy:

- Management of adverse drug reactions
- Understanding of and compliance with the prescribed treatment regimen

Implementation: Promoting Optimal Response to Therapy

Ensure proper administration

Allow time for culture and sensitivity test

Infections: immediate treatment

Maintain adequate blood levels of drug

- Peak and trough levels

Give oral penicillins on empty stomach

Take care when preparing and administering various forms of penicillin

Implementation: Impaired Skin Integrity

Administer frequent skin care

Avoid harsh soaps, perfumed lotions, rough or irritating clothing

Report rash or hives

Instruct patient to avoid rubbing the area

Administer prescribed emollients, topical corticosteroid, antihistamine, antipyretic creams

Implementation: Risk for Impaired Gas Exchange

Observe for major hypersensitivity reactions; ensure immediate treatment

Tracheostomy may be required

After administering penicillin IM in outpatient setting, ask patient to wait 30 minutes to assess for anaphylactic reactions

Impaired Urinary Elimination

Nephrotoxic effects of cephalosporin

An early sign of this adverse reaction may be a decrease in urine output

Measure and record the fluid intake and output and notify the primary health care provider if the output is less than 500 mL daily

Any changes in the fluid intake–output ratio or in the appearance of the urine also may indicate nephrotoxicity

Implementation: Diarrhea

Inspect stools, and report abnormalities

Save sample of stool and test for occult blood

Observe for and report symptoms of a bacterial or fungal superinfection

Severe symptoms: provide additional treatment

Implementation: Impaired Oral Mucous Membranes

Inspect patient's mouth daily; report signs of impaired mucous membranes

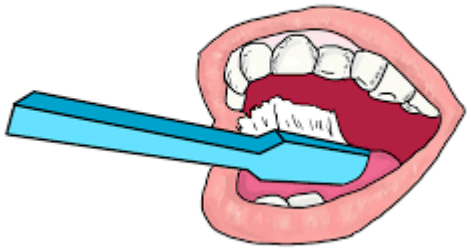
Provide frequent mouth care

Use soft-bristled toothbrush

Recommend nonirritating soft diet

Monitor dietary intake

Severe symptoms: administer antipyretic or antifungal drug



Implementation: Impaired Comfort

Increased fever

- Take vital signs every 4 hours
- Report increase in temperature
- Increase in temperature several days after start of therapy may indicate:
  - Secondary bacterial infection
  - Failure to control original infection

- If fever is caused by adverse reaction, manage by use of antipyretic drug

Educating the Patient and Family

Ensure patient has thorough understanding of drug, treatment, and adverse reactions

Describe drug regimen; stress importance of continued and uninterrupted therapy

Explain to shake and keep oral suspensions refrigerated

Advise to avoid alcohol and take with food if GI upset

Evaluation #1

Therapeutic drug effect achieved

Infection is controlled

Adverse reactions: identified; reported; managed successfully

Urine output at least 500 mL daily; diarrhea—not experienced

Evaluation #2

Patient and family demonstrate understanding of drug regimen

Patient verbalizes importance of compliance with prescribed therapeutic regimen

Skin—free of inflammation, irritation, or ulcerations

Question #1

Is the following statement true or false?

Penicillin, cephalosporin, carbapenem, and vancomycin are primarily bactericidal.

Answer to Question #1

True

Penicillin, cephalosporin, carbapenem, and vancomycin are primarily bactericidal; they work by breaking or inhibiting the growth of the cell walls found in bacterial cells. Categories of penicillin drugs are defined by modifications for resistance, and cephalosporin generations tend to define the sensitivity of the drugs to microorganisms.

Question #2

Is the following statement true or false?

People allergic to penicillin usually do not have an allergy to cephalosporins because they are structurally and chemically different drugs.

Answer to Question #2

False

People allergic to penicillin may also have an allergy to cephalosporins because they are structurally and chemically related drugs.

Question #3

Is the following statement true or false?

One of the best methods to prevent resistance to antibacterial drugs that disrupt the cell wall is to teach the patient to take the medication as instructed: take on time, no omissions, and for the length of the prescription.

Answer to Question #3

True

One of the best methods to prevent resistance is to teach the patient to take the medication as instructed: take on time, no omissions, and for the length of the prescription.