Wolters Kluwer
When you have to be right

Introduction to Clinical Pharmacology

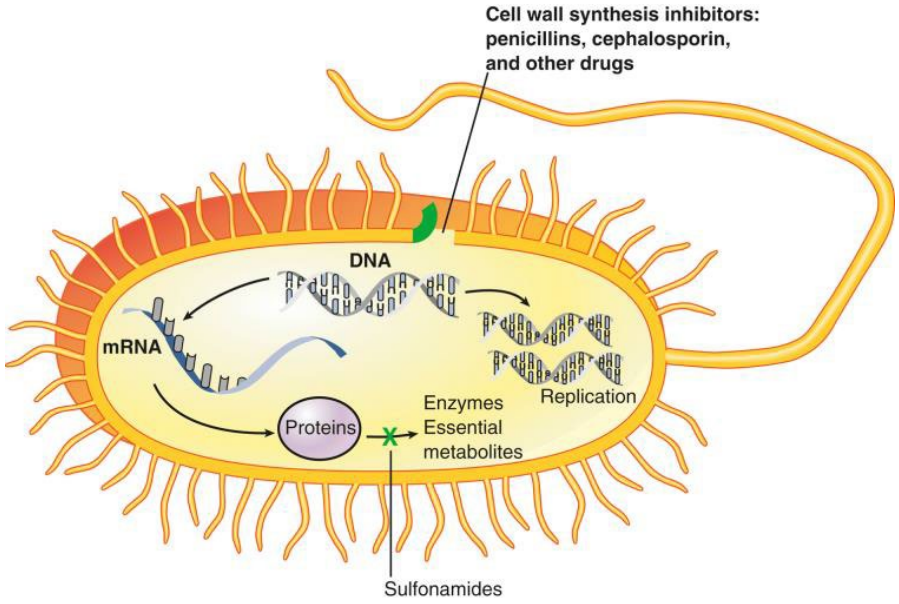
Chapter 7
Antibacterial Drugs That Disrupt the Bacterial Cell Wall

Learning Objectives

1. Explain the uses, general drug actions, and general adverse reactions, contraindications, precautions, and interactions of antibacterial drugs that disrupt bacterial cell walls.
2. Distinguish important preadministration and ongoing assessment activities the nurse should perform on the client taking an antibacterial drug that disrupts bacterial cell walls.
3. List nursing diagnoses particular to a client taking an antibacterial drug that disrupts bacterial cell walls.
4. Discuss hypersensitivity reactions as they relate to antibiotic therapy.
5. Examine ways to promote optimal response to therapy, nursing actions to minimize adverse effects, and important points to keep in mind when educating clients about the use of antibacterial drugs that disrupt bacterial cell walls.

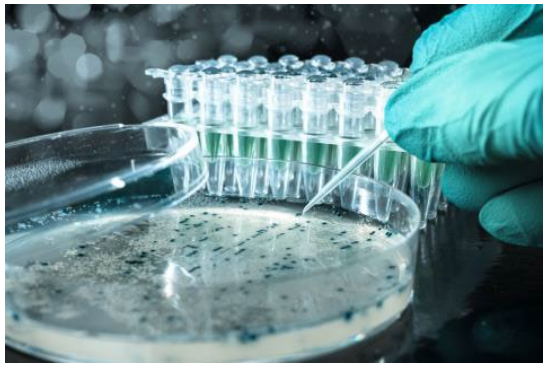
Antibiotics That Disrupt the Cell Wall

- Human cells have cell membranes and bacterial cells have cell walls
- The following antibiotics interfere with cell wall synthesis and cause bacterial cell death
  - Penicillins
  - Cephalosporins
  - Carbapenems
  - Vancomycin



Resistance to Drugs

- Bacterial resistance—some bacteria develop the ability to produce substances that inactivate or destroy the antibiotic
- Drug resistance becomes an issue when:
  - Antibiotics are regularly used by a client
  - A group of people live in close proximity



- Bacteria are either naturally resistant or develop 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

Antibiotic Stewardship

BOX 7.1 Ten Commandments of Antibiotic Use

1. Teach clients nondrug ways to manage nonbacterial infections
2. Know the bacteria, treat it specifically
3. Treat for effectiveness and shorten the course, if appropriate
4. Communicate with clients to increase adherence
5. Use a combination of drugs only in specific situations
6. Substitute only when equivalent product is available
7. Educate to prevent self-prescription
8. Follow evidence-based guidelines
9. Use laboratory results correctly to prescribe
10. Research and understand your local trends and limits

Adapted from Levy-Hara, G., et al. (2011). Ten commandments for the appropriate use of antibiotics by the practicing physician in an outpatient setting. *Front Microbiology*, 2, 230.

Penicillins—Actions

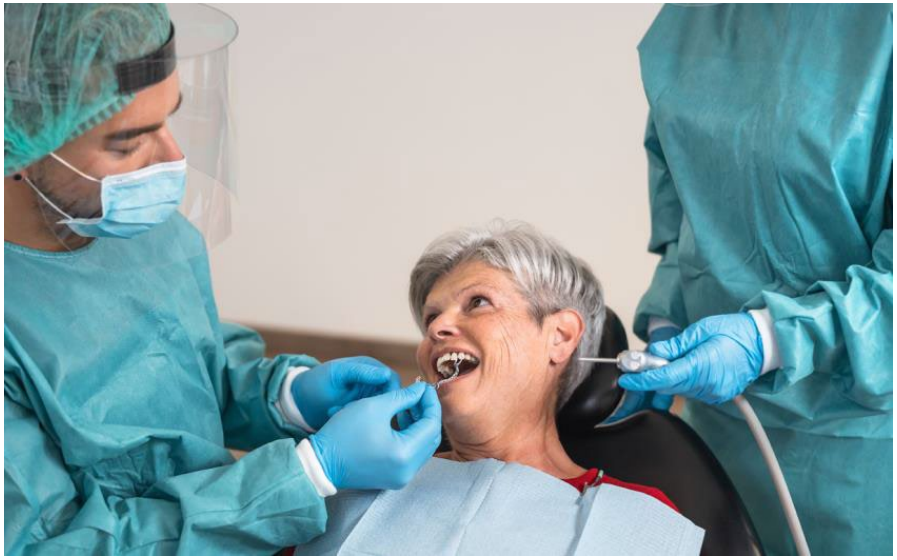
- Group of antibiotics for treatment of susceptible pathogens
- Action—Interferes with cell wall synthesis
- There are four groups of penicillins:
  - natural penicillins,
  - penicillinase-resistant penicillins,
  - aminopenicillins, and
  - extended-spectrum penicillins
- Broader spectrum penicillins
  - Penicillin–lactamase-inhibitor combinations
  - Extended spectrum penicillins

Penicillins—Uses #1

- Used against infectious diseases:
  - Urinary tract infections
  - Septicemia
  - Meningitis
  - Intra-abdominal infections
  - Sexually transmitted infections (syphilis)
  - Pneumonia and other respiratory infections
  - Soft tissue infections and injuries
  - Used as initial therapy for any suspected *staphylococcal* infection

Penicillins—Uses #2

- Prescribed as prophylaxis
  - Potential secondary bacterial infection
  - Potential infection in high-risk clients
  - Prior to dental, oral, or respiratory procedures
  - On a continuing basis to those with rheumatic fever or have chronic ear infections



Penicillins—Adverse Reactions #1

- Common Gastrointestinal System Reactions:
  - Glossitis (inflammation of the tongue)
  - Stomatitis (inflammation of the mouth), dry mouth
  - Gastritis
  - Nausea, vomiting
  - Diarrhea, abdominal pain
- Other Common Reactions
  - Pain at injection site (IM)
  - Phlebitis (IV)

Penicillins—Adverse Reactions #2

- Hypersensitivity reactions
  - Anaphylactic shock
  - Cross-sensitivity
- Other adverse reactions
  - Anemia
  - Thrombocytopenia
  - Leukopenia
  - Bone marrow depression

Penicillins—Contraindications

- Penicillins should not be administered in clients with hypersensitivity to penicillins or cephalosporins
- Penicillins should be used cautiously in clients with
  - Renal disease
  - Asthma
  - Bleeding disorders
  - Gastrointestinal disease
  - Pregnancy (category C)
  - Lactation (diarrhea or candidiasis in the infant)
  - Any indication of sensitivity

Penicillins—Interactions

Interacting Drug	Common Use	Effect of Interaction
Oral contraceptives (with estrogen)	Contraception	Decreased effectiveness of contraceptive agent (with ampicillin, penicillin V)
Tetracyclines	Anti-infective	Decreased effectiveness of penicillins
Anticoagulants	Prevent blood clots	Increased bleeding risks (with large doses of penicillins)
Beta-adrenergic blocking (β-adrenergic blocking) drugs	Blood pressure control and heart problems	May increase the risk for an anaphylactic reaction

Cephalosporins—Actions

- Bactericidal—have a beta-lactam ring and target the bacterial cell wall making it unstable and kill the bacteria
- Classification: divided into first-, second-, third-, fourth-, and fifth-, generation drugs
- As the cephalosporins progress from first- to fifth-generation—increase in sensitivity of gram-negative microorganisms and a decrease in sensitivity of gram-positive microorganisms
- Fifth generation are broad spectrum—effective against MRSA

BOX 7.4 Examples of First-, Second-, Third-, Fourth-, and Fifth-Generation Cephalosporins

- First generation—cephalexin
- Second generation—cefaclor
- Third generation—cefoperazone
- Fourth generation—cefepime
- Fifth generation—ceftaroline

Cephalosporins—Uses

- Used to treat infections:
  - Respiratory infections
  - Otitis media (middle ear infection)
  - Bone/joint infections
  - Complicated intra-abdominal or genitourinary tract infections
- Prophylactically to prevent infection:
  - From sexual assault
  - Throughout the perioperative period

Cephalosporins—Adverse Reactions

- Common Gastrointestinal System Reactions:
  - Nausea
  - Vomiting
  - Diarrhea
- Other Reactions
  - Headache
  - Dizziness
  - Malaise
  - Heartburn
  - Fever
  - Nephrotoxicity
  - Aplastic anemia
  - Toxic epidermal necrolysis
  - Positive direct Coombs test (cefepime)

Nursing Alert: Cephalosporins—Adverse Reactions

- Allergy: approximately 10% of people allergic to penicillin are also allergic to cephalosporins
- Can cause pain, tenderness, and inflammation when given IM
- Can cause phlebitis or thrombophlebitis when given IV
- Can cause a bacterial or fungal superinfection

Cephalosporins—Contraindications

- Cephalosporins should not be administered
  - In clients with a history of allergies to cephalosporins
- Cephalosporins should be used cautiously in clients with:
  - Renal disease (seizures can occur)
  - Hepatic impairment
  - Bleeding disorder
  - Pregnancy (category B)
  - Known penicillin allergy

Cephalosporins—Interactions

Interacting Drug	Common Use	Effect of Interaction
Aminoglycosides	Anti-infective	Increases risk for nephrotoxicity
Oral Anticoagulants	Blood thinner	Increased risk for bleeding
Loop diuretics	Hypertension, reduce edema	Increased cephalosporin blood level
Probenecid	Used for gout pain	Increases the levels of most cephalosporins except cefoperazone, ceftazidime, and ceftriaxone

Nursing Alert: Cephalosporins—Contraindications

- Cephalosporins should not be taken with alcohol
- Disulfiram-like reaction if alcohol consumed within 72 hours
- Symptoms: flushing, throbbing, respiratory problems, vomiting, sweating, chest pain, hypotension
- Severe reactions: dysrhythmias and unconsciousness

Pharmacology in Practice Exercise #1

- Cephalosporins are structurally and chemically related to which classes of antibiotic(s)?

a) Fluroquinolones

b) Aminoglycosides

c) Tetracyclines

d) Penicillins

Carbapenems and Other Misc. Drugs That Inhibit Cell Wall Synthesis—Actions

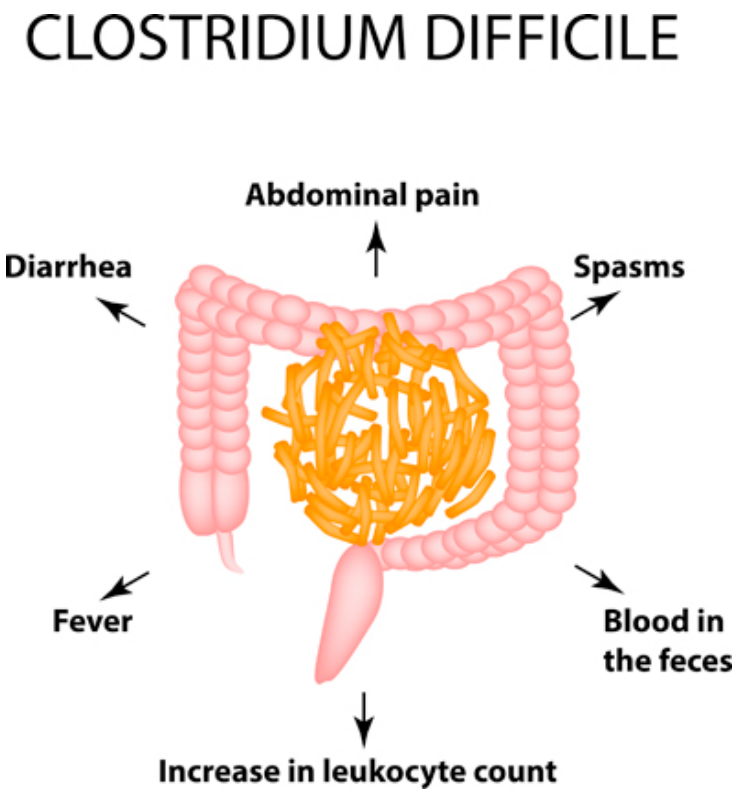
- Carbapenems—inhibit synthesis of the bacterial cell wall
- Vancomycin—inhibits bacterial cell wall synthesis and increases cell wall permeability; act against gram-positive bacteria
- Monobactam—has a beta-lactam nucleus; inhibits bacterial cell wall synthesis

Carbapenems—Uses #1

- Meropenem: used for intra-abdominal infections and bacterial meningitis
- Imipenem-cilastatin: used to treat serious infections, endocarditis, and septicemia
- Doripenem: used to treat bacterial intra-abdominal infections and complicated UTIs
- Telavancin and oritavancin: used to treat complicated skin and skin structure infections; effective against *Staph* and *Strep* including methicillin-resistant strains
- Vancomycin: treats serious gram-positive infections that do not respond to other treatments; treats pseudomembranous colitis cause by *C. diff*.
- Monobactams: treat gram-negative microorganisms

Carbapenems—Uses #2

- Vancomycin: treats serious gram-positive infections that do not respond to other treatments; treats pseudomembranous colitis caused by *C. diff*.
- Monobactams: treat gram-negative microorganisms



Carbapenems—Adverse Reactions

- Common Gastrointestinal System Reactions:
  - Nausea
  - Vomiting
  - Diarrhea
  - Risk of pseudomembranous colitis
- Other Reactions
  - Abscess, phlebitis, or tissue sloughing at injection site
  - Nephrotoxicity (vancomycin)
  - Ototoxicity (vancomycin)
  - Chills, fever, urticaria, and sudden low blood pressure with IV administration

Carbapenems—Contraindications

- Carbapenems, aztreonam, and telavancin
- Contraindicated in clients:
  - With allergies/hypersensitivity to cephalosporins and penicillins
  - With renal failure
  - Younger than 3 years
  - Who are pregnant (pregnancy category B/C)/lactating
- Carbapenems should be used cautiously in clients with
  - Central nervous system disorders
  - Seizure disorders
  - Renal/hepatic failure

Carbapenems—Interactions

Interacting Drug	Common Use	Effect of Interaction
Probenecid	Used for gout pain	Excretion of carbapenems is inhibited
Anticoagulants	Prevents blood clots	Increased risk of bleeding
Other drugs with ototoxic and nephrotic adverse effects	Various drugs	Additive effect that may together cause ototoxicity and/or nephrotoxicity

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #1

- **Preadministration Assessment**
- **Objective** Data
  - General client appearance (paleness, flushing)
  - Vital signs
  - Description of the infection (site, color, type of drainage, pain, redness, inflammation, color of sputum, presence of odor)
  - Review results of tests (e.g., C&S, liver or kidney function tests)
- **Subjective** Data
  - Current symptoms (malaise, fatigue, pain)
  - Allergy history (especially penicillin or cephalosporin)
  - Drug history
  - History of medical and surgical treatment

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #2

- **Ongoing Assessment**
  - Observe for relief/intensification of symptoms (pain/discomfort)
  - Monitor temperature and appetite
  - Assess appearance and amount of drainage
  - Report to the health care provider if the infection appears to worsen or if there are adverse reactions
  - Check lab reports at 3-7 days after initial treatment
  - Additional C&S tests (resistance)
  - Check for diarrhea
  - Monitor for superinfection
  - Assess skin for rash
  - Check for signs of hypersensitivity

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #3

- **Nursing Diagnoses**
  - Altered Skin Integrity related to hypersensitivity to the drug
  - Impaired Gas Exchange Risk related to an allergic reaction to the drug
  - Impaired Urinary Elimination related to nephrotoxic effects of cephalosporin
  - Diarrhea related to bacterial secondary infection or superinfection
  - Impaired Oral Mucous Membranes related to secondary bacterial or fungal infection
  - Impaired Comfort: increased Fever related to ineffectiveness of antibiotic against the infection

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #4

- Planning
  - Expected client outcomes depend on the reason for administration of the antibiotic but may include:
    - An optimal response to drug therapy
    - Meeting client needs related to the management of adverse drug reactions
    - Confidence in an understanding of the prescribed treatment regimen

Pharmacology in Practice Exercise #2

- Given below, in random order, are important interventions when caring for a client receiving antibiotics for an infection. Arrange the interventions in the order they morse likely occur in most situations.

a) Identify the appropriate penicillin or cephalosporin

b) Order a culture and sensitivity test

c) Document improvement on client's chart

d) Administer penicillin or cephalosporin to client

e) Obtain general history of client

Nursing Process—Client Receiving Antibacterial Drugs that Disrupt the Bacterial Cell Wall #5

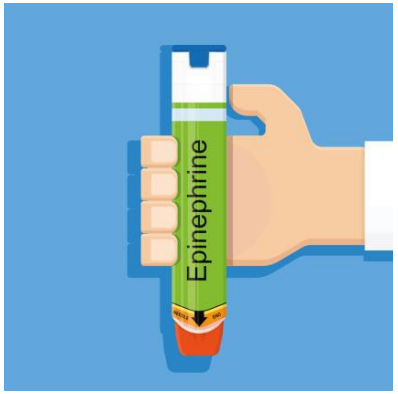
- **Implementation**
  - Promoting an optimal response to therapy
    - Broad-spectrum antibiotic will likely be prescribed until results of C&S test (3 days or up to 2 months for sputum)
    - Maintain adequate blood level of drug
    - Give oral penicillins on an empty stomach or 1 hour before or 2 hours after a meal
    - Cefuroxime and and cefpodoxime are better absorbed when taken with food
    - Keep oral suspensions refrigerated and shake well before administering
    - Follow parenteral reconstitution directions
    - Administer IV antibiotics over appropriate rate to prevent adverse effects

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #6

- **Implementation—Monitoring and Managing Client Needs**
  - Altered Skin Integrity
    - Administer frequent skin care
    - Avoid harsh soaps, perfumed lotions, rough or irritating clothing
    - Report rash or hives
    - Instruct client to avoid rubbing the area
    - Administer prescribed diphenhydramine to treat minor hypersensitivity reactions
    - Administer prescribed emollients, topical corticosteroid, antihistamine, antipyretic creams

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #7

- **Implementation—Monitoring and Managing Client Needs**
  - Risk for Impaired Gas Exchange
    - Observe for major hypersensitivity reactions; ensure immediate treatment with prescribed drugs (epinephrine, cortisone, or IV antihistamine)
    - Tracheostomy may be required—know where supplies are/have supplies on hand
    - After administering penicillin IM in outpatient setting, ask client to wait 30 minutes to assess for anaphylactic reactions



Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #8

- **Implementation—Monitoring and Managing Client Needs**
  - Impaired Urinary Elimination
    - Monitor for early signs of nephrotoxicity—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

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #9

- **Implementation—Monitoring and Managing Client Needs**
  - Diarrhea
    - Inspect stools, and report abnormalities to provider
    - Save sample of stool and test for occult blood and/or sent to lab to rule out *C. diff*.
    - Observe for and report symptoms of a bacterial or fungal superinfection
    - Prevent the spread of infection to other clients with good handwashing/appropriate precautions
    - Severe symptoms: provide additional treatment as prescribed for fever or fungal infection

fecal occult blood testing

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #10

- **Implementation—Monitoring and Managing Client Needs**
  - Impaired Oral Mucous Membranes
    - Inspect client's mouth daily; report signs of glossitis, sore tongue, or a black, furry tongue
    - Provide frequent mouth care
    - Use soft-bristled toothbrush
    - Recommend nonirritating soft diet/use of yogurt, buttermilk, or *Acidophilus* capsules
    - Monitor dietary intake
    - Severe symptoms: administer antipyretic or antifungal drug
    - Provide additional treatment as prescribed for fever or fungal infection

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #11

- **Implementation—Monitoring and Managing Client Needs**
  - 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 prescribed antipyretic drug

Pharmacology in Practice Exercise #3

- The client has developed a rash after the administration of cephalexin. The primary health care provider has diagnosed it as a mild hypersensitivity reaction. Which of the following interventions should the nurse perform to reduce the client's skin infections?

a) Reduce the dosage to provide relief to the client

b) Instruct the client to avoid taking baths

c) Tell the client to avoid contact of clothing with the affected area

d) Teach the client to do frequent skin care to the affected area

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #12

- **Implementation—Educating the** Client and Family
  - Develop a teaching plan for the client and family to include:
    - Ensure client 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
    - To reduce the risk of superinfection, eat yogurt, buttermilk, or take *Acidophilus* capsules
    - If client is taking oral contraceptives with estrogen and prescribed ampicillin or penicillin V advise that back-up contraception methods are needed

Nursing Process—Client Receiving Antibacterial Drugs That Disrupt the Bacterial Cell Wall #13

- **Evaluation**
  - Was the therapeutic response achieved?
  - Was infection controlled?
  - Were adverse reactions identified, reported, and managed successfully with appropriate interventions?
    - Skin intact and free of infection
    - Adequate gas exchange
    - Adequate fluid intake and urinary elimination
    - Adequate bowel movements
    - Mucous membranes moist and intact
    - Client reports comfort without fever
  - Do the client and family express confidence and demonstrate understanding of the drug regimen?

Turn and Talk—Case Study

- A mother brings in a 6-year-old child to the physician's office today with bilateral ear pain, nasal congestion, cough, and a low-grade fever. The mother reports the child is not taking any medications and has no allergies that the mother is aware of at this point. The physician writes a prescription for amoxicillin 250 mg/5 mL, give 2 teaspoonful three times a day for 10 days.

1. The mother is concerned that the child may have an allergic reaction to the amoxicillin. What signs or symptoms should the nurse tell the mother to look for that may indicate an allergic reaction has occurred?
2. What should the nurse tell the child's mother about oral suspensions?
3. What should the nurse tell the child's mother about the prevention of anti-infective resistance?