Chapter-16

Chemotherapy of Malignancy-I

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ABSTRACT

Chemotherapy, a common treatment for cancer, can have a profound impact on the immune system, making patients more susceptible to infections, including urinary tract infections (UTIs) and sexually transmitted diseases (STDs). The drugs used in chemotherapy often lower white blood cell counts, which are crucial for fighting off infections. As a result, even minor infections can become severe and require prompt medical attention. UTIs, caused by bacteria entering the urinary tract, can lead to symptoms like pain, burning during urination, and frequent urges to urinate. In immunocompromised patients, these infections can quickly spread to the kidneys and bloodstream, posing significant health risks. Similarly, the weakened immune response can make chemotherapy patients more vulnerable to contracting STDs, which can further complicate their overall health status. Preventive measures, such as practicing good hygiene, staying hydrated, and engaging in safe sexual practices, are essential. Regular medical check-ups and prompt reporting of any symptoms to healthcare providers are also critical for timely diagnosis and treatment. Managing the risk of infections during chemotherapy requires a comprehensive approach that includes patient education, preventive strategies, and vigilant monitoring.

Introduction

Chemotherapy, a cornerstone of cancer treatment, involves the use of potent drugs to target and eliminate cancer cells. However, this aggressive approach also affects healthy cells, particularly those in the immune system, leaving patients more vulnerable to various infections. Among these, urinary tract infections (UTIs) and sexually transmitted diseases (STDs) are of particular concern. The immunosuppressive nature of chemotherapy reduces the body's ability to fend off pathogens, increasing the risk of infections that can complicate treatment and recovery. Understanding the link between chemotherapy and these infections is crucial for developing effective preventive and management strategies, ensuring better patient outcomes and quality of life during this challenging period.

Chemotherapy is a medical treatment that involves the use of drugs to kill or inhibit the growth of rapidly dividing cells, such as cancer cells. The goal of chemotherapy is to destroy cancer cells throughout the body or prevent their further growth and division. While cancer cells are the primary target, chemotherapy can also affect normal, healthy cells that divide quickly, such as those in the bone marrow, digestive tract, and hair follicles. This can lead to side effects such as fatigue, nausea, hair loss, and a weakened immune system.

Urinary Tract Infections (UTIS)

A Urinary Tract Infection (UTI) is a bacterial infection that affects any part of the urinary system, which includes the kidneys, bladder, ureters, and urethra. Most UTIs involve the lower urinary tract, which comprises the bladder and the urethra. UTIs are more common in women than in men.

Urinary tract infections (UTIs) are commonly treated with various classes of antibiotics, each with specific pharmacological properties tailored to eliminate the causative bacteria. Below are some classifications and pharmacology of drugs used to treat UTIs:

1. **Sulfonamides**

   Example: Trimethoprim-sulfamethoxazole (Bactrim, Septra)

   Pharmacology: Sulfonamides inhibit the synthesis of dihydrofolic acid, a form of folic acid that bacteria need for DNA synthesis and growth. Trimethoprim inhibits dihydrofolate reductase, leading to a synergistic effect when combined with sulfamethoxazole. They are often used as first-line treatment for uncomplicated UTIs due to their effectiveness against a broad range of pathogens.

2. **Quinolones**

   Example: Ciprofloxacin (Cipro), Levofloxacin (Levaquin)

   Pharmacology: Quinolones, or fluoroquinolones, inhibit bacterial DNA gyrase and topoisomerase IV, enzymes critical for DNA replication and cell division. They are broad-spectrum antibiotics effective against both Gram-negative and Gram-positive bacteria, making them suitable for complicated UTIs and cases resistant to other antibiotics.

3. **Beta-lactams**

   Example: Amoxicillin-clavulanate (Augmentin), Ceftriaxone (Rocephin)

   Pharmacology: Beta-lactams, including penicillins and cephalosporins, interfere with bacterial cell wall synthesis by binding to penicillin-binding proteins, leading to cell lysis and death. The addition of clavulanate, a beta-lactamase inhibitor, extends the spectrum of amoxicillin by preventing bacterial resistance.

4. **Nitrofurans**

   Example: Nitrofurantoin (Macrobid, Macrodantin)

   Pharmacology: Nitrofurantoin is reduced by bacterial enzymes to reactive intermediates that damage bacterial DNA, ribosomal proteins, and other macromolecules. It is primarily used for treating uncomplicated UTIs due to its high urinary concentration and effectiveness against common uropathogens.

5. **Aminoglycosides**

   Example: Gentamicin, Amikacin

   Pharmacology: Aminoglycosides bind to the bacterial 30S ribosomal subunit, causing misreading of mRNA and inhibition of protein synthesis. They are effective against

Gram-negative bacteria and are often used in severe or complicated UTIs, particularly in hospitalized patients.

6. **Fosfomycin**

   Example: Fosfomycin tromethamine (Monurol)

   Pharmacology: Fosfomycin inhibits bacterial cell wall synthesis by inactivating the enzyme enolpyruvyl transferase, which is critical for peptidoglycan formation. It is often used as a single-dose treatment for uncomplicated UTIs due to its broad-spectrum activity and low resistance rates.

7. **Tetracyclines**

   Example: Doxycycline (Vibramycin)

   Pharmacology: Tetracyclines bind to the 30S ribosomal subunit, preventing the attachment of aminoacyl-tRNA to the ribosomal acceptor site, thereby inhibiting protein synthesis. They are effective against a variety of bacteria and are sometimes used for UTIs caused by atypical pathogens.

8. **Carbapenems**

   Example: Imipenem-cilastatin (Primaxin), Meropenem (Merrem)

   Pharmacology: Carbapenems inhibit bacterial cell wall synthesis and are highly resistant to beta-lactamases. They have a broad spectrum of activity and are often reserved for multidrug-resistant bacterial infections, including complicated UTIs.

Sexually Transmitted Diseases (STDS)

Sexually transmitted diseases (STDs) are treated with various classes of antibiotics and antiviral medications, each with specific pharmacological actions tailored to eliminate or suppress the causative pathogens. Below are the classifications and pharmacology of drugs commonly used to treat STDs:

1. **Penicillins**

   Example: Penicillin G, Penicillin V

   Pharmacology: Penicillins inhibit bacterial cell wall synthesis by binding to penicillin-binding proteins, leading to cell lysis and death. Penicillin G is the first-line treatment for syphilis caused by *Treponema pallidum* due to its efficacy and low resistance rates.

2. **Cephalosporins**

   Example: Ceftriaxone (Rocephin)

   Pharmacology: Cephalosporins, similar to penicillins, interfere with bacterial cell wall synthesis. Ceftriaxone is used to treat gonorrhea due to its effectiveness against *Neisseria gonorrhoeae*, including strains resistant to other antibiotics.

3. **Macrolides**

   Example: Azithromycin (Zithromax)

Pharmacology: Macrolides bind to the 50S ribosomal subunit, inhibiting bacterial protein synthesis. Azithromycin is used to treat chlamydia and is also effective against *Neisseria gonorrhoeae* when combined with ceftriaxone.

4. **Tetracyclines**

   Example: Doxycycline (Vibramycin)

   Pharmacology: Tetracyclines bind to the 30S ribosomal subunit, preventing the attachment of aminoacyl-tRNA to the ribosomal acceptor site, thereby inhibiting protein synthesis. Doxycycline is used to treat chlamydia, syphilis, and *Mycoplasma genitalium* infections.

5. **Fluoroquinolones**

   Example: Ciprofloxacin (Cipro), Levofloxacin (Levaquin)

   Pharmacology: Fluoroquinolones inhibit bacterial DNA gyrase and topoisomerase IV, enzymes critical for DNA replication and cell division. They are used for treating chlamydia and gonorrhea, although resistance has limited their use.

6. **Nitroimidazoles**

   Example: Metronidazole (Flagyl), Tinidazole (Tindamax)

   Pharmacology: Nitroimidazoles are reduced in anaerobic bacteria and protozoa to reactive intermediates that damage DNA. They are the treatment of choice for trichomoniasis caused by *Trichomonas vaginalis* and bacterial vaginosis.

7. **Antivirals**

   Example: Acyclovir (Zovirax), Valacyclovir (Valtrex), Famciclovir (Famvir)

   Pharmacology: Antivirals inhibit viral DNA polymerase, preventing viral replication. These drugs are used to manage herpes simplex virus (HSV) infections, reducing the frequency and severity of outbreaks.

8. **Antifungals**

   Example: Fluconazole (Diflucan)

   Pharmacology: Antifungals inhibit ergosterol synthesis, disrupting fungal cell membrane integrity. Fluconazole is used to treat candidiasis, including vulvovaginal candidiasis.

9. **Nucleoside Reverse Transcriptase Inhibitors (NRTIs)**

   Example: Tenofovir (Viread), Emtricitabine (Emtriva)

   Pharmacology: NRTIs are incorporated into the viral DNA by reverse transcriptase, causing premature chain termination. They are used in combination therapies for HIV infection.

10. **Non-nucleoside Reverse Transcriptase Inhibitors (NNRTIs)**

    Example: Efavirenz (Sustiva), Nevirapine (Viramune)

    Pharmacology: NNRTIs bind directly to reverse transcriptase, causing a conformational change that inhibits its activity. They are part of combination therapies for HIV treatment.