LESSON ASSIGNMENT

LESSON 4  
Diuretics.

LESSON ASSIGNMENT  
Paragraphs 4-1 through 4-6.

LESSON OBJECTIVES  
After completing this lesson, you will be able to:

4-1. Identify the general characteristics of diuretics.

4-2. Identify the types of diuretics.

4-3. Identify the location of action for specific diuretics.

4-4. Identify the indications/contraindications for use of specific diuretics.

4-5. Identify the routes of administration for specific diuretics.

4-6. Select the proper dosage for a specific diuretic.

SUGGESTIONS  
After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.
LESSON 4
DIURETICS

4-1. INTRODUCTION

As the turn of the century, one of the primary drugs used in the treatment of syphilis was mercury. Although the mercury had little, if any, effect on the syphilis, it did produce a wide assortment of side effects including an increase in urine output. This observation of elevated urine output following the administration of mercury stimulated a great deal of research into safer and more effective diuretic agents. As a result, today we possess a wide range of agents capable of stimulating urine output in a variety of clinical situations. Several of these agents are available to the Medical NCO Specialist in the field. Because of the potential dangers with diuretics, it is imperative that you know how to handle and administer these agents properly.

4-2. DEFINITION OF TERMS

To understand the nature and actions of diuretics, it is essential to understand these terms.

a. Diuresis--a condition characterized by increased urine production and increased urine output.

b. Diuretics--agents that increase urine output. In other words, diuretic agents cause diuresis.

4-3. STRUCTURE AND FUNCTION OF THE KIDNEY

The kidneys are organs of the urinary system which includes the ureters, the urinary bladder, and the urethra. The kidneys are important organs in the operation of the urinary system. The functions of this system include elimination of some of the body's soluble waste products and the regulation of water and electrolyte balance.

a. Structure of the Kidney.

(1) Location. The kidneys, reddish organs that are shaped like kidney beans, are located just above the waist between the parietal peritoneum and the posterior wall of the abdomen. In relation to the vertebral column, the kidneys are located between the last thoracic and the third lumbar vertebrae. The eleventh and twelfth pairs of ribs partly protect the kidneys. Because liver is a large organ which takes up space on the right side of the body, the right kidney is a little lower than the left kidney.
Structure. A coronal (frontal) section of the internal anatomy of the kidney is called the cortex. The inner, reddish-brown region of the kidneys is called the medulla. Eight to 18 striated, triangular structure termed renal pyramids are located in the medulla. The characteristic tissue of the kidneys is made up of the cortex and the renal pyramids. Tissue in each kidney is made up of about 1 million microscopic units called nephrons, collecting ducts, and their associated vascular supply. The working units of each kidney are the nephrons which help regulate the composition of blood and the formation of urine.

Figure 4-1. The kidneys.

b. The Nephron Unit. The nephron is the functional unit of the kidney. The estimation is that each kidney has about a million nephron units. A nephron is a long tubular structure made up of successive segments of different structure and transport functions. A nephron unit includes the following: renal corpuscle (Bowman's capsule and the glomerulus), proximal tubule, Henle's Loop, distal tubule, and collecting duct system.
(1) Renal corpuscle.

(a) Structure. The renal corpuscle has a hollow double-walled sac called the renal capsule (Bowman's capsule). Leading into the capsule in a very small artery called the afferent arteriole. Within the capsule, this artery becomes a mass of capillaries known as the glomerulus. An efferent arteriole drains blood away from the capsule. The capsule and glomerulus together are known as the renal corpuscle.

(b) Function. An afferent arteriole supplies blood to the glomerulus. An efferent arteriole drains blood from the glomerulus. The blood from the afferent arteriole fills the glomerulus. Because of a pressure gradient, a large percentage of fluid in this blood passes through the wall of the glomerular capillary. The fluid then passes through the inner wall of the capsule. This brings the fluid into the hollow space between the inner and outer walls of the renal capsule.
Renal tubule.

(a) Structure. Each renal capsule is drained by a renal tubule. The first part of this tubular system runs quite a distance in a coiled formation and is called the proximal convoluted tubule. A long loop, the called the descending loop or the descending limb of Henle leads down to the medulla with two straight parts and a sharp bend at the bottom. The sharp bend at the bottom is called the loop of Henle and is U-shaped. As the tube returns to the cortex layer, it once again becomes coiled and here is known as the distal convoluted tubule. The distal tubule is the end of the nephron unit.

(b) Function -- tubular reabsorption. The fluid (also called filtrate) passes through the tubular system of the nephron. Here, the majority of the water, glucose, and other valuable substances are removed from the fluid and returned to the cardiovascular system. Essential electrolytes such as sodium, chloride, and bicarbonate are reabsorbed in the tubules. Reabsorption of sodium salts is controlled by the hormone aldosterone. Water and electrolytes such as glucose, amino acids, and nutrients are also absorbed from the renal tubes. Other fluids reabsorbed include water and nonelectrolyte such as glucose and amino acids.

(c) Function -- tubular secretion. Tubular reabsorption removes substances from the filtrate into the blood, but tubular secretion adds materials to the fluid from the blood. These secreted substances are included: potassium ions, hydrogen ions, ammonia, creatinine, and the drugs penicillin and aminohippuric acid. There are two main effects from tubular secretions. The substances in the secretions help rid the body of certain materials and also help control the blood pH.

4-4. GENERAL CHARACTERISTICS OF DIURETICS

The kidneys have an important role in maintaining the volume and composition of fluids in the body. It is sometimes necessary to reduce the amount of fluid in the body. Diuretics can perform this function. A number of diuretic drugs have been developed over the years. Most diuretics operate in one of two ways: they inhibit renal tubular sodium reabsorption or they increase the filtration of sodium. Drugs used as diuretics can be classified according to their specific effect on the renal system. In such a system, diuretics can be grouped into five classes: Water, osmotic diuretics, loop diuretics, thiazide diuretics, potassium sparing diuretics, and combination diuretics. Drugs used as diuretics effect the body is many ways, but remember that the chief effect on the urinary system is to increase the rate of urine formation and, subsequently, urine flow out of the body.
a. **Indications for Diuretic Use.** Diuretics can be given to patients with edema associated with congestive heart failure, cirrhosis of the liver, and early renal disease. Diuretics may also be administered to control hypertension.

b. **Contraindications for Diuretic Use.** Do not use diuretics for patients with late renal disease, pregnancy (the medication crosses the placenta), and hypersensitivity to the drug.

c. **Adverse Effects from Diuretic Use.** Included are the following: dehydration, electrolyte imbalance, and hypokalemia. The condition hypokalemia may be characterized by smooth and skeletal muscle weakness. The respiratory and cardiac muscles may be involved. Electrocardiogram (EKG) changes may occur with cardiac involvement. The patient may need potassium supplements in the form of drug therapy and/or foods.

4-5. **TYPES OF DIURETICS AND LOCATION OF ACTION**

a. **Water—a Diuretic.** When given in excess, water can act as a diuretic. At times, it may be necessary to limit the intake of water, but if, for example, medications irritate the urinary tract, a higher intake of water can stimulate excretion enough to avoid any real damage to the urinary tract.

b. **Osmotic Diuretics.** Certain nonelectrolyte with common attributes have been grouped together and called osmotic diuretics. Osmotic diuretics can be given in relatively large quantities. When so given, these diuretics contribute to the osmolality of plasma, glomerular filtrate, and tubular fluid in the body. Osmosis, osmolality - refers to the passage of pure solvent from a dilute solution to a concentrated solution. The dissolve substances solutions are concentrated through a semipermeable membrane that separates the two solution.

(1) **Characteristics of osmotic diuretics.** None-electrolyte action in the kidney depends on the concentration of osmotically active particles in solution. Most osmotic diuretics resist being changed by metabolism. An osmotic diuretic acts by decreasing reabsorption of water in the proximal tubule of the kidney due to increased osmotic pressure. The primary agent is mannitol (Osmitrol®). The chief characteristics of these diuretics are:

   (a) The nonelectrolyte are freely filterable at the glomerulus.

   (b) The nonelectrolyte undergo limited reabsorption by the renal tubule.

   (c) The nonelectrolyte are pharmacologically inert by conventional criteria.
(2) **Specific indications for osmotic diuretic use.**

(a) Prevention of treatment of an early oliguric phase (oliguria = abnormally low excretion of urine; in an average adult, less than 400 cm per day) of an acute renal failure. Conditions which might bring on acute renal failure include the following:

1. Cardiovascular operations.
2. Severe traumatic injury.
5. Acute trauma.

(b) Reduction of intracranial pressure and treatment of cerebral edema.

(c) Promotion of urinary excretion of toxic substances; for example, alcohol and drugs.

(3) **Specific contraindications for osmotic diuretic use.**

(a) DO NOT use if the patient has severe pulmonary congestion or congestive heart failure.

(b) DO NOT use if there is active intracranial bleeding. In this instance, vasodilation could occur because of increased plasma volume.

(4) **Administration and dosage of osmotic diuretics.** Proceed as follows:

(a) DO NOT infuse if crystals are present in the solution. Crystals can be removed by heating the vials with hot water or heating in a microwave.

(b) The usual dosage is 5 mg per kg.

(c) Osmotic diuretics act in 15 to 30 minutes after an IV infusion.

(d) Duration of diuresis (increased production of urine) if four to six hours.
c. **Loop Diuretics.** The primary agent of loop diuretics is furosemide (Lasix\textsuperscript{R}). Loop diuretics act by blocking reabsorption of sodium in the ascending Loop of Henle.

(1) **Specific indications for loop diuretic use.**

(a) Pulmonary edema.

(b) Congestive heart failure.

(2) **Administration and dosage of loop diuretics.** Follow this procedure:

(a) Given an oral dosage of 40 mg one to two times a day. Lasix\textsuperscript{R} may be given up to maximum dose of 120 mg three times a day.

(b) IV dosage is 20 to 40 mg. The diuretic acts 5 minutes after IV administration. The duration of action is about 2 hours.

d. **Thiazide Diuretics.** These diuretics are often classified as benzothiadiazides. The primary agents are hydrochlorothiazide (HCTZ, Oretic\textsuperscript{ }, Esidrix\textsuperscript{R}) and chlorothiazide (Diuril\textsuperscript{R}). The diuretic acts in the distal tubule.

(1) **Specific indications for thiazide diuretics.**

(a) Less severe edematous states.

(b) Hypertension.

(2) **Administration and dosage.** Proceed as follows:

(a) This diuretic is usually administered orally.

(b) The duration of action is 6 to 12 hours, depending on the agent used.

e. **Potassium-sparing Diuretics.** The primary agents of this type of diuretic are spironolactone (Aldactone\textsuperscript{R}) and triamterene (Dyrenium\textsuperscript{R}). A potassium-sparing diuretic acts in the distal tubule. A specific indication for this class of diuretic is excessive potassium loss. DO NOT use if patient suffers from hyperkalemia. Spironolactone (Aldactone\textsuperscript{R}) is given in the dosage of 25mg 4 times per day by mouth. Triamterene (Dyrenium\textsuperscript{R}) is given in the dosage 100 mg every day by mouth.

f. **Combination type Diuretics.** The primary agent is thiazide with a potassium-sparing diuretic. Other agents are hydrochlorothiazide and spironolactone (Aldactazide\textsuperscript{ }). Fixed dose combinations may be more convenient in patient management.
(1) **Mechanisms of action.** These diuretics act on different areas of the nephron unit at the same time. Diuresis is enhanced. Electrolyte imbalance is reduced.

(2) **Specific indications for combination type diuretics.** Combination diuretics can be used for patients with these conditions:

   (a) **Mild** diuresis.

   (b) Excessive potassium wasting.

(3) **Contraindications for combination type diuretics.** Do not use combination diuretics for patients with these conditions:

   (a) Hyperkalemia. (elevated potassium level in the blood).

   (b) Hypersensitivity to thiazides or potassium-sparing agents.

**NOTE:** Combination type diuretics are generally not prescribed as initial therapy.

4-6. **CLOSING**

Water is one of man's primary needs. Without a sufficient supply, all of us would soon perish. Likewise, excessive amounts of fluid in the body can be just as fatal. Our total body water and electrolytes are maintained in a delicate balance, and it is essential to exercise great care when administering diuretic agents. Indiscriminate use of these agents can result in severe fluid and electrolyte imbalance, which can be fatal to the patient.

**Continue with Exercises**

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EXERCISES, LESSON 4

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. A condition characterized by increased urine production and increased urine output is the definition of ___________________________.
2. Agents that increase urine output are called ________________________.
3. List the main organs of the urinary system.
   a. _______________ ______________________________________________
   b. __________________ ___________________________________________
   c. __________________ ___________________________________________
   d. __________________ ___________________________________________
4. The _________________________ is the outer covering of the kidney, and the _______________ medulla is the inner, reddish-brown region of the kidney.
5. Approximately how many nephrons, the working units of the kidneys, are in each kidney? ________________
6. Each nephron is made up a ____________ corpuscle and a _______________ system.
7. The function of the renal corpuscle in the kidney is to: ____________________
   ________________________________________________________________

8. In the process of reabsorption in the renal tubule, fluid passes through the tubular
   system of the nephron. In this process, substances such as water and glucose
   are removed from the fluid and returned to the ______________ system.

9. Diuretics operate in one of two ways. List the two ways.
   a. __________________ ___________________________________________
   b. __________________ ___________________________________________

10. List four reasons to use diuretics.
   a. ____________________________________________________________
   b. ____________________________________________________________
   c. ____________________________________________________________
   d. ____________________________________________________________

11. Three reasons NOT to use diuretics are:
   a. ____________________________________________________________
   b. ____________________________________________________________
   c. ____________________________________________________________
12. Six types of diuretics are named in this lesson. They are:
   a. __________________ ___________________________________________.
   b. __________________ ___________________________________________.
   c. __________________ ___________________________________________.
   d. __________________ ___________________________________________.
   e. __________________ ___________________________________________.
   f. __________________ ___________________________________________.

13. What is the primary action of loop diuretics? ____________________________
    __________________ ________________________________________________.

14. List two specific indications for using combination type diuretics.
   a. __________________ _____________________________________________.
   b. __________________ _____________________________________________.

Check Your Answers on Next Page
SOLUTIONS TO EXERCISES, LESSON 4

1. Diuresis. (para 4-2a)

2. Diuretics. (para 4-2b)

   Ureters.
   Urinary bladder.
   Urethra. (para 4-3)

   Medulla. (para 4-3a)

5. About 1 million. (para 4-3a)

6. Renal.
   Tubular. (para 4-3b)

7. The function of the renal corpuscles in the nephron units of the kidneys is to carry blood to (afferent) and carry blood away from (efferent) the glomerulus. (para 4-3b(1)(b))

8. Cardiovascular. (para 4-3b(2)(b))

   OR
   Diuretics increase the filtration of sodium. (para 4-4)

    Cirrhosis of the liver.
    Early renal disease.
    Early renal disease. (para 4-4a)

11. Late renal disease.
    Pregnancy (medication can cross the placenta).
    Hypersensitivity to the drug. (para 4-4b)

    . Osmotic diuretics.
    . Loop diuretics.
    . Thiazide diuretics.
      Potassium-sparing diuretics.
      Combination type diuretics. (paras 4-5a through f)
13. The primary action of loop diuretics is to block reabsorption of sodium in the ascending Loop of Henle. (para 4-5c)

   Excessive potassium wasting. (para 4-5f(2))

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