Module 26
RENAL DISEASES

UNIT 1
Review of Renal Anatomy and Physiology

OBJECTIVES

Upon completion of this unit, you should be able to

- Identify the location of the kidneys.
- Name the functional unit of the kidney and its components.
- List two excretory and three non-excretory or metabolic functions of the kidney.
- Name the three processes by which the kidney accomplishes its excretory functions.
- Identify the normal 2-hour urine output.

COMMENTS:

The two purplish-brown kidneys are located in the **retroperitoneal space** on either side of the spinal column.

Anatomy of the kidney

They weigh approximately 5 ounces each and are 10 to 12 centimeters long and 6 to 7 centimeters wide. The right kidney is 1-2 cm lower than the left due to displacement by the liver. In the supine position, the upper border (or pole) of the right kidney is at T-12 posteriorly and the left kidney's pole is at T-11 or T-12 posteriorly.

The functional unit of the kidney is called the **nephron**. Each kidney contains approximately one million nephrons. Each is capable of urine formation. The nephron is composed of the glomerulus, Bowman's capsule, proximal convoluted tubule, the loop of Henle, distal convoluted tubule, and collecting duct (see Figure 1).

FIGURE 1
Components of Nephron

The **glomerulus** is a ball of truft of capillaries which fits into **Bowman's capsule**, a sac of epithelial tissue. The glomerulus serves as a filter for water and solutes from the blood but is normally impermeable to glucose and protein molecules. The fraction of blood that filters through the glomerulus into Bowman's capsule travels through the **proximal convoluted tubule**, loop of **Henle**, and **distal convoluted tubule**. During this process, reabsorption of essentials materials and excretion of excesses occur. The urine travels through the **collecting duct** to the pelvis of the kidney and out of the ureter.

The **juxatgaglomerular apparatus,** or **JGA** for short, is found at the point at which the distal convoluted tubule meets the arterioles entering)afferent) and the arterioles leaving (efferent) the glomerulus. The **JGA** is the site for rennin secretion. Rennin is an enzyme that helps to regulate water and sodium retention and, therefore, affect blood pressure regulation.

Interrelationship of body systems

Normal renal function depends upon the normal of and interrelated functioning of the cardiovascular system, the nervous system, the endocrine system, and the urinary collecting system. The kidneys normally receive **20 to 25% of the cardiac output** via the renal arteries. Therefore, normal renal blood flow averages over one liter of blood per minute. Any disturbance in cardiac output can adversely affect the perfusion and therefore, the function of the kidneys. The kidneys receive both sympathetic and parasympathetic innervation. This is essential for blood pressure regulation and control of the urination proves.

The endocrine system is involved with the production of **antidiuretic hormone,** or ADH, and **aldosterone.** Recall that ADH is released by the pituitary gland and controls water reabsorption by the kidneys. Therefore, water is retained by the body rather than excreted in the urine, and the urine becomes concentrated. Aldosterone is secreted by the adrenal cortex and acts to increase sodium and water reabsorption. Both of these hormones are stimulated with reduced circulating blood volume and under stress.

Once urine is produced, there must be an intact avenue for its exit from the body. This requires an intact collecting system of calyces, renal pelvis, and ureters. In addition, any obstruction to

the flow of urine from the ureters to the bladder through the urethra can lead to serious problems as the result of pressure backing up into the kidneys.

Functions of the kidneys

The kidneys have two main excretory functions. They are:

- The removal of waste products from the body.
- The regulation of fluids, electrolytes, blood pressure, and pH within the body.

These functions are accomplished through three processes: filtration, reabsorption, and secretion. Filtration refers to the passage of fluid through the semipermeable membrane of the glomerulus. **Reabsorption** occurs when fluids and electrolytes are taken back into the body (retention). **Secretion** is the process by which excess elements are actively transported form the blood into the tubules and are then excreted via the urine. Other functions of the kidney which are **non-excretory** or **metabolic** include the following:

- Release of rennin in response to renal ischemia to maintain normal blood pressure
- Production of prostaglandins, a class of vasodepressors
- Production of erythropoietin which stimulates red blood cell production in response to decreased oxygen concentration
- Conversion of Vitamin D to 1.25 DHCC which helps to maintain normal calcium levels in the body.
- Insulin degradation (breaks down 20% if insulin)
- Calcium and phosphorus regulation

Normal 24-hour urine output

The kidneys filter about 180 liters of fluid each day. Since we know that the kidneys receive 20% to 25% of the cardiac output, the amount of filtrate produced by the glomerulus in a given time period (one minute) can be determined. This is referred to as the **Glomerular Filtration Rate (GFR)**. The normal GFR is determined to be approximately 132 cc/minute. Not all this fluid becomes urine, obviously, or we would die rapidly of dehydration. Ninety-nine percent (99%) of this filtrate is reabsorbed into the circulation. Only 1% or 1 cc/minute becomes urine. Therefore, the normal urine output for a 24-hour period should be approximately 1440 or 1500 cc/day.

Unit 1
Self-Test

1. The kidneys are located in the _____ space.

2. The functional unit of the kidney is the _____.

3. List the components of #2:

   a. _____ d. _____

   b. _____ e, _____

   c. _____ f. _____

4. The kidneys normally receive _____ to _____ % of the cardiac output.

5. Two hormones, _____ and _____, help to control water absorption by the kidneys.

6. Name two excretory and three non-excretory or metabolic functions of the kidney:

   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____

7. The kidney accomplishes its excretory functions through the three processes of _____, _____ , and _____.

8. _____ is the process by which fluids and electrolytes are taken back into the body and retained.

9. Only _____ % or _____ % cc/minute of the glomerular filtrate becomes urine and excreted.

10. The normal 24-hour urine output should be approximately _____ or _____ cc/day.

Unit 2
Acute Renal Failure

OBJECTIVES

Upon completing this unit, you should be able to

- Define acute renal failure.
- List the three categories of causes of acute renal failure and give one example of each cause.
- Define nephrotoxic agents and give two examples.
- Describe each phase of acute renal failure.
- Discuss nursing care associated with each phase of acute renal failure.

DEFINITION

Acute renal failure can be defined as a rapid loss of renal function over a short period of time (hours to days). The urine output falls abruptly and renal laboratory values as well as the patient's clinical signs and symptoms reflect the inability of the body to excrete sufficient quantities of fluid and waste products to maintain an equilibrium state. Fortunately, acute renal failure is **potentially reversible**. The prognosis is dependent upon the extent of permanent damage to the nephrons.

Causes of Acute Renal Failure

The various causes of acute renal failure can be categorized into three major areas: prerenal, postrenal, and intrarenal. **Prerenal causes** related to factors outside of the kidney that decrease renal blood flow by either vasoconstriction or decreased blood pressure. Remember that the kidney normally receives 20 to 25% of the cardiac output. Examples of prerenal causes of acute renal failure include hypovolemia associated with hemorrhage, burns, cardiac insufficiency, or septic shock and a thrombus or embolus in the renal artery causing obstruction of renal blood flow.

Postrenal causes are related to an obstruction to the flow of urine into the ureters, bladder, or urethra. The kidney is being perfused adequately and urine is being produced by the kidney. However, there is a blockage to the flow of urine out of the kidney. The backward pressure exerted upon the kidney from the obstruction can cause significant damage to the nephrons if not treated promptly. Examples of postrenal causes of acute renal failure include urinary calculi or stones, tumors in the urinary tract, and trauma that leads to urinary obstruction.

The most frequent cause of acute renal failure is associated with intrarenal factors. Intrarenal causes are related to actual damage to the kidney itself from disease or nephrotoxic substances. With acute tubular necrosis, or ATN, destruction of the tubular epithelial cells occurs. ATN accounts for approximately 75% of all causes of acute renal failure. Examples of intrarenal causes of acute renal failure include primary renal diseases such as acute glomerulonephritis and acute pyelonephritis, systemic diseases such as systemic lupus erythematosus (SLE), hemolytic blood transfusion reactions, and administration of nephrotoxic substances.

Additional examples of causes of acute renal failure are listed in Table 1.

Nephrotoxic agents can be damaging to the kidney, particularly in toxic doses or when the patient already has some degree of renal dysfunction. In cases of acute renal failure, assessment of exposure to nephrotoxic substances is essential. Careful monitoring of therapeutic blood levels of a class of potentially nephrotoxic antibiotics called the aminoglycosides is vital. A list of specific nephrotoxic agents is found in Table 2.

Phases of acute renal failure

There are three distinct phases seen with cases of acute renal failure: the oliguric phase, the diuretic phase, and the recovery phase. During the **oliguric phase**, the urine output falls to less than 400 cc/day. (Oliguria means scant urine.) This phase can last from 8 days to up to 14 days. The patient's renal laboratory values are markedly elevated and fluid/electrolyte status must be monitored carefully due to retention of both fluid and electrolytes such as potassium. Short-term dialysis is frequently necessary to sustain stable fluid/electrolyte status.

Table 1
Cause of Acute Renal Failure

Prerenal Causes (inadequate renal perfusion)	Intrarenal Causes (primary kidney pathology)	Postrenal Causes (obstructive disorders)
Decreased vascular volume; burns, hemorrhage, severe vomiting or diarrhea, excessive diuresis	Acute tubular necrosis (ATN): drugs, chemicals, hemolytic blood transfusion reactions, crush injuries (myoglobin)	Renal calculi Neoplasms Collecting duct obstructions Structures
Decreased cardiac output: MI, CHF, arrhythmias	Acute glomerulonephritis (GN)	Benign prostatic hypertrophy (BPH)
Intravascular pooling of blood: septic shock, anaphylaxis	Acute pyelonephritis Toxemia of pregnancy Malignant HTN Acute interstitial nephritis Hepatorenal syndrome Systemic lupus erythematosus (SLE)	Trauma
Renal vasoconstriction: Renal artery stenosis, Bilateral renal vein Thrombosis		

Table 2
Nephrotoxic Agents

Aminoglycosides:
- Gentamicin, Kanamycin, Neomycin
- Tobramycin, Streptomycin

Heavy Metals:
- Mercury, Lead poisoning

Solvents:
- Calcium Tetrachloride

Phenacetin (an analgesic found in combination with aspirin and caffeine in the past in products such as Goody's Powders and BC Powders)

Radioiodine Contrast Agents
- Iodine dyes used during IVP studies, arteriograms, cardiac catherizations, and other procedures using contrast dyes

The longer the oliguric phase lasts, the poorer the prognosis for full or partial renal recovery. If damage to the nephrons is too severe and is sustained for an extended period of time, the patient's acute renal failure may be irreversible and therefore, become chronic renal failure necessitating long-term dialysis to maintain his life. The patient will not enter the next phase, the diuretic phases.

Because the oliguric phase of acute renal failure can last up to two weeks, this period of time is often called "the wait and see" period. It is frequently uncertain whether the patient's acute renal failure will be reversible or not. Hopefully, if the patient's renal dysfunction is reversible, he will enter the diuretic phase.

The **diuretic phase** may last up to one week. During this phase of acute renal failure, the patient's urinary output begins to increase gradually at first. The urine is extremely hypotonic (dilute) because the kidney is unable to concentrate the urine; the ability to concentrate urine is the last function to return during the diuretic phases. Therefore, as the urine output increases, the patient is unable to retain fluids or electrolytes in the early diuretic phase leading to potentially large amounts of fluid and electrolyte losses. The patient can become hyponatremic (low sodium), hypokalemic (low potassium), and dehydrated rapidly. This is a critical period since severe dehydration may lead to decreased renal perfusion (prerenal cause of acute renal failure) and therefore, can restart the entire cycle of acute renal failure.

Therefore, it is vital that urinary losses of fluids and electrolytes be closely monitored and replaced. This is frequently done with intravenous replacement of urine output. The patient's urine output (and therefore IV replacement) can sometimes reach extremely large amounts such as 15 to 20 liters per day! This condition persists until the kidney regains the ability to concentrate the urine.

The **recovery phase** of acute renal failure can last up to four to five months. During this period, the kidney is particularly susceptible to further renal insults and is in a vulnerable state.

Nursing Care in Acute Renal Failure

Nursing care is related to the specific phase of acute renal failure that the patient is experiencing. General nursing care for each phase is as follows:

Oliguric phase. Strict intake and output, daily weights, and careful monitoring of laboratory values are essential during this phase. The patient's signs and symptoms related to renal failure must also be closely assessed with the physician to determine the need for dialysis therapy. Renal medications, dietary restrictions, and fluid restriction frequently are necessary. nursing education and support of the patient and mainly related to his symptoms and treatments, especially the initiation of dialysis, is a crucial nursing role.

Diuretic phase. Careful monitoring of urinary output and electrolyte values is vital during this period. Strict intake and output and daily weights remain important assessment items. Assessment for signs of dehydration, hyponatremia, and hypokalemia as well as IV replacement of urinary output is essential. Frequently, the patient will need sodium and/or potassium supplements. The patient's diet should be unrestricted with free access to salt and fluids. In addition, nursing education and support of the patient and family remains a significant part of the patient's plan of care.

Recovery phase. During this phase, careful follow-up care is important. Laboratory values must be monitored to determine renal function. Instruct the patient to avoid substances or exposure to potential renal insults, such as nephrotoxic substances or exposure to persons with infections. Teach the patient how to monitor his fluid status at home by keeping records of his intake and output and daily weights. Lastly, inform the patient of early warning signs of worsening renal failure about which to immediately contact the nurse or physician.

Unit 2
Self-Test

1. A rapid loss of renal function over a short period of time is called _____ . This condition is potentially _____ .

2. Name the three categories of causes of acute renal failure.

   a. _____

   b. _____

   c. _____

3. Urinary calculior stones are an example of a _____ cause of acute renal failure.

4. Give two examples of prerenal causes of acute renal failure.

   a. _____

   b. _____

5. _____ accounts for 75% of cases of acute renal failure.

6. Two examples of nephrotoxic agents are ca class of antibiotics called _____ and an analgesic called _____ that used to be present in Goody's Powders.

7. List the three phases of acute renal failure.

   a. _____

   b. _____

   c. _____

8. During the _____ phase, the patient can become dehydrated, hyponatremic, and hypokalemic rapidly.

9. Nursing care during the _____ phase is concerned with careful follow-up care and education of the patient to avoid potential renal insults.

10. Dialysis may be initiated during the _____ phase of acute renal failure if necessary.

Unit 3
Chronic Renal Failure

OBJECTIVES

Upon completing this unit, you should be able to

- Define chronic renal failure, end stage renal disease, and uremia or the uremic syndrome.
- Describe age-related changes in renal function and state the percentage of kidney function that can be lost without apparent complications.
- List four causes of chronic renal failure.
- Discuss the importance of each of the following laboratory values associate with renal failure: BUN, creatinine, creatinine clearance, sodium, potassium, calcium, and phosphorus.
- List common clinical manifestations seen in renal failure patients in the following body systems: cardiovascular, pulmonary, hematologic, gastrointestinal, integumentary, neuromuscular behavioral, endocrine/metabolic, and psychosocial changes.

DEFINITION

Chronic renal failure is defined as an irreversible reduction in kidney function in which the kidney can no longer maintain the body's internal environment. It usually develops slowly over years of worsening renal function but can also be a result of sudden irreversible acute renal failure as previously discussed. There are varying degrees of chronic renal failure ranging from mild to severe. The most severe degree is termed **end stage renal disease** or **ESRD**. All patients with chronic renal failure will eventually require dialysis treatment or kidney transplantation to sustain their lives. Dialysis and transplantation will be discussed in more detail in Unit 4.

The constellation of signs and symptoms associate with renal failure is termed **uremia** or the **uremic syndrome**. These changes are related to fluid and electrolyte abnormalities, an accumulation of uremia toxins in the body, and dysfunction of various regulatory functions.

Age-Related Changes

After the age of 40, the glomerular filtration rate (GFR) slowly declines. By age 80, the GFR may be one-half of that of a healthy young adult due to the aging process. Therefore, the elderly are more susceptible to renal injury due to the decreased number of functioning nephrons.

It is amazing to realized that as much as 75% of normal renal function can be lost before there is a significant rise in the renal laboratory values. How remarkable that the kidney can continue to regulate the body's internal environment even after three-quarters of its usual function is lost!

Causes of chronic renal failure

Chronic renal failure has numerous causes. Some patients present with a history of two or more risk factors for renal failure. The following is a list of some possible causes/risk factors associated with chronic renal failure.

Hypertension
Diabetes Mellitus
Long history of Phenacetin use
Chronic urinary tract infections
Chronic glomerulonephritis
Long history of kidney stones
Polycystic kidney disease
System lupus erythematosus (SLE)
Chronic pyelonephritis

Laboratory values associated failure

BUN (Blood Urea Nitrogen). Urea is a product of protein metabolism. Urea concentration is regulated primarily by the rate at which the kidney excretes urea. However, BUN is affected by other factors, such as muscle mass, excessive protein intake, or GI bleeding. The normal range of BUN is 10 to 20 mg/dL.

Creatinine. Since creatinine is a product of muscle metabolism, it is excreted by the kidney at a constant rate. Therefore, it is **the most reliable index of renal function.** The normal range for creatinine is 0.5 to 1.2 mg/dL and is normally lower in women than men due to less muscle mass.

Creatinine Clearance. Since creatinine is relatively constant, the creatinine clearance is an excellent guide for determining the glomerular filtration rate (GFR). The normal GFR ranges from 100 to 150 ml/minute and is also usually lower in women. The creatinine clearance is calculated from the values obtained from a 24-hour urine collection. The equation is as follows:

$$\text{Creatinine Clearance} = \frac{\text{Urine creatinine} \times \frac{\text{Urine volume}}{\text{Time (minutes)}}}{\text{Serum creatinine}} \quad (\text{ml/min})$$

The necessity of an accurate 24-hour urine collection is vital in determining the creatinine clearance.

Sodium (Na+). Sodium is an important determinant of blood volume. Increased Na+ retention results from renal tubular damage in renal failure. Therefore, renal failure patients must follow strict Na+ restrictions in their diet and avoid over-the-counter medications that are high in sodium. The normal range for Na is 135 to 145 meq/L.

Potassium (K+). Potassium aids in the regulation of osmotic pressure and is important in the conduction of nerve impulses. It is essential for normal excitability of muscles, especially the cardiac muscle. Abnormalities in serum K+ can lead to serious and possible life-threatening cardiac arrhythmias.

In renal failure patients, K+ is retained due to the kidney's inability to excrete excess K+. Therefore, hyperkalemia (high K+) can occur easily and rapidly in these patients. Dietary restriction of K is essential and careful monitoring of this lab value is necessary. The normal serum K value is 3.5 to 5.0 meq/L.

Calcium (Ca++) and phosphorus (PO4-). Calcium is necessary for normal muscular contractions, nerve transmissions, and clotting mechanisms. Phosphorus is related to calcium in an inverse relationship. Normal serum Ca++ is 9 to 10.5 mg/dL and normal PO4 ranges from 3 to 5 mg/dL.

In renal failure, there is decreased Ca++ and Vitamin D absorption in the GI tract. Therefore, patients with renal failure tend to be hypocalcemic (low Ca) and hyperphosphatemic (high PO4). This leads to the stimulation of the parathyroid gland to secrete parathyroid hormone)PTH) to increase serum Ca++. Since the most available source of Ca++ in the body is the bones, PTH causes Ca++ extraction from the bones. Chronic PTH stimulation can therefore lead to long-term orthopedic complications in renal failure patients if untreated.

Clinical manifestations

The clinical manifestations associated with renal failure are numerous and affect every body system to some degree. We will discuss selected clinical manifestations by body system.

Cardiovascular changes

Cardiovascular complications related to renal failure account for 50% to 65% of deaths. The most frequent clinical manifestation is hypertension from sodium and fluid retention and from a malfunctioning renin-angiotensin system in renal failure. Other cardiovascular alterations include the presence of congestive heart failure from fluid overload, edema, the potential for cardiac arrhythmias related to electrolyte disturbances, and pericarditis.

Pericarditis is seen in 30% to 50% of patients with renal failure and is caused by irritation of the pericardial sac from the circulating uremic toxins. If inflammation continues, a pericardial effusion (fluid accumulation in the pericardial space) can occur. If untreated, some patients develop rapid bleeding into the pericardial space leading to cardiac tamponage. This condition is life threatening because the pressure around the heart prevents adequate contraction of the heart muscle, inadequate venous return, and decreasing cardiac output.

Pulmonary

Pulmonary edema from fluid overload and pleuritic pain, pleural rub, and pleural effusions from uremic toxin irritation comprise the majority of pulmonary problems seen in renal failure patients. Several patients complain of shortness of breath either at rest and/or with exertion due to extra fluid retention.

Hematologic changes

Anemia is common in patients with renal failure. It is caused by several factors: decreased red blood cell production due to lack of erythropoietin made by the kidney, reduced red blood cell survival from the uremic environment, and blood loss from dialysis. Other hematologic alterations include a defect in the quality of platelets leading to an increased bleeding tendency and easy bruising. Lastly, a deficit in the immune system of renal failure patients due to uremic environment leads to an increased susceptibility to infections.

Gastrointestinal changes

Perhaps the most visible clinical manifestations are related tot he gastrointestinal (GI) changes that occur with renal failure. The entire GI system is affected. Anorexia and nausea and vomiting are almost universal. Some patients experience taste alterations, stomatitis, fetor uremicus (smell of urine and ammonia on breath), and constipation from medications' irritation of the entire GI tract lining leading to esophagitis, gastritis, duodenal ulcers, lesions in the small and large bowel, and proctitis. These mucosal changes lead to an increased risk of GI bleeding. Some patients suffer from chronic GI bleeding. All renal failure patients should routinely have stool tests for occult blood.

Integumentary changes

Some patients show a discoloration in skin with a grayish-bronze color. Many have pale, dry, scaly skin. Pruritus or itching is a common complaint of these patients. Uremic frost, a white powdery substance seen on the skin, is a very rare occurrence with modern dialysis treatment.

Neuromuscular behavior changes

These alterations are dependent on the degree of renal failure experienced by the patient. Uremia can lead to lethargy, disorientation, or extreme agitation and irritability in some patients. There has been documentation of shortened memory and attention span, daytime drowsiness and insomnia. Muscular alterations include muscle weakness and cramping and peripheral neuropathy, a condition characterized by numbness or burning in the feet and painful leg cramps usually at night.

Endocrine/Metabolism changes

The calcium/phosphorus imbalance seen in renal failure patients with renal failure has already been discussed. If untreated, this condition can lead to renal osteodystrophy, a chronic bone disorder with bone weakness and increased risk of fractures.

Metabolic acidosis is often seen in renal failure patients. This condition is caused by the accumulation of the acidic end-products of protein metabolism, the inability to excrete excess H+ (hydrogen) ions, and the inability of the kidney to regenerate bicarbonate.

Sexual functioning is also affected. Infertility occurs in both men and women. Amenorrhea takes place in most women. Decreased libido in both sexes and impotence in males is noted with uremia, but usually improves after the initiation of dialysis. Successful pregnancy for the female with renal failure is extremely rare.

Psychosocial changes

The psychosocial adjustment to this chronic disease is difficult for many patients. Anger, denial, and depression are common reactions to the diagnosis. Changes in body image, alterations in self-concept, and adjustment of family roles are critical areas for assessment. Excessive dependency upon caregivers and family can become a problem. The patient's support systems are vital in his adjustment to and acceptance of this chronic illness.

Unit 3
Self-Test

1. Chronic renal failure is an _____ reduction in _____ _____ in which the body can no longer maintain normal homeostasis. The most severe degree of chronic renal failure is called _____.

2. The constellation of signs and symptoms associated with renal failure is known as _____ or the _____ syndrome.

3. As much as _____% of normal renal function can be lost before there is a significant alteration in serum BUN and creatinine levels.

4. Name four causes/risk factors associated with chronic renal failure:

   a. _____

   b. _____

   c. _____

   d. _____

5. The most reliable laboratory indicator of renal function is _____. The normal values for this lab are _____ to _____ mg/dL.

6. A 24-hour urine collection is used to calculate a patient's _____.

7. Renal failure patients tend to be hypokalemic/hyperkalemic, hypocalcemic/hypercalcemic, and hypophosphatemia/hyperphosphatemic. (Circle the correct one of each pair.)

8. Calcium and phosphorus imbalances in renal failure patients may make them more susceptible to long-term _____ complications due to chronic stimulation of the _____ hormone.

9. List three cardiovascular clinical manifestations associated with renal failure:

   a. _____

   b. _____

   c. _____

10. Give an example of a renal clinical manifestation in each of the following body systems:

    Pulmonary:

    Hematologic:

    Gastrointestinal:

    Integumentary:

    Neuromuscular/behavioral:

    Endocrine/metabolic:

    Psychosocial:

Unit 4
Dialysis and Transplantation

OBJECTIVES

Upon completing this unit, you should be able to

- List the basic goals of dialysis therapy.
- Distinguish between hemodialysis and peritoneal dialysis and identify their most common complications.
- Contrast the three types of peritoneal dialysis.
- State the current trends with renal transplantation and the most important contributor to this increased success.

Basic goals of dialysis

The four basic goals of dialysis therapy are

- To remove the end products of protein metabolism, such as urea and creatinine, from the blood
- To remove excess fluid from the body
- To maintain a safe concentration of serum electrolytes
- To correct metabolic acidosis

Types of dialysis

There are two types of dialysis available today. Modern technology has increased the efficiency of each method over the years. **Hemodialysis** uses an external membrane within the dialysis machine to filter the blood and to remove excess fluid and elements. **Peritoneal dialysis**, or PD for short, uses the patient's own peritoneal membrane to accomplish these same goals.

Hemodialysis

The hemodialysis procedure involves diverting blood from the renal patient into a dialyzer which filters out the toxins and excess fluid and chemicals and returns the filtered blood back to the patient. This procedure requires the patient to have a patent vascular access, an area of high blood flow, that can be readily used during the hemodialysis procedure. There are two types of vascular accesses: arteriovenous (AV) fistulas and Gore-tex grafts.

AV fistulas require a surgical procedure in which an internal connection is made between an artery and vein, usually in the wrist. The procedure used the patient's own blood vessels. As the site "matures", an area of high blood flow is achieved. Ten days to two weeks is usually required before the AV fistula is fully healed and can be used for hemodialysis.

Gore-tex grafts involve surgical placement of a synthetic material called Gore-tex to connect an artery and a vein internally. This procedure is used for patients with poor peripheral blood vessels. A graft can be placed in the patient's arm or leg and also requires a waiting period of ten days to two weeks until it adequately "matures."

A temporary dialysis catheter can be placed externally in the subclavian or femoral vein for immediate use for cases of acute renal failure or until fistula or graft is ready for use.

Specific nursing care of vascular accesses is a must. With both AV fistulas and grafts, the high blood flow between the artery and the vein creates a palpable "thrill" and a "bruit" audible by a stethoscope. Each vascular access should be assessed routinely for presence of both a thrill and a bruit to ensure patency of the access. No intravenous devices should be done in the extremity of the vascular access. No heavy lifting or restrictive clothing should be worn on that extremity. Adequate blood pressure should be maintained to sustain the patency of the access site.

The most common complications of vascular accesses include infection of the site, clotting of the access, and septicemia. Strict sterile technique is vital during the hemodialysis procedure. A severe localized infection of the vascular access can rapidly lead to a systemic infection (septicemia) because of the high amount of blood flow at the site.

Most renal failure patients receive a four- to five-hour hemodialysis treatment three days per week. The procedure can be done at a hemodialysis center or at home after special training is mastered by a spouse or dialysis partner.

Peritoneal dialysis

Peritoneal dialysis or PD is a procedure in which a special fluid (dialysate) is instilled into the patient's peritoneal cavity, allowed to remain (dwell) for a period of time, and is removed from the patient's body. During this "dwelling" time, fluid, uremic toxins, and electrolytes are removed from the patient vial diffusion across this internal membrane. This treatment is done through a special peritoneal dialysis catheter inserted surgically in the peritoneal cavity.

There are three types of peritoneal dialysis. They include:

a. Intermittent Peritoneal Dialysis (IPD): IPD involves using a PD machine to dialyze about 40 hours per week, in segments or all at one time.
b. Continuous Ambulatory Peritoneal Dialysis (CAPD): With CAPD, the dialysate is instilled by gravity in to the peritoneal cavity and left in place for four to eight hours. The empty dialysate bag is left intact or removed (with a new technique known as "bagless" PD). After a designated time period, the dialysate is allowed to drain by gravity and is discarded. Then a new bag of dialysate is attached and instilled.

The patient completes three to five of these "exchanges" every day. Each exchange takes about 20 to 30 minutes to complete. In this manner, the patient received a continuous peritoneal dialysis treatment, even during the night.

Some advantages to this type of PD include more gently and continuous dialysis process that keeps the body in a more constant state of homeostasis, the independence with this procedure (no machines, electricity, or water source is required), and the ability to treat diabetics on PD with insulin in the dialysate instead of the subcutaneous route.

Continuous Cycle Peritoneal Dialysis (CCPD): CCPD is similar to CAPD in that it is relatively continuous process but requires a PD machine to perform peritoneal dialysis for about eight hours a day, usually at night. One advantage is that the PD catheter is opened fewer times per day, thus reducing the risk of infection.

The most common and serious complication related to peritoneal dialysis is the risk of peritonitis (an infection or inflammation of the peritoneal membrane). With peritonitis, the patient complains of rebound tenderness, fever, nausea, malaise, and has a cloudy dialysate output.

Peritonitis can be treated on an outpatient basis initially with antibiotics directly in the peritoneal cavity via the PD fluid. If this is unsuccessful, the patient may require a hospital admission for intravenous antibiotic therapy. The long-term complication with repeated episodes of peritonitis is scarring of the peritoneal membrane. This scarring gradually reduces the efficiency of the dialysis process and may eventually lead to the inability of this type of dialysis to maintain adequate homeostasis. Therefore, PD may by ruled out as a dialysis option for the patient.

Renal transplantation

Kidney transplants are being done with increasing frequency. There are two types: living related donor (LRD) renal transplants and cadaveric renal transplants. An extensive work up is done on all potential renal donors before consideration of the LRD option is made. If no compatible donor exists, the patient is placed on the cadaveric renal transplant list and must await an available kidney which is compatible.

The increasing success of kidney transplantation is due in part to the recent introduction of new anti-rejection medications such as Cyclosporine. The one-year renal graft survival rate is 97% in LRD cases and 90% in cadaveric cases. The long-term renal graft survival rate has also shown a significant increase. A new medication used to treat rejection episodes, OKT-3, has been partially responsible for this increased survival rate.

The complications related to renal transplantation include the risk of kidney rejection and infection. The signs and symptoms of rejection are fever, decreased urine output, edema, weight gain, increased blood pressure, and/or pain or tenderness over the transplant site. Kidney rejection can occur as an acute or chronic process. The increased risk of infections is related to the immunosuppressive medications, such as Azathioprine, Cyclosporine, and steroid therapy, that the patient must take for the rest of the life of his transplant.

Unit 4
Self-Test

1. Name two of the four basic goals of dialysis therapy.

a. _____

b. _____

2. Hemodialysis uses an _____ membrane to filter the blood while peritoneal dialysis uses the patient's own _____ membrane.

3. The two types of vascular accesses are called _____ and _____.

4. The high blood flow in the vascular access creates a palpable _____ and an audible _____.

5. _____, _____, and _____ are the most common complications of vascular accesses.

6. List and describe the three types of peritoneal dialysis.

   a. _____
   _____

   b. _____
   _____

   c. _____
   _____

7. The most common complication associated with peritoneal dialysis is _____ .

8. Describe the effect of chronic peritonitis upon the peritoneal membrane and its implications.

9. The improved success rates of renal transplants are related in part to the introduction of new _____.

10. _____ and _____ are two complications related to renal transplantation.

Unit 5
Nursing Care of the Chronic Renal Failure Patient

OBJECTIVES

Upon completing this unit, you should be able to

- Identify components of the assessment as well as critical assessment items for the renal failure patient.
- Describe the typical dietary restrictions in the renal diet.
- Name four common renal medications and state their purpose.

INTRODUCTION

The care of the patient with chronic renal failure can be a challenging experience for the nurse. This chronic illness can dramatically affect the lives of both its patients and their families. Treatment measure become a lifelong necessity for survival. The physiologic as well as the psychosocial and emotional needs of patients and families require consistent and supportive professional caregivers.

ASSESSMENT

Assessment of the chronic renal failure patient includes a careful history of signs and symptoms, a thorough physical examination, and laboratory data. Since this chronic disease affects every system in the body, a review of signs/symptoms and physical assessment data in every body system is essential. Some critical areas of assessment include:

- Fluid status: Evidence of edema. Intake and output figures. Daily weights. Blood pressure.
- Cardiac status: Health sounds. Pulse rate.
- Respiratory status: Respiratory rate and effort. Lung sounds. Pleuritic pain.

Essential laboratory data includes serum BUN, creatinine, creatinine clearance, Na, and K values. Ca and PO4 levels are important as well. Hematocrit and hemoglobin values are valuable assessment items in patients with a history of anemia or GI bleeding.

Nursing diagnosis

Because chronic renal failure affects all body systems, many nursing diagnoses are possible. The following list of possible nursing diagnoses may be identified by the RN in planning the nursing care of the clients.

- Activity intolerance related effects of anemia.
- Alteration in comfort: pleritic pain, Pruritus, nausea/vomiting, peripheral neuropathy.

- Alteration in bowel elimination: constipation related to medications.
- Alteration in nutrition: less than body requirements related to anorexia, nausea/vomiting.
- Alteration in thought processes related to effects of uremia.
- Anxiety related to diagnosis, treatment for renal failure.
- Disturbance in self concept: body image, self esteem, role performance, personal identity related to renal failure, dialysis.
- Fluid volume excess related to fluid, Na+ retention.
- Ineffective airway clearance related to fluid overload.
- Knowledge deficit related to renal failure, dialysis, treatment.
- Potential for impairment of skin integrity related to edema, skin dryness, procedures.
- Potential for ineffective individual coping related to feelings about new diagnosis of renal failure, dialysis.
- Potential for ineffective family coping related it implications of renal failure, dialysis.
- Potential for infection related to effects of uremia.
- Potential for injury related to disorientation, agitation.
- Self-care deficit: (specify) related to fatigue, weakness.
- Sexual dysfunction related to effects of uremia.
- Sleep pattern disturbance related to effects of uremia.

Planning

Planning for the renal failure patient's care involves a structured program of education and intervention for the various needs of each individual patient and family. Ideally, planning should include both the patient and the family as goals are identified and the plan of care is outlined. Nursing education about renal failure, dialysis, and treatments is vital.

Implementation

Implementation of the plan of care requires a supportive approach from the nurse. Dietary restrictions and renal medications are an important part of the patient's treatment.

Renal Diet: The typical diet for patients with renal failure includes protein restriction, sodium restriction, and potassium restriction. Protein is usually restricted to 60 to 80 grams daily. Frequently, the patient must observe a fluid restriction of one liter per day. Most patients can benefit from vitamin supplementation.

Renal Medications: The following are common medications for renal failure patients:

- Tabor-a vitamin containing iron, folic acid, and a stool softener
- Basalgel-a phosphate binder, helps to maintain Ca-PO4 balance by lowering phosphorus levels, can cause constipation

- Oscal or Calcium Carbonate-a Ca supplement to increase serum Ca++
- Shohl's solution or Oral citrate solution-bicarbonate replacement, used to treat chronic metabolic acidosis.
- Sorbitol-an artificial sweetener used as a laxative.
- Kayexalate-a resin that binds potassium in the GI tract, used to treat hyperkalemia, can cause diarrhea.

Beware of medication containing magnesium and phosphorus! Renal failure patients cannot excrete these substances and they may lead to electrolyte imbalances. Examples of medications with which to use caution are Mylanta, Milk of Magnesia, and Fleets products.

EVALUATION

Evaluation involves an assessment of whether established goals have been fully or partially met. Ideally, this evaluation process should also include input from the patient and the family. If goals have been met, new ones may need to be established. However, if goals are not met or only partially met, a revision in the plan of care by the RN warranted.

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Unit 5
Self-Test

Read the following case study and answer the questions that accompany it. Good Luck!

Chronic renal failure case study

Mr. Thomas, a 65-year-old black male with a long history of diabetes and hypertension, arrives on your unit for the Emergency Room. From the ER report, you learn that Mr. Thomas has a history of renal dysfunction during the past four years with increasing BUN and creatinine levels.

When Mr. Thomas arrives on your floor, he is lethargic and when aroused, has difficulty knowing where he is and today's date. His statements are frequently inappropriate, and he states "I feel sick to my stomach." When his family is questioned, the reveal that the patient has been nauseated and vomiting for three days and has refused to eat. He has become progressively more confused.

Assessment reveals the following data: T-36.7, P-92 regular, R-28 and slightly labored, BP-200/120. 4+pitting edema in lower extremities up to mid-thigh bilaterally. Lungs with coarse crackles 2/3 way up bilaterally. Weight is 185 lbs. (Family member states that Mr. Thomas' usual weight is 177 lbs.) I & O cath shows 40 cc dark amber urine. Labs: BUN-50, Creatinine-6.8, (last value was 3.2 in the clinic 3 months ago), K-6.0, Glucose-378.

Answer the following questions:

1. What are Mr. Thomas's risk factors for developing chronic renal failure?
2. What are his clinical manifestations of renal failure.
3. What important nursing assessments should be done daily and every shift?
11. What are Mr. Thomas's immediate medical and nursing needs? What necessary medications can you anticipate for him?

Mr. Thomas remains in the hospital for two weeks. He is treated with hemodialysis. He and his family are told that he will need dialysis for the rest of his life. His BUN and creatinine levels have stabilized. His BP is 160/90 on medications. His appetite has improved, and nausea and vomiting seldom occur. His potassium is stable at 4.6. the patient and his family receive information about long-term dialysis options. Hemodialysis is selected as the best option for him. He is scheduled for vascular access placement in two days and already has a temporary hemodialysis catheter in place. Discharge is tentatively planned for three days after surgery. Mr. Thomas will be going home on a renal diet and will be on multiple medications.

Module 26
Answers to Self-Tests

Unit 1

1. retroperitoneal
4. nephron
5. glomerulus, Bowman's capsule, proximal convoluted tubule, loop of Henle, distal convoluted tubule, collecting duct
6. 20 to 25%
7. antidiuretic hormone or ADH, aldosterone
8. Excretory functions: removal of waste products from the body; regulation of fluids, electrolytes, blood pressure, and pH within the body non-excretory or metabolic functions (any three of the following): release of renin to maintain normal blood pressure; production of prostaglandins; production of erythropoietin; conversion of Vitamin D to 1, 25 DHCC; calcium and phosphorus regulation; insulin degradation.
9. Filtration, reabsorption, secretion
10. Reabsorption
11. 1% or 1 cc/minute
12. 1440 or 1500 cc/day

Unit 2

1. Acute renal failure, reversible
2. prerenal, postrenal, intrarenal
3. postrenal
4. Any two of the following: hypovolemia from hemorrhage, burns, cardiac insufficiency, or septic shock; thrombus or embolus in renal artery
5. Acute tubular necrosis or ATN
6. Aminoglycosides, Phenacetin
7. Oliguric phase, diuretic phase, recovery phase
8. Diuretic
9. Recovery
10. Oliguric

Unit 3

1. irreversible, kidney or renal function, end stage renal disease or ESRD
2. uremica or the uremic syndrome
3. 75%
4. Any four of the following: hypertension, diabetes mellitus, long history of Phenacetin use, chronic urinary tract infections, chronic glomerulonephritis, long history of kidney stones, Polycystic kidney disease, systemic lupus erythematosus or SLE, chronic pyelonephritis
5. Creatinine, 0.5 to 1.2

6. Creatinine clearance
7. Hyperkalemic, hypocalcemic, hyperphosphatemic
8. Orthopedic, parathyroid hormone or PTH
9. Any three of the following: hypertension, congestive heart failure, edema, cardiac arrhythmias, pericarditis
10. One example in each system:

    Pulmonary: pulmonary edema, pleuritic pain, pleural rub, pleural effusions, shortness of breath
    Hematologic: anemia, platelet defect with bleeding tendency and easy bruising, increased susceptibility to infections
    Gastrointestinal: anorexia, nausea/vomiting, taste alterations, stomatitis, fetor uremicus, constipation, esophagitis, gastritis, duodenal ulcers. Lesions in small or large intestine, proctitis, GI bleeding
    Integumentary: grayish-bronze skin color, pale, dry scaly skin, Pruritus or itching, uremic frost
    Neuromuscular/behavioral: lethargy, disorientation, extreme agitation or irritability, shortened memory and attention, daytime drowsiness, insomnia, muscle weakness and cramping, peripheral neuropathy
    Endocrine/metabolic: renal osteodystrophy with bone weakness and fractures, metabolic acidosis, infertility, amenorrhea, decreased libido, impotence
    Psychosocial: anger, denial depression, changes in body image, self-concept alterations, family role adjustments, dependency

Unit 4

1. Any two of the following: removal of end products of protein metabolism, removal of excess fluid, maintenance of electrolyte balance, correction or metabolic acidosis
2. external, peritoneal
11. arteriovenous (AV) fistulas, Gore-tex grafts
12. thrill, bruit
13. infection, clotting, septicemia
14. Intermittent Peritoneal Dialysis, (IPD): about 40 hours weekly of dialysis on a PD machine, in segments or all at one time.
    Continuous Ambulatory Peritoneal Dialysis (CAPD): PD fluid instilled and drained by gravity during three to five exchanges daily
    Continuous Cycle Peritoneal Dialysis (CCPD): about eight hours daily or PD using a machine, usually at night
15. peritonitis
16. Chronic peritonitis can lead to scarring of the peritoneal membrane which reduces PD's efficiency and may lead to the inability of this type of dialysis to maintain adequate homeostasis.
17. Anti-rejection mediations
18. Kidney rejection, infection

Unit 5

1. history or renal dysfunction, diabetes, hypertension
2. lethargy, disorientation, nausea/vomiting, anorexia, increasing confusion, slightly labored respirations, increased blood pressure, pitting edema, crackles in lungs, weight gain, decreased urine output, increased BUN, creatinine, and potassium
3. strict intake and output, daily weights, assessment of fluid status/edema, lungs, mental status, appetite, blood pressure, monitor blood glucose and other labs

12. treatment of blood pressure, potassium, and glucose values, safety issues, reorientation, treatment of nausea;
    Possible medications: Kayexalate to lower potassium, insulin to treat glucose, BP meds, diuretics, antiemetic medications

EVALUATION

1. Did this module cover what you expected it to? Yes _____ No _____

2. Was the topic treated in sufficient depth? Yes _____ No _____
   If no, check one of the following: Too little depth _____ Too great a depth _____ Assumed I know too much _____

3. Did the module hold your interest: Yes _____ No _____

4. Were the objectives fulfilled? Yes, very much _____ Somewhat _____ Very little _____

5. Was the module written in easily understood language? Yes _____ No _____

6. Estimate the number of hours you spent reading and studying
   1-5 hrs. _____
   6-10 hrs. _____
   11-20 hrs. _____
   More than 20 hrs. _____

7. Will you be able to use this information when you return to practice? Yes _____ No _____

8. Overall, were you satisfied with module? Yes _____ No _____

9. Please use the space below (and on the back, if needed) to offer additional comments or suggestions.

10. Module #_____