UNIT 11 Kidney and Urinary Tract Function

Case Study

AVOIDING FALLS FOR THE PATIENT AT RISK

You are a nurse working in an intermediate medical unit caring for a 78-year-old man who was admitted from the emergency department (ED) with a change in level of consciousness and falling at home. His diagnostic and laboratory findings show that he has a lower urinary tract infection (UTI). Your initial assessment reveals the patient is still not oriented to person, place, or time. In addition, he is trying to get up to the bathroom due to urinary urgency caused by the UTI. Because of his change in level of consciousness and urgency, you determine that safety is a priority. You implement falls precautions.

QSEN Competency Focus: Safety

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care***, ***interdisciplinary teamwork and collaboration***, ***evidence-based practice***, ***quality improvement***, ***safety***, and ***informatics.***

Safety Definition: Minimizes risk of harm to patients and providers through both system effectiveness and individual performance.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Examine human factors and other basic safety design principles as well as commonly used unsafe practices (such as, work-arounds and dangerous abbreviations)	Describe how you will prioritize care for this patient. How does safety impact priority decisions for this patient? Based on the assessment findings, why was the patient placed on falls precautions?
Skills	
Demonstrate effective use of technology and standardized practices that support safety and quality	Identify the technology and standardized practices you will use to implement falls precautions for this patient. How will you determine when the falls precautions can be discontinued?
Attitudes	
Value vigilance and monitoring (even of own performance of care activities) by patients, families, and other members of the health care team	Reflect on what you learned from this case study. The nurse's role in patient safety is essential. How can the nurse educate the patient and family to value safety in the home environment to prevent falls? Which additional health care team members could be consulted to assist the patient and family in a home assessment for safety?

Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122–131; Institute of Medicine. (2003). *Health professions education: A bridge to quality*. Washington, DC: National Academies Press; QSEN Institute. (2020). *QSEN competencies: Definitions and pre-licensure KSAs; Safety*. Retrieved on 8/15/2020 at: qsen.org/competencies/pre-licensure-ksas/#safety

47 Assessment of Kidney and Urinary Function

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the structure and function of the renal and urinary systems.
2. Explain the role of the kidneys in regulating fluid and electrolyte balance, acid–base balance, and blood pressure.
3. Identify the diagnostic studies used to determine upper and lower urinary tract function and related nursing implications.
4. Discriminate between normal and abnormal assessment findings of upper and lower urinary tract function.
5. Initiate education and preparation for patients undergoing assessment of the urinary system.

NURSING CONCEPTS

Acid–Base Balance
Acid–Base Balance Assessment
Comfort
Elimination
Fluids and Electrolytes
Infection
Patient Education

GLOSSARY

aldosterone: hormone synthesized and released by the adrenal cortex; causes the kidneys to reabsorb sodium

antidiuretic hormone (ADH): hormone secreted by the posterior pituitary gland; causes the kidneys to reabsorb more water (*synonym:* vasopressin)

anuria: decreased urine output of less than 50 mL in 24 hours

bacteriuria: bacteria in the urine

creatinine: endogenous waste product of muscle energy metabolism

diuresis: increased urine volume

dysuria: painful or difficult urination

erythropoietin: glycoprotein produced by kidney; stimulates bone marrow to produce red blood cells

glomerular filtration rate (GFR): amount of plasma filtered through the glomeruli per unit of time

glomerulus: tuft of capillaries forming part of the nephron through which filtration occurs

glycosuria: excretion of glucose in the urine

hematuria: red blood cells in the urine

micturition: urination or voiding

nephrons: structural and functional units of the kidney responsible for urine formation

nocturia: awakening at night to urinate

oliguria: urine output less than 400 mL in 24 hours or less than 0.5 mL/kg/h over 6 hours

proteinuria: protein in the urine

pyuria: white blood cells in the urine

renal clearance: ability of the kidneys to clear solutes from the plasma

specific gravity: expression of the degree of concentration of the urine

urea nitrogen: end product of protein metabolism (*synonym:* blood urea nitrogen [BUN])

urinary frequency: voiding more frequently than every 3 hours

Function of the renal and urinary systems is essential to life. The primary purpose of the renal and urinary systems is to maintain the body's state of homeostasis by carefully regulating fluid and electrolytes, removing wastes, and providing other functions (see Chart 47-1). Dysfunction of the kidneys and lower urinary tract is common and may occur at any age and with varying degrees of severity. Assessment of upper and lower urinary tract function is part of every health examination and requires the nurse to understand the anatomy and physiology of the urinary system as well as the effects of changes in the system on other physiologic functions.

Chart 47-1

Functions of the Kidney

Control of blood pressure
Control of water balance
Excretion of waste products
Regulation of electrolytes
Regulation of acid–base balance
Regulation of red blood cell production
Renal clearance
Secretion of prostaglandins
Synthesis of vitamin D to active form
Urine formation

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Anatomic and Physiologic Overview

A focused assessment of kidney and urinary tract function requires an understanding of the anatomy and physiology of these systems.

Anatomy of the Kidney and Urinary Systems

The kidney and urinary systems include the kidneys, ureters, bladder, and urethra. Urine is formed by the kidney and flows through the other structures to be eliminated from the body.

Kidneys

The kidneys are a pair of bean-shaped, brownish-red structures located retroperitoneally (behind and outside the peritoneal cavity) on the posterior wall of the abdomen—from the 12th thoracic vertebra to the 3rd lumbar vertebra in the adult (see Fig. 47-1A). The rounded outer convex surface of each kidney is called the hilum. Each hilum is penetrated with blood vessels, nerves, and the ureter. The average adult kidney weighs approximately 113 to 170 g (about 4.5 oz) and is 10 to 12 cm long, 6 cm wide, and 2.5 cm thick (Norris, 2019; Russell, 2017). The right kidney is slightly lower than the left due to the location of the liver.

Externally, the kidneys are well protected by the ribs and by the muscles of the abdomen and back. Internally, fat deposits surround each kidney, providing protection against jarring. The kidneys and surrounding fat are suspended from the abdominal wall by renal fascia made of connective tissue which holds the kidney in place (Norris, 2019). The fibrous connective tissue, blood vessels, and lymphatics surrounding each kidney are known as the renal capsule. An adrenal gland lies on top of each kidney. The kidneys and adrenals are independent in function, blood supply, and innervation.

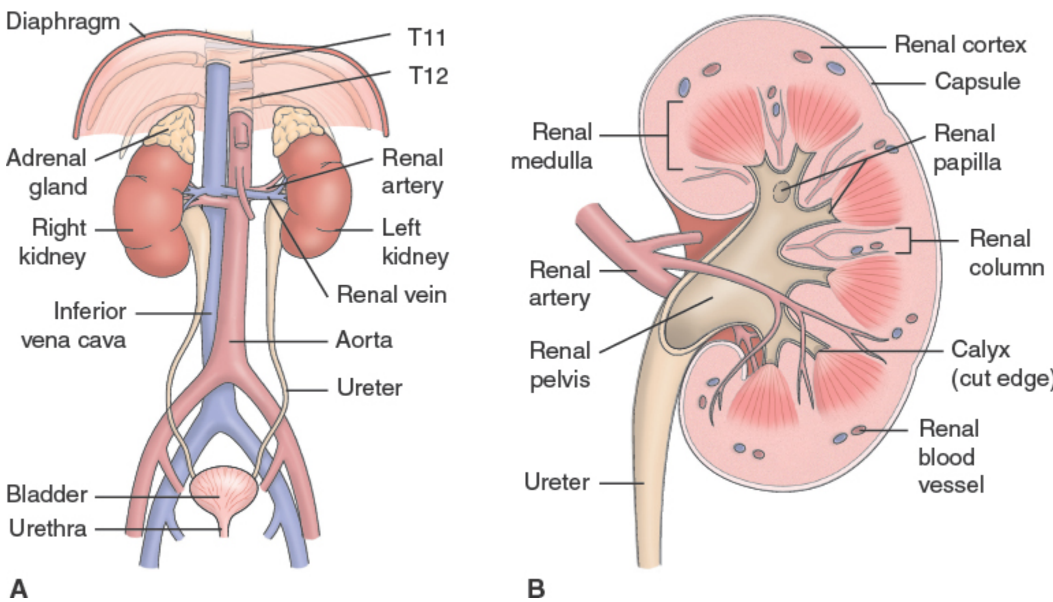


Figure 47-1 • **A.** Kidneys, ureters, and bladder. **B.** Internal structure of the kidney. Redrawn with permission from Porth, C. M., & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

The renal parenchyma is divided into two parts: the cortex and the medulla (see Fig. 47-1B). The medulla, which is approximately 5 cm wide, is the inner portion of the kidney. It contains the loops of Henle, the vasa recta, and the collecting ducts of the juxtamedullary nephrons. The collecting ducts from both the juxtamedullary and the cortical nephrons connect to the renal pyramids, which are triangular and are situated with the base facing the concave surface of the kidney and the point (papilla) facing the hilum, or pelvis. Each kidney contains approximately 8 to 18 pyramids. The pyramids drain into minor calyces, which drain into major calyces that open directly into the renal pelvis. The tip of each pyramid is called a papilla and projects into the minor calyx. The renal pelvis is the beginning of the collecting system and is composed of structures that are designed to collect and transport urine. Once the urine leaves the renal pelvis, the composition or amount of urine does not change.

The cortex, which is approximately 1 cm wide, is located farthest from the center of the kidney and around the outermost edges (Norris, 2019). It contains the **nephrons** (the structural and functional units of the kidney responsible for urine formation), which are discussed later.

Blood Supply to the Kidneys

The hilum is the concave portion of the kidney through which the renal artery enters and the ureters and renal vein exit. The kidneys receive 20% to 25% of the total cardiac output, which means that all of the body's blood circulates through the kidneys approximately 12 times per hour (Norris, 2019). The renal artery (arising from the abdominal aorta) divides into smaller and smaller vessels, eventually forming the afferent arterioles. Each afferent arteriole branches to form a **glomerulus**, which is the tuft of capillaries forming part of the nephron through which filtration occurs. Blood leaves the glomerulus through the efferent arteriole and flows back to the inferior vena cava through a network of capillaries and veins.

Nephrons

Each kidney has one million nephrons that are located within the renal parenchyma and are responsible for the formation of filtrate that will become urine (Norris, 2019). The large number of nephrons allows for adequate renal function even if the opposite kidney is damaged or becomes nonfunctional. If the total number of functioning nephrons is less than 20% of normal, kidney replacement therapy needs to be considered.

There are two types of nephrons. The cortical nephrons (80% to 85%) are located in the outermost part of the cortex, and the juxtamedullary nephrons (15% to 20%) are located deeper in the cortex (Norris, 2019). The juxtamedullary nephrons are distinguished by long loops of Henle and are surrounded by long capillary loops called vasa recta that dip into the medulla of the kidney. The length of the tubular component of the nephron is directly related to its ability to concentrate urine.

Nephrons are made up of two basic components: a filtering element composed of an enclosed capillary network (the glomerulus) and the attached tubule (see Fig. 47-2). The glomerulus is a unique network of capillaries suspended between the afferent and efferent blood vessels, which are enclosed in an epithelial structure called the Bowman capsule. The glomerular membrane is composed of three filtering layers: the capillary endothelium, the basement membrane, and the epithelium. This membrane normally allows filtration of fluid and small molecules yet limits passage of larger molecules, such as blood cells and albumin. Pressure changes and the permeability of the glomerular membrane of the Bowman capsule facilitate the passage of fluids and various substances from the blood vessels, filling the space within the Bowman capsule with this filtered solution.

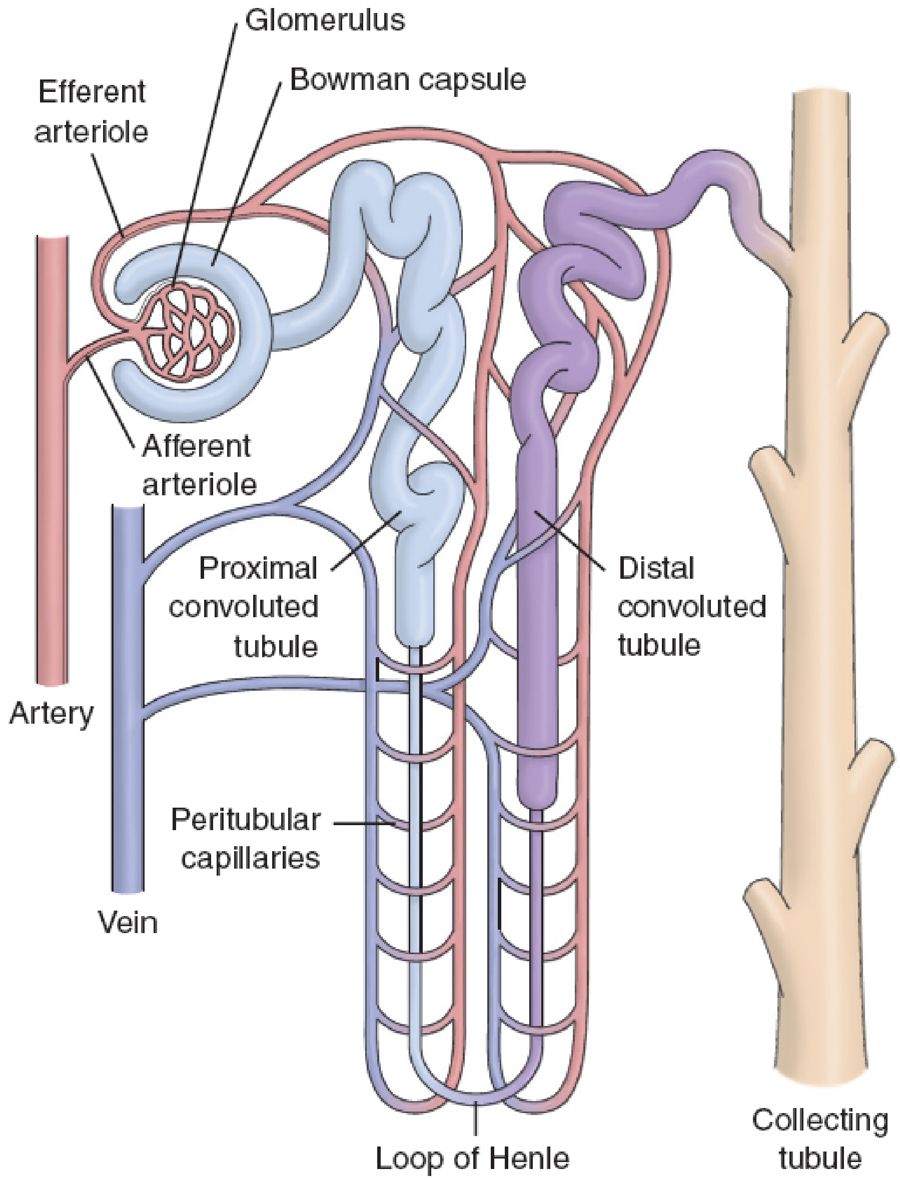


Figure 47-2 • Representation of a nephron. Each kidney has about one million nephrons of two types: cortical and juxtamedullary. Cortical nephrons are located in the cortex of the kidney; juxtamedullary nephrons are adjacent to the medulla.

The tubular component of the nephron begins in the Bowman capsule. The filtrate created in the Bowman capsule travels first into the proximal tubule, which is made up of epithelial cells resting on the basement membrane, then the loop of Henle, the distal tubule, and either the cortical or medullary collecting ducts. The structural arrangement of the tubule allows the distal tubule to lie in close proximity to where the afferent and efferent arterioles, respectively, enter and leave the glomerulus. The distal tubular cells located in this area, known as the macula densa, function with the adjacent afferent arteriole and create what is known as the juxtaglomerular apparatus. This is the site of renin production. Renin is a hormone directly involved in the control of arterial blood pressure; it is essential for proper functioning of the glomerulus (see later discussion).

The tubular component consists of the Bowman capsule, the proximal tubule, the descending and ascending limbs of the loop of Henle, and the cortical and medullary collecting ducts. This portion of the nephron is responsible for making adjustments in the filtrate based on the body's needs. Changes are continually made as the filtrate travels through the tubules until it enters the collecting system and is expelled from the body (see Fig. 47-2).

Ureters, Bladder, and Urethra

The urine formed in the nephrons flows through the renal calyces and then into the ureters, which are long fibromuscular tubes that connect each kidney to the bladder (Verlander & Clapp, 2019). These narrow tubes, each 24 to 30 cm long, originate at the lower portion of the renal pelvis and terminate in the trigone (tissue between the opening of the ureters and urethra) of the bladder wall.

The lining of the ureters is made up of transitional cell epithelium called urothelium. The urothelium prevents reabsorption of urine. The movement of urine from each renal pelvis through the ureter into the bladder is facilitated by peristaltic contraction of the smooth muscles in the ureter wall. Each ureter has three narrow areas that are prone to obstruction by renal calculi (kidney stones) or stricture. These three areas include the ureteropelvic junction, the ureteral segment near the sacroiliac junction, and the ureterovesical junction. Obstruction of the ureteropelvic junction is the most serious because of its close proximity to the kidney and the risk of associated kidney dysfunction.

The urinary bladder is a distensible muscular sac located just behind the pubic bone (Weber & Kelley, 2018). The usual capacity of the adult bladder is 400 to 500 mL, but it can distend to hold a larger volume. The bladder is characterized by its central, hollow area, called the vesicle, which has two inlets (the ureters) and one outlet (the urethra). The area surrounding the bladder neck is called the ureterovesical junction. The angling of the ureterovesical junction is the primary means of providing antegrade, or downward, movement of urine, also referred to as efflux of urine. This angling prevents vesicoureteral reflux (retrograde, or backward, movement of urine) from the bladder, up the ureter, toward the kidney.

The wall of the bladder contains four layers. The outermost layer is the adventitia, which is made up of connective tissue. Immediately beneath the adventitia is a smooth muscle layer known as the detrusor. Beneath the detrusor is a submucosal layer of loose connective tissue that serves as an interface between the detrusor and the innermost layer, a mucosal lining. The inner layer contains specialized transitional cell epithelium, a membrane that is impermeable to water and prevents reabsorption of urine stored in the bladder. The bladder neck contains bundles of involuntary smooth muscle that form a portion of the urethral sphincter known as the internal sphincter. An important portion of the sphincter mechanism that helps maintain continence is the external urinary sphincter at the anterior urethra, which is the segment most distal from the bladder (Norris, 2019). During **micturition** (voiding or urination), increased intravesical pressure keeps the ureterovesical junction closed and urine within the ureters. As soon as micturition is completed, intravesical pressure returns to its normal low baseline value, allowing efflux of urine to resume. Therefore, the only time that the bladder is completely empty is in the last seconds of micturition, before efflux of urine resumes.

The urethra arises from the base of the bladder: In the male, it passes through the penis; in the female, it opens just anterior to the vagina. In the male, the prostate gland, which lies just below the bladder neck, surrounds the urethra posteriorly and laterally.

Physiology of the Kidney and Urinary Systems

Understanding the physiology of the kidney and urinary systems includes comprehending urine formation, antidiuretic hormone, osmolarity and osmolality; the regulation of water excretion, electrolyte excretion, and acid–base balance; autoregulation of blood pressure, renal clearance, regulation of red blood cell (RBC) production, vitamin D synthesis, secretion of prostaglandins and other substances, excretion of waste products, urine storage as well as bladder emptying.

Urine Formation

The healthy human body is composed of approximately 60% water. Water balance is regulated by the kidneys and results in the formation of urine. Urine is formed in the nephrons through a complex three-step process: glomerular filtration, tubular reabsorption, and tubular secretion (see Fig. 47-3). Each nephron functions independently from other nephrons because each has its own blood supply (Norris, 2019). The various substances normally filtered by the glomerulus, reabsorbed by the tubules, and excreted in the urine include sodium, chloride, bicarbonate, potassium, glucose, urea, creatinine, and uric acid. Within the tubule, some of these substances are selectively reabsorbed into the blood. Others are secreted from the blood into the filtrate as it travels down the tubule.

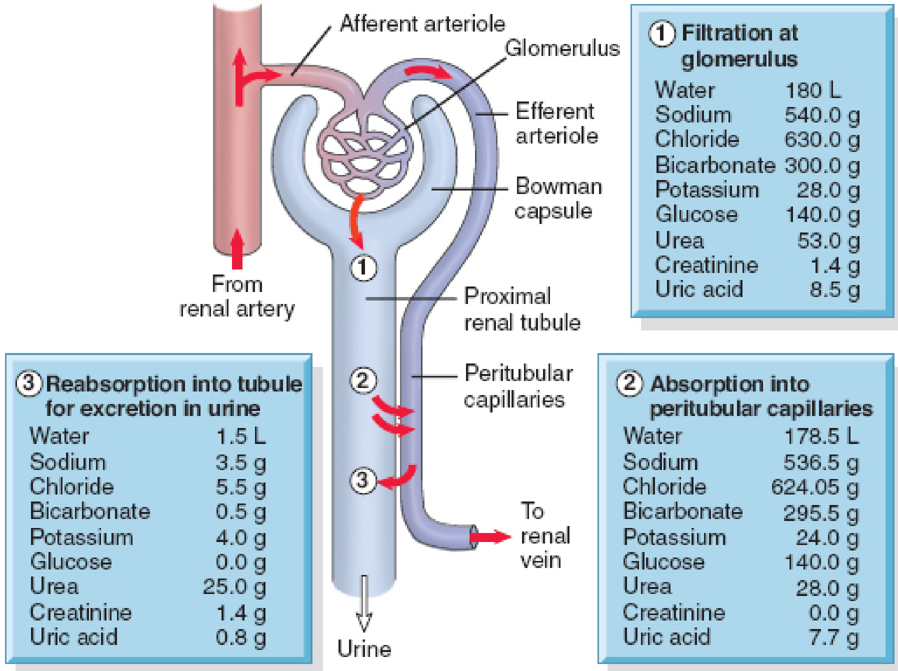


Figure 47-3 • Urine is formed in the nephrons in a three-step process: filtration, reabsorption, and secretion. Water, electrolytes, and other substances, such as glucose and creatinine, are filtered by the glomerulus; varying amounts of these substances are reabsorbed in the renal tubule or excreted in the urine. Approximate normal volumes of these substances during the steps of urine formation are shown at the top. Wide variations may occur in these values depending on diet.

Amino acids and glucose are usually filtered at the level of the glomerulus and reabsorbed so that neither is excreted in the urine. Normally, glucose does not appear in the urine. However, **glycosuria** (excretion of glucose in the urine) occurs if the amount of glucose in the blood and glomerular filtrate exceeds the amount that the tubules are able to reabsorb. Renal glycosuria can occur on its own as a benign condition. It also occurs in poorly controlled diabetes—the most common condition that causes the blood glucose level to exceed the kidney’s reabsorption capacity.

Protein molecules also are not usually found in the urine; however, low-molecular-weight proteins (globulins and albumin) may periodically be excreted in small amounts. Protein in the urine is referred to as **proteinuria** (Fischbach & Fischbach, 2018).

Glomerular Filtration

The normal blood flow through the kidneys is between 1000 and 1300 mL/min (Norris, 2019). As blood flows into the glomerulus from an afferent arteriole, filtration occurs. The filtered fluid, also known as filtrate or ultrafiltrate, then enters the renal tubules. Under normal conditions, about 20% of the blood passing through the glomeruli is filtered into the nephron, amounting to about 180 L/day of filtrate (Norris, 2019). The filtrate normally consists of water, electrolytes, and other small molecules, because water and small molecules are allowed to pass, whereas larger molecules stay in the bloodstream. As blood enters the glomerulus from the afferent arteriole, filtration depends on adequate blood flow that maintains a consistent pressure through the glomerulus called hydrostatic pressure. Many factors can alter this blood flow and pressure, including hypotension, decreased oncotic pressure in the blood, and increased pressure in the renal tubules from an obstruction (Norris, 2019).

Tubular Reabsorption and Tubular Secretion

The second and third steps of urine formation occur in the renal tubules. In tubular reabsorption, a substance moves from the filtrate back into the peritubular capillaries or vasa recta. In tubular secretion, a substance moves from the peritubular capillaries or vasa recta into tubular filtrate. Of the 180 L (45 gallons) of filtrate that the kidneys produce each day, 99% is reabsorbed into the bloodstream, resulting in the formation of 1 to 2 L of urine each day. Although most reabsorption occurs in the proximal tubule, reabsorption occurs along the entire tubule. Reabsorption and secretion in the tubule frequently involve passive and active transport and may require the use of energy. Tubular secretion occurs when substances move from the peritubular capillary blood plasma (blood) into the tubular lumen (filtrate). Tubular secretion helps with the elimination of potassium, hydrogen ions, ammonia, uric acid, some drugs, and other waste products (Fischbach & Fischbach, 2018). Filtrate becomes concentrated in the distal tubule and collecting ducts under hormonal influence and becomes urine, which then enters the renal pelvis. In the absence of tubular reabsorption, volume depletion would rapidly occur.

Antidiuretic Hormone

Antidiuretic hormone (ADH), also known as vasopressin, is a hormone that is secreted by the posterior portion of the pituitary gland in response to changes in osmolality of the blood. With decreased water intake, blood osmolality tends to increase, stimulating ADH release. ADH then acts on the kidney, increasing reabsorption of water and thereby returning the osmolality of the blood to normal. With excess water intake, the secretion of ADH by the pituitary is suppressed; therefore, less water is reabsorbed by the kidney tubule, leading to **diuresis** (increased urine volume).

A dilute urine with a fixed **specific gravity** (about 1.010) or fixed osmolality (about 300 mOsm/L) indicates an inability to concentrate and dilute the urine, which is a common early sign of kidney disease (Fischbach & Fischbach, 2018).

Osmolarity and Osmolality

Osmolarity refers to the ratio of solute to water. The regulation of salt and water is paramount for control of the extracellular volume and both serum and urine osmolarity. Controlling either the amount of water or the amount of solute can change osmolarity. Osmolarity and ionic composition are maintained by the body within very narrow limits. As little as a 1% to 2% change in the serum osmolarity can cause a conscious desire to drink and conservation of water by the kidneys (Emmett & Palmer, 2018).

The degree of dilution or concentration of the urine is also measured in terms of osmolality (the number of osmoles [the standard unit of osmotic pressure] dissolved per kilogram of solution). The filtrate in the glomerular capillary normally has the same osmolality as the blood—280 to 300 mOsm/kg. Serum and urine osmolality and osmolarity are discussed in more detail in Chapter 10.

Regulation of Water Excretion

Regulation of the amount of water excreted is an important function of the kidney. With high fluid intake, a large volume of dilute urine is excreted. Conversely, with a low fluid intake, a small volume of concentrated urine is excreted. A person normally ingests about 1300 mL of oral liquids and 1000 mL of water in food per day. Of the fluid ingested, approximately 800 mL is lost through the skin and lungs and 200 mL through feces (called insensible loss). It is important to consider all fluid gained and lost when evaluating total fluid status. Daily weight measurements are a reliable means of determining overall fluid status. One pound (1 lb) equals approximately 500 mL, so a weight change of as little as 1 lb could suggest an overall fluid gain or loss of 500 mL (Norris, 2019).

Regulation of Electrolyte Excretion

When the kidneys are functioning normally, the volume of electrolytes excreted per day is equal to the amount ingested. For example, the average American daily diet contains 6 to 15 g each of sodium chloride (salt) and 8 g potassium chloride, and approximately the same amounts are excreted in the urine.

The regulation of sodium volume excreted depends on **aldosterone,** a hormone synthesized and released by the adrenal cortex. With increased aldosterone in the blood, less sodium is excreted in the urine, because aldosterone fosters renal reabsorption of sodium. Release of aldosterone from the adrenal cortex is largely under the control of angiotensin II. Angiotensin II levels are in turn controlled by renin, an enzyme that is released from specialized cells in the kidneys (see Fig. 47-4). This complex system is activated when pressure in the renal arterioles falls below normal levels, as occurs with shock, dehydration, or decreased sodium chloride delivery to the tubules. Activation of this system increases the retention of water and expansion of the intravascular fluid volume, thereby maintaining enough pressure within the glomerulus to ensure adequate filtration.

The regulation of serum sodium and potassium is discussed in detail in Chapter 10.

Physiology/Pathophysiology

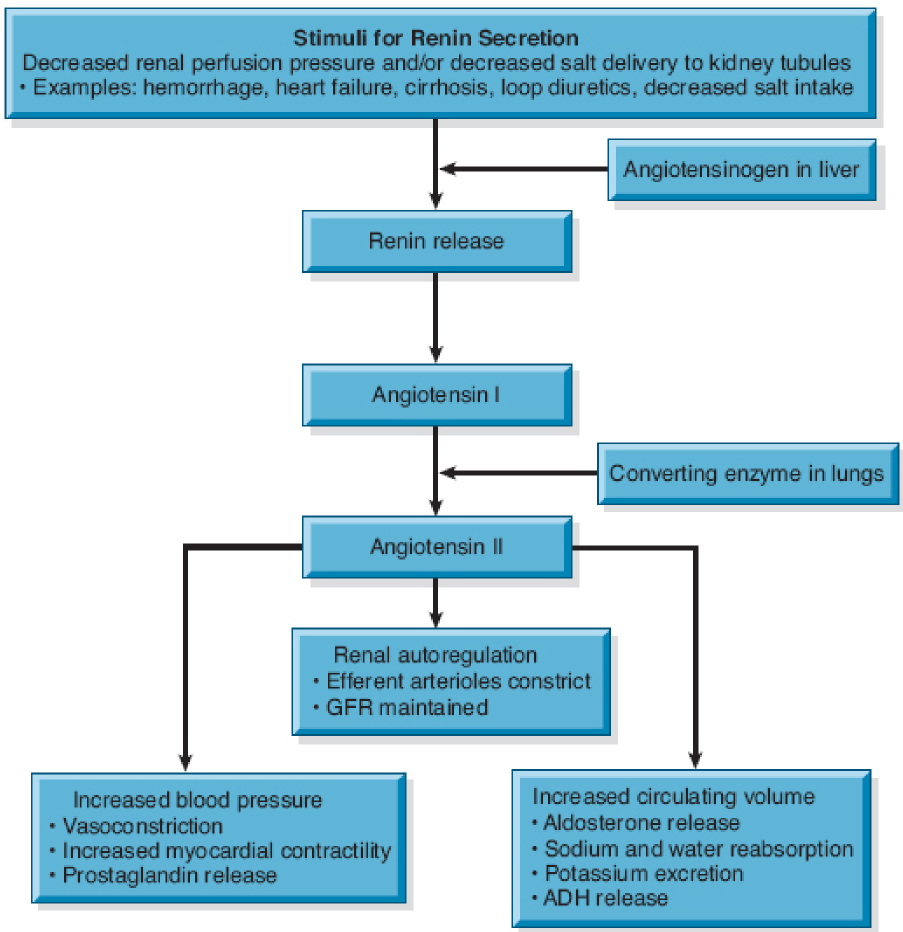


Figure 47-4 • The renin–angiotensin system. ADH, antidiuretic hormone; GFR, glomerular filtration rate.

Regulation of Acid–Base Balance

The normal serum pH is about 7.35 to 7.45 and must be maintained within this narrow range for optimal physiologic function (Norris, 2019). The kidney performs major functions to assist in this balance. One function is to reabsorb and return to the body's circulation any bicarbonate from the urinary filtrate; other functions are to excrete or reabsorb acid, synthesize ammonia, and excrete ammonium chloride (Fischbach & Fischbach, 2018). Because bicarbonate is a small ion, it is freely filtered at the glomerulus. The renal tubules actively reabsorb most of the bicarbonate in the urinary filtrate. To replace any lost bicarbonate, the renal tubular cells generate new bicarbonate through a variety of chemical reactions. This newly generated bicarbonate is then reabsorbed by the tubules and returned to the body.

The body's acid production is the result of catabolism, or breakdown, of proteins, which produces acid compounds, particularly phosphoric and sulfuric acids. The normal daily diet also includes a certain amount of acid materials. Unlike carbon dioxide (CO_2), phosphoric and sulfuric acids cannot be eliminated by the lungs. Because accumulation of these acids in the blood lowers pH (making the blood more acidic) and inhibits cell function, they must be excreted in the urine. However, if the hydrogen ions are low, they will be reabsorbed. A person with normal kidney function excretes about 70 mEq of acid each day. The kidney is able to excrete some of this acid directly into the urine until the urine pH reaches 4.5, which is 1000 times more acidic than blood (Norris, 2019).

However, more acid usually needs to be eliminated from the body than can be secreted directly as free acid in the urine. These excess acids are bound to chemical buffers so that they can be excreted in the urine. Two important chemical buffers are phosphate ions and ammonia (NH_3). When buffered with acid, ammonia becomes ammonium (NH_4). Phosphate is present in the glomerular filtrate, and ammonia is produced by the cells of the renal tubules and secreted into the tubular fluid. Through the buffering process, the kidney is able to excrete large quantities of acid in a bound form without further lowering the pH of the urine.

Autoregulation of Blood Pressure

Regulation of blood pressure is an important function of the kidney. Specialized vessels of the kidney, called the vasa recta, constantly monitor blood pressure as blood begins its passage into the kidney. When the vasa recta detect a decrease in blood pressure, specialized juxtaglomerular cells near the afferent arteriole, distal tubule, and efferent arteriole secrete the hormone renin. Renin converts angiotensinogen to angiotensin I, which is then converted to angiotensin II—the most powerful vasoconstrictor known; angiotensin II causes the blood pressure to increase (Norris, 2019). The adrenal cortex secretes aldosterone in response to stimulation by the pituitary gland, which occurs in response to poor perfusion or increasing serum osmolality. The result is an increase in blood pressure. When the vasa recta recognize the increase in blood pressure, renin secretion stops. Failure of this feedback mechanism is one of the primary causes of hypertension (see Fig. 47-4).

Renal Clearance

Renal clearance refers to the ability of the kidneys to clear solutes from the plasma. A 24-hour collection of urine is the primary test of renal clearance used to evaluate how well the kidney performs this important excretory function. Renal clearance depends on several factors: how quickly the substance is filtered across the glomerulus, how much of the substance is reabsorbed along the tubules, and how much of the substance is secreted into the tubules. It is possible to measure the renal clearance of any substance, but the one measure that is particularly useful is the creatinine clearance.

Creatinine is an endogenous waste product of skeletal muscle that is filtered at the glomerulus, passed through the tubules with minimal change, and excreted in the urine. Hence, creatinine clearance is a good measure of the **glomerular filtration rate (GFR),** the amount of plasma filtered through the glomeruli per unit of time. To calculate creatinine clearance, a 24-hour urine specimen is collected. Midway through the collection, the serum creatinine level is measured. The following formula is then used to calculate the creatinine clearance:

$$\frac{(\text{Volume of urine [mL/min]} \times \text{Urine creatinine [mL/dL]})}{\text{Serum creatinine (mg/dL)}}$$

The adult glomerular filtration rate (GFR) can vary from a normal of approximately 125 mL/min (1.67 to 2 mL/s) to a high of 200 mL/min (Norris, 2019). Creatinine clearance is the best approximation of renal function. As renal function declines, both creatinine clearance and renal clearance (the ability to excrete solutes) decrease.

Regulation of Red Blood Cell Production

When the kidneys detect a decrease in the oxygen tension in renal blood flow, because of anemia, arterial hypoxia, or inadequate blood flow, they release erythropoietin. **Erythropoietin** is a glycoprotein from the kidney that stimulates the bone marrow to produce RBCs, which carry oxygen throughout the body (Norris, 2019).

Vitamin D Synthesis

The kidneys are also responsible for the final conversion of inactive vitamin D to its active form, 1,25-dihydroxycholecalciferol. Vitamin D is necessary for maintaining normal calcium balance in the body.

Secretion of Prostaglandins and Other Substances

The kidneys also produce prostaglandin E and prostacyclin, thromboxanes, and leukotrienes, which have vasoactive effects. These substances help the afferent and efferent arterioles maintain renal blood flow by causing selective vasodilation or vasoconstriction (Norris, 2019).

Excretion of Waste Products

The kidneys eliminate the body's metabolic waste products. The major waste product of protein metabolism is urea, of which about 25 to 30 g are produced and excreted daily (Norris, 2019). All of this urea must be excreted in the urine; otherwise, it accumulates in body tissues. Other waste products of metabolism that must be excreted are creatinine, phosphates, and sulfates. Uric acid, formed as a waste product of purine metabolism, is also eliminated in the urine. The kidneys serve as the primary mechanism for excreting drug metabolites.

Urine Storage

The bladder is the reservoir for urine. Both filling and emptying of the bladder are mediated by coordinated sympathetic and parasympathetic nervous system control mechanisms involving the detrusor muscle and the bladder outlet. Conscious awareness of bladder filling occurs as a result of sympathetic neuronal pathways that travel via the spinal cord to the level of T10 through T12, where peripheral, hypogastric nerve innervation allows for continued bladder filling. As bladder filling continues, stretch receptors in the bladder wall are activated, coupled with the desire to void. This information from the detrusor muscle is relayed back to the cerebral cortex via the parasympathetic pelvic nerves at the levels of S1 through S4 (Norris, 2019). Overall bladder pressure remains low due to the bladder's compliance (ability to expand or collapse) as urine volume changes.

Bladder compliance is due in part to the smooth muscle lining of the bladder and collagen deposits within the wall of the bladder, as well as to neuronal mechanisms that inhibit the detrusor muscle from contracting (specifically, adrenergic receptors that mediate relaxation). To maintain adequate kidney filtration rates, bladder pressure during filling must remain lower than 40 cm water (H_2O). This low pressure allows the urine to freely leave the renal pelvis and enter the ureters. The sensation of bladder fullness is transmitted to the central nervous system when the bladder has reached about 150 to 200 mL in adults, and an initial desire to void occurs (Weber & Kelley, 2018). A marked sense of fullness and discomfort with a strong desire to void usually occurs when the bladder reaches its functional capacity of 400 to 500 mL of urine. Neurologic changes to the bladder at the level of the supraspinal nerves, the spinal nerves, or the bladder wall itself can cause abnormally high volumes (up to 2000 mL) of urine to be stored due to a decreased or absent urge to void.

Under normal circumstances with average fluid intake of approximately 1 to 2 L/day, the bladder should be able to store urine for periods of 2 to 4 hours at a time during the day (Norris, 2019). At night, the release of vasopressin in response to decreased fluid intake causes a decrease in the production of urine and makes it more concentrated. This phenomenon usually allows the bladder to continue filling for periods of 6 to 8 hours in adolescents and adults, making them able to sleep for longer periods before needing to void. In older adults, decreasing bladder compliance and decreased vasopressin levels often cause **nocturia** (awakening during the night to urinate).

Bladder Emptying

Micturition normally occurs approximately eight times in a 24-hour period. It is activated via the micturition reflex arc within the sympathetic and parasympathetic nervous systems, which causes a coordinated sequence of events. Initiation of voiding occurs when the efferent pelvic nerve, which originates in the S1 to S4 area, stimulates the bladder to contract, resulting in complete relaxation of the striated urethral sphincter. This is followed by a decrease in urethral pressure, contraction of the detrusor muscle, opening of the vesical neck and proximal urethra, and flow of urine. This coordinated effort by the parasympathetic system is mediated by muscarinic and, to a lesser extent, cholinergic receptors within the detrusor muscle. The pressure generated in the bladder during micturition is about 20 to 40 cm H_2O in females. It is somewhat higher and more variable in males 45 years and older due to the normal hyperplasia of the cells of the middle lobes of the prostate gland, which surround the proximal urethra. Any obstruction of the bladder outlet, such as in advanced benign prostatic hyperplasia (BPH), results in a high voiding pressure. High voiding pressures make it more difficult to start urine flow and maintain it.

If the spinal pathways from the brain to the urinary system are destroyed (e.g., after a spinal cord injury), reflex contraction of the bladder is maintained, but voluntary control over the process is lost. In both situations, the detrusor muscle can contract and expel urine, but the contractions are generally insufficient to empty the bladder completely, so residual urine (urine left in the bladder after voiding) remains. Normally, residual urine amounts to no more than 50 mL in the middle-age adult and less than 50 to 100 mL in the older adult (Weber & Kelley, 2018).

Gerontologic Considerations

Upper and lower urinary tract function changes with age. The GFR decreases, starting between 35 and 40 years of age, and a yearly decline of about 1 mL/min continues thereafter. Older adults are more susceptible to acute kidney injury and chronic kidney disease due to the structural and functional changes in the kidney. Examples include sclerosis of the glomerulus and renal vasculature, decreased blood flow, decreased GFR, altered tubular function, and acid–base imbalance. Although renal function usually remains adequate, renal reserve is decreased and may reduce the kidneys' ability to respond effectively to drastic or sudden physiologic changes. This steady decrease in glomerular filtration, combined with the use of multiple medications in which metabolites are cleared by the kidneys, puts the older person at higher risk for adverse drug effects and drug–drug interactions (Eliopoulos, 2018).

Older adults are more prone to develop hypernatremia and fluid volume deficit, because increasing age is also associated with diminished osmotic stimulation of thirst. Thirst is defined as one's awareness of the desire to drink. The sense of thirst is so protective that hypernatremia almost never occurs in adults younger than 60 years.

Structural or functional abnormalities that occur with aging may also prevent complete emptying of the bladder. This may be due to decreased bladder wall contractility; secondary to myogenic or neurogenic factors; or related to bladder outlet obstruction, such as in BPH or after prostatectomy. Vaginal and urethral tissues atrophy (become thinner) in aging women due to decreased estrogen levels. This causes decreased blood supply to the urogenital tissues, resulting in urethral and vaginal irritation and urinary incontinence.

Urinary incontinence is present in 15% to 30% of community-dwelling older adults, 50% of older adults who are institutionalized, and 30% of older adults who are hospitalized (Eliopoulos, 2018). Many older adults and their families are unaware that urinary incontinence stems from many causes. The nurse needs to inform the patient and family that with appropriate evaluation, urinary incontinence can often be managed at home, and in many cases it can be eliminated. Many treatments are available for urinary incontinence in older adults, including noninvasive, behavioral interventions that the patient or caregiver can carry out. Treatment modalities for urinary incontinence are described in further detail in Chapter 49.

Preparation of the older adult patient for diagnostic tests must be managed carefully to prevent dehydration, which might precipitate kidney disease in a patient with marginal renal function. Limitations in mobility may affect an older patient's ability to void adequately or to consume an adequate volume of fluids. The patient may limit fluid intake to minimize the frequency of voiding or the risk of incontinence.

Concept Mastery Alert

Providing education about the dangers of an inadequate fluid intake is an important role of the nurse caring for the older patient. The nurse emphasizes the need to drink throughout the day even if the patient does not feel thirsty, because the thirst stimulation is decreased.

Older adults often have incomplete emptying of the bladder and urinary stasis, which may result in urinary tract infection (UTI) or increasing bladder pressure, leading to overflow incontinence, hydronephrosis, pyelonephritis, or chronic kidney disease (Eliopoulos, 2018). Urologic symptoms can mimic disorders such as appendicitis, peptic ulcer disease, and cholecystitis, which can make diagnosis difficult in older adults due to decreased neurologic innervation (Eliopoulos, 2018).

TABLE 47-1 Risk Factors for Select Kidney or Urologic Disorders

Risk Factor	Possible Kidney or Urologic Disorder
Advanced age	Incomplete emptying of bladder, leading to urinary tract infection and urosepsis
Benign prostatic hyperplasia	Obstruction to urine flow, leading to frequency, oliguria, anuria
Diabetes	Chronic kidney disease, neurogenic bladder
Gout, hyperparathyroidism, Crohn's disease, ileostomy	Kidney stone formation
Hypertension	Renal insufficiency, chronic kidney disease
Instrumentation of urinary tract, cystoscopy, catheterization	Urinary tract infection, incontinence
Immobilization	Kidney stone formation
Multiple sclerosis	Incontinence, neurogenic bladder, and other complications
Occupational, recreational, or environmental exposure to chemicals (plastics, pitch, tar, rubber)	Acute kidney injury
Obstetric injury, tumors	Incontinence
Parkinson's disease	Incontinence and other complications
Pregnancy	Proteinuria, urinary frequency
Radiation therapy to pelvis	Cystitis, fibrosis of ureter, or fistula in urinary tract
Recent pelvic surgery	Inadvertent trauma to ureters or bladder
Sickle cell disease, multiple myeloma	Chronic kidney disease
Spinal cord injury	Neurogenic bladder, urinary tract infection, incontinence
Strep throat, impetigo, nephrotic syndrome	Chronic kidney disease
Systemic lupus erythematosus	Nephritis, chronic kidney disease

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Assessment of the Kidney and Urinary Systems

An assessment of the kidney and urinary systems involves conducting a health history and physical assessment.

Health History

Obtaining a urologic health history requires excellent communication skills, because many patients are embarrassed or uncomfortable discussing genitourinary function or symptoms (Ball, Dains, Flynn, et al., 2019; Weber & Kelley, 2018). It is important to use language the patient can understand and to avoid medical jargon. It is also important to review risk factors, particularly for those patients who are at high risk. For example, the nurse needs to be aware that multiparous women delivering their children vaginally have a high risk for stress urinary incontinence, which, if severe enough, can also lead to urge incontinence. People with neurologic disorders such as diabetic neuropathy, multiple sclerosis, or Parkinson's disease often have incomplete emptying of the bladder and urinary stasis, which may result in UTI or increasing bladder pressure, leading to overflow incontinence, hydronephrosis, pyelonephritis, or chronic kidney disease (Eliopoulos, 2018). Risk factors for specific disorders and kidney and lower urinary tract dysfunction are summarized in Table 47-1 and discussed in Chapters 48 and 49.

TABLE 47-2 Identifying Characteristics of Genitourinary Pain

Type	Location	Characteristics	Associated Signs and Symptoms	Possible Etiology
Kidney	Costovertebral angle; may extend to umbilicus	Dull constant ache; if sudden distention of capsule, pain is severe, sharp, stabbing, and colicky in nature	Nausea and vomiting, diaphoresis, pallor, signs of shock	Acute obstruction, kidney stone, blood clot, acute pyelonephritis, trauma
Bladder	Suprapubic area	Dull, continuous pain that may be intense with voiding; may be severe if bladder full	Urgency, pain at end of voiding, painful straining	Overdistended bladder, infection, interstitial cystitis; tumor
Ureteral	Costovertebral angle, flank, lower abdominal area, testis, or labium	Severe, sharp, stabbing pain, colicky in nature	Nausea and vomiting, paralytic ileus	Ureteral stone, edema or stricture, blood clot
Prostatic	Perineum and rectum	Vague discomfort, feeling of fullness in perineum, vague back pain	Suprapubic tenderness, obstruction to urine flow; frequency, urgency, dysuria, nocturia	Prostatic cancer, acute or chronic prostatitis
Urethral	*Male:* Along penis to meatus *Female:* Urethra to meatus	Pain variable, most severe during and immediately after voiding	Frequency, urgency, dysuria, nocturia, urethral discharge	Irritation of bladder neck, infection of urethra, trauma, foreign body in lower urinary tract

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer; Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.

When obtaining the health history, the nurse should inquire about the following:

- The patient's chief concern or reason for seeking health care, the onset of the problem, and its effect on the patient's quality of life
- The location, character, and duration of **dysuria** (painful or difficult urination), if present, and its relationship to voiding; factors that precipitate dysuria, and those that relieve it
- History of UTIs, including past treatment or hospitalization for UTI
- Fever or chills

- Previous renal or urinary diagnostic tests, surgeries or procedures; or the use of indwelling urinary catheters
- Hesitancy, straining to urinate, or frequency of urination
- Urinary incontinence (stress incontinence, urge incontinence, overflow incontinence, or functional incontinence)
- **Hematuria** (RBCs in the urine) or change in color or volume of urine
- Nocturia and its date of onset
- Renal calculi (kidney stones), passage of stones or gravel in urine
- In female patients, the number and type (vaginal or cesarean) of deliveries; the use of forceps; vaginal infection, discharge, or irritation; contraceptive practices
- History of **anuria** (decreased urine production of less than 50 mL in 24 hours) or other kidney problem
- Presence or history of genital lesions or sexually transmitted infections
- The use of tobacco, alcohol, or recreational drugs
- Any prescription and over-the-counter medications (including those prescribed for renal or urinary problems)

Common Symptoms

Dysfunction of the kidney can produce a complex array of symptoms throughout the body. Pain, changes in voiding, and gastrointestinal symptoms are particularly suggestive of urinary tract disease.

Pain

Genitourinary pain is usually caused by distention of some portion of the urinary tract as a result of obstructed urine flow or inflammation and swelling of tissues. Severity of pain is related to the sudden onset, rather than the extent of distention.

Table 47-2 lists the various types of genitourinary pain, characteristics of the pain, associated signs and symptoms, and possible causes. However, kidney disease does not always involve pain. It tends to be diagnosed because of other symptoms that cause a patient to seek health care, such as pedal edema, shortness of breath, and changes in urine elimination (Weber & Kelley, 2018).

Changes in Voiding

Micturition is normally a painless function that occurs approximately eight times in a 24-hour period. The average person voids 1 to 2 L of urine in 24 hours, although this amount varies depending on fluid intake, sweating, environmental temperature, vomiting, or diarrhea. Common problems associated with voiding include **urinary frequency** (voiding more frequently than every 3 hours), urgency, dysuria, hesitancy, incontinence, enuresis, polyuria, **oliguria** (urine output less than 400 mL in 24 hours or less than 0.5 mL/kg/h over 6 hours), and hematuria. These problems and others are described in Table 47-3. Increased urinary urgency and frequency, coupled with decreasing urine volumes strongly suggest urine retention. Depending on the acuity of the onset of these symptoms, immediate bladder emptying via catheterization and evaluation may be necessary to prevent kidney dysfunction.

Gastrointestinal Symptoms

Gastrointestinal signs and symptoms are often associated with urologic conditions because of shared autonomic and sensory innervation and renointestinal reflexes (see Table 47-3). The proximity of the right kidney to the colon, duodenum, head of the pancreas, common bile duct, liver, and gallbladder may cause gastrointestinal disturbances. The proximity of the left kidney to the colon (splenic flexure), stomach, pancreas, and spleen may also result in intestinal symptoms. The most common signs and symptoms are nausea, vomiting, diarrhea, abdominal discomfort, and abdominal distention.

TABLE 47-3	Problems Associated with Changes in Voiding

Problem	Definition	Possible Etiology
Anuria	Urine output <50 mL/day	Acute kidney injury or chronic kidney disease (see Chapter 48), complete obstruction
Bacteriuria	Bacterial count >100,000 colonies/mL in the urine	Infection
Dysuria	Painful or difficult voiding	Lower urinary tract infection, inflammation of bladder or urethra, acute prostatitis, stones, foreign bodies, tumors in bladder
Enuresis	Involuntary voiding during sleep	Delay in functional maturation of central nervous system (bladder control usually achieved by 5 yrs of age), obstructive disease of lower urinary tract, genetic factors, failure to concentrate urine, urinary tract infection, psychological stress
Frequency	Frequent voiding—more than every 3 h	Infection, obstruction of lower urinary tract leading to residual urine and overflow, anxiety, diuretic agents, benign prostatic hyperplasia, urethral stricture, diabetic neuropathy
Hematuria	Red blood cells in the urine	Cancer of genitourinary tract, acute glomerulonephritis, renal stones, renal tuberculosis, blood dyscrasia, trauma, extreme exercise, rheumatic fever, hemophilia, leukemia, sickle cell trait or disease
Hesitancy	Delay, difficulty in initiating voiding	Benign prostatic hyperplasia, compression of urethra, outlet obstruction, neurogenic bladder
Incontinence	Involuntary loss of urine	External urinary sphincter injury, obstetric injury, lesions of bladder neck, detrusor dysfunction, infection, neurogenic bladder, medications, neurologic abnormalities
Nocturia	Awakening during the night to urinate	Decreased renal concentrating ability, heart failure, diabetes, incomplete bladder emptying, excessive fluid intake at bedtime, nephrotic syndrome, cirrhosis with ascites
Oliguria	Urine output <400 mL in 24 h or <0.5 mL/kg/h over 6 h	Acute kidney injury or chronic kidney disease, inadequate fluid intake
Polyuria	Increased volume of urine voided	Diabetes, diabetes insipidus, the use of diuretics, excess fluid intake, lithium toxicity, some forms of kidney disease (hypercalcemic and hypokalemic nephropathy)
Proteinuria	Protein in the	Acute kidney injury or chronic kidney disease, nephrotic

	urine	syndrome, vigorous exercise, heatstroke, severe heart failure, diabetic nephropathy, multiple myeloma
Urgency	Strong desire to void	Infection, chronic prostatitis, urethritis, obstruction of lower urinary tract leading to residual urine and overflow, anxiety, diuretic agents, benign prostatic hyperplasia, urethral stricture, diabetic neuropathy

Unexplained Anemia

Gradual kidney dysfunction can be insidious in its presentation, although fatigue is a common symptom. Fatigue, shortness of breath, and exercise intolerance all result from the condition known as anemia of inflammation formerly known as anemia of chronic disease. See Chapter 29 for more information on anemia of inflammation.

Past Health, Family, and Social History

Data collection about previous health problems or diseases provides the health care team with useful information for evaluating the patient's current urinary status. People with diabetes who have hypertension are at risk for renal dysfunction. Older men are at risk for prostatic enlargement, which causes urethral obstruction and can result in UTIs and kidney disease. People with a family history of urinary tract problems are at increased risk for renal disorders. Genetics may also influence renal conditions (see Chart 47-2).

It is also important to assess the patient's psychosocial status, level of anxiety, perceived threats to body image, available support systems, and sociocultural patterns.

Physical Assessment

Several body systems can affect upper and lower urinary tract dysfunction, and conversely that dysfunction can affect several end organs; therefore, a head-to-toe assessment is indicated. Areas of emphasis include the abdomen, suprapubic region, genitalia, lower back, and lower extremities.

The kidneys are not usually palpable. However, palpation of the kidneys may detect an enlargement that could prove to be very important (Weber & Kelley, 2018). The correct technique for palpation is illustrated in Figure 47-5. It may be possible to palpate the smooth, rounded lower pole of the kidney between the hands. The right kidney is easier to detect, because it is somewhat lower than the left one. In patients with obesity, palpation of the kidneys is more difficult.

Chart 47-2 GENETICS IN NURSING PRACTICE

Kidney and Urinary Disorders

Various conditions that affect the renal system and urinary tract function are influenced by genetic factors. Some examples of these genetic disorders are:
Autosomal Dominant:

- Familial Wilms tumor
- Polycystic kidney disease
- Renal cystic disease in tuberous sclerosis complex

X-Linked Recessive:

- Alport syndrome (primarily X-linked but autosomal dominant and recessive forms exist)

Congenital Kidney Disorders:

- Congenital absence of the vas deferens (caused by *CFTR* gene mutation for cystic fibrosis)
- Horseshoe kidney
- Multicystic dysplastic kidneys

Other Genetic Disorders that Impact the Renal System:

- Alpha$_1$-antitrypsin deficiency
- Anderson–Fabry disease
- Diabetes
- Coronary artery disease
- Pulmonary hypertension
- von Hippel–Lindau syndrome

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Specific to Kidney and Urinary Disorders

- Inquire about other family members with a history of renal and/or urinary tract malformations, kidney disease, or end-stage kidney disease and age of onset.
- Determine if other family members have diabetic kidney disease (clustering of this within the family could indicate genetic susceptibility).
- Identify family history of male infertility and cystic fibrosis (congenital absence of vas deferens).
- Be alert to family members with history of early-onset renal (Wilms tumor) or other cancers.

Physical Assessment Specific to Genetic Kidney and Urinary Disorders

- Be alert to signs and symptoms of kidney disease at an early age.

- Ascertain for presence and frequency of kidney stones or urinary tract infections.
- Assess for the presence and frequency of:
  - Abdominal pain or presence of an abdominal mass
  - Hematuria
  - Hypertension
  - Peripheral or orbital edema
  - Proteinuria
- Assess for clinical findings suggesting that kidney disease is a component of a genetic syndrome (e.g., seizures, intellectual disability, skin involvement).
- Assess for bleeding tendencies, abnormal clotting, or history of anemia.

Genetics Resources

Alport Syndrome Foundation, www.alportsyndrome.org
American Kidney Fund, www.kidneyfund.org
See Chapter 6, Chart 6-7 for components of genetic counseling resources.

Renal dysfunction may produce tenderness over the costovertebral angle, which is the angle formed by the lower border of the 12th, or bottom, rib and the spine (see Fig. 47-6). The abdomen (just slightly to the right and left of the midline in both upper quadrants) is auscultated to assess for bruits (low-pitched murmurs that indicate renal artery stenosis or an aortic aneurysm). The abdomen is also assessed for the presence of ascites (accumulation of fluid in the peritoneal cavity), which may occur with kidney as well as liver dysfunction (see Chapter 43 for further discussion of ascites and liver disorders).

Figure 47-5 • The left kidney is palpated by reaching over to the patient's left side and placing the right hand beneath the patient's lower left rib. Push the hand on top forward as the patient inhales deeply. Reprinted with permission from Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed., Fig. 23-27). Philadelphia, PA: Wolters Kluwer.

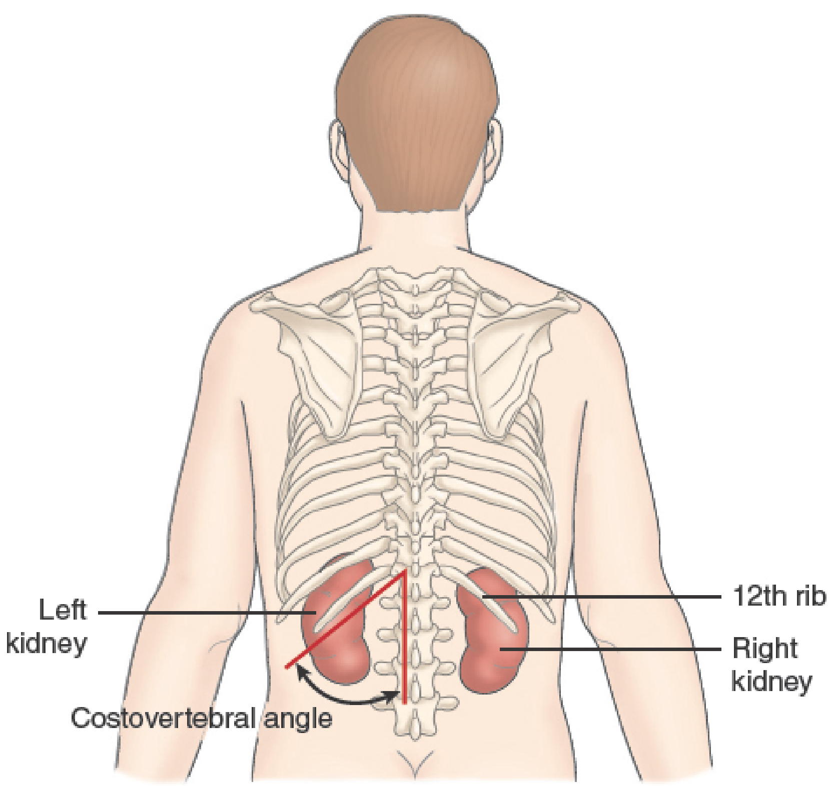


Figure 47-6 • Location of the costovertebral angle.

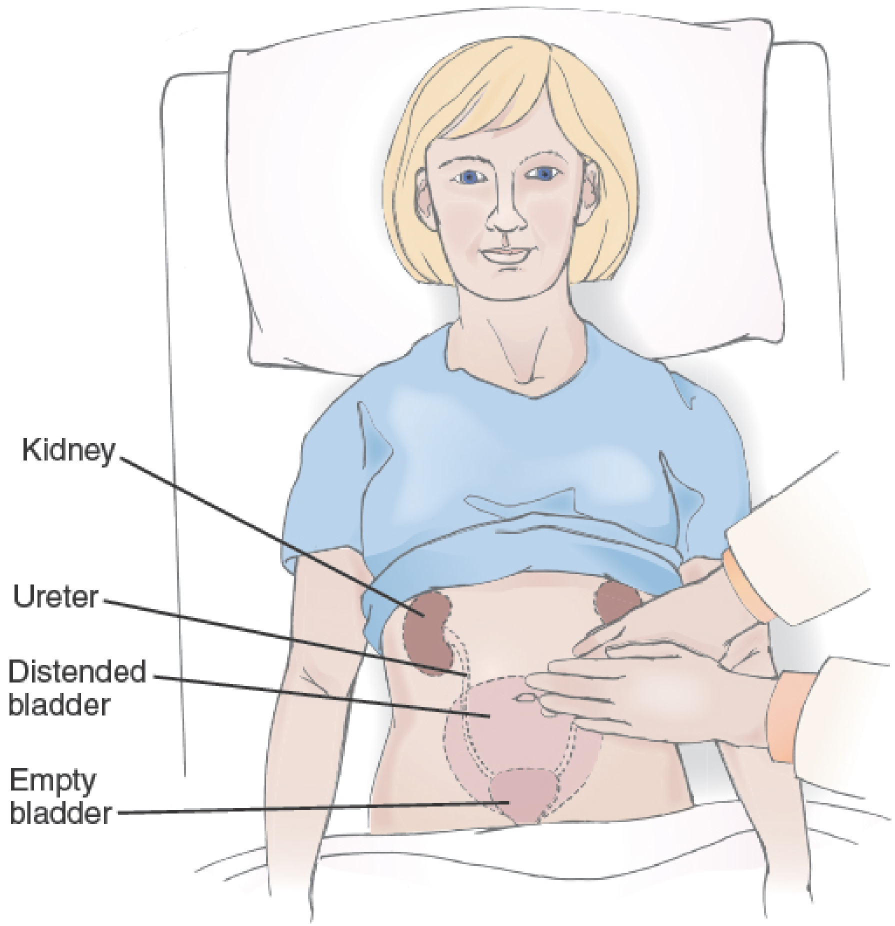


Figure 47-7 • Palpating distended bladder (larger *dotted line* is area of distention). Reprinted with permission from Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed., Fig. 23-28). Philadelphia, PA: Wolters Kluwer.

To check for residual urine, the bladder can be percussed after the patient voids. Percussion of the bladder begins at the midline just above the umbilicus and proceeds downward. The sound changes from tympanic to dull when percussing over the bladder. The bladder, which can be palpated only if it is moderately distended, feels like a smooth, firm, round mass rising out of the abdomen, usually at midline (see Fig. 47-7). Dullness to percussion of the bladder after voiding indicates incomplete bladder emptying (Weber & Kelley, 2018).

Chart 47-3 **NURSING RESEARCH PROFILE**

Positive Outcomes with the Use of a Portable Bladder Ultrasound

Chen, S., Chen, P., Chen, G., et al. (2018). Portable bladder ultrasound reduces incidence of urinary tract infection and shortens hospital length of stay in patients with acute ischemic stroke. *Journal of Cardiovascular Nursing*, *31*(6), 551–558.

Purpose

Certain patient populations, such as those who have had a stroke, have high rates of urinary tract infections (UTIs). The purpose of this study was to investigate whether there was a change in patient outcomes, such as UTI rates, following implementation of the use of portable bladder ultrasound to measure postvoid urine residuals on a unit that provided care for patients following an acute ischemic stroke.

Design

The medical records of all patients admitted to one unit for a 3-year period prior to the implementation of the use of portable bladder ultrasound were retrospectively reviewed and outcomes compared to all patients admitted for a 3-year period after the implementation of the use of portable bladder ultrasound.

Findings

Those patients admitted during the period after the implementation of the portable bladder ultrasound had a lower incidence of UTI (4% vs. 6.9%) and a shorter hospital length of stay (11.9 days vs. 13.6 days). Multivariate analysis revealed that patients at higher risk of UTI were patients 75 years of age or older, women, and those with a more severe stroke.

Nursing Implications

Nurses can make a difference in patient outcomes by using portable bladder ultrasound to measure postvoid urine residuals in patients at risk for UTI when this technology is available. This study reported that UTI rates and hospital length of stay were lower following implementation of this technology. This study needs to be replicated in other patient populations at high risk for UTI.

Portable bladder ultrasound is another method of detecting urinary retention. These devices provide a three-dimensional image of the bladder and should be used after voiding to detect urine retention. Researchers have reported that the use of a portable bladder ultrasound reduces the rate of UTIs and shortens the length of stay for patients who have had an ischemic stroke (Chen, Chen, Chen, et al., 2018). See the Nursing Research Profile in Chart 47-3 and the later discussion in the bladder ultrasonography section.

In older men, BPH or prostatitis can cause difficulty with urination. Because the signs and symptoms of prostate cancer can mimic those of BPH, the prostate gland is palpated by digital rectal examination (DRE) as part of the yearly physical examination in men 40 years and older (see Chapter 53). In addition, a blood specimen is obtained to test the prostate-specific antigen (PSA) level annually; the results of the DRE and PSA are then correlated. Blood is drawn for PSA before the DRE, because manipulation of the prostate can cause the PSA level to increase temporarily. The inguinal area is examined for enlarged nodes, an inguinal or femoral hernia, and varicocele (varicose veins of the spermatic cord).

In women, the vulva, urethral meatus, and vagina are examined (Weber & Kelley, 2018). The urethra is palpated for diverticula, and the vagina is assessed for adequate estrogen effect and any of five types of herniation: urethrocele, cystocele, pelvic prolapse, enterocele, and rectocele. Urethrocele is the bulging of the anterior vaginal wall into the urethra. Cystocele is the herniation of the bladder wall into the vaginal vault. Pelvic prolapse is bulging of the cervix into the vaginal vault. Enterocele is herniation of the bowel into the posterior vaginal wall. Rectocele is herniation of the rectum into the vaginal wall. These prolapses are graded depending on the degree of herniation. See Chapter 51 for more information.

The woman is asked to cough and perform a Valsalva maneuver to assess the urethra's system of muscular and ligament support. If urine leakage occurs, the index and middle fingers of the examiner's gloved hand are used to support either side of the urethra as the woman is asked to repeat the Valsalva maneuver; this is called the *Marshall–Bonney maneuver.* If this produces urinary leakage, referral is suggested.

The patient is assessed for edema and changes in body weight. Edema may be observed, particularly in the face and dependent parts of the body, such as the ankles and sacral areas, and suggests fluid retention. An increase in body weight commonly accompanies edema. A 1 kg weight gain equals approximately 1000 mL of fluid (1 lb is approximately 500 mL) (Weber & Kelley, 2018).

The deep tendon reflexes of the knee are examined for quality and symmetry. This is an important part of testing for neurologic causes of bladder dysfunction, because the sacral area, which innervates the lower extremities, is the same peripheral nerve area responsible for urinary continence. The gait pattern of the person with bladder dysfunction is also noted, as well as the patient's ability to walk toe to heel. These tests evaluate possible supraspinal causes for urinary incontinence.

Unfolding Patient Stories: Lloyd Bennett • Part 2

Recall from Chapter 28 **Lloyd Bennett**, who presented to the emergency department with a hip fracture. What effect can significant blood loss from surgery to repair the fracture have on renal function? What clinical findings would indicate to the nurse that kidney function is impaired? What clinical assessment findings would alert the nurse of potential trauma to the urinary tract resulting from the hip fracture? What diagnostic tests may be used to identify a urinary tract complication that the nurse would consider for preparatory patient education?

Care for Lloyd and other patients in a realistic virtual environment: *vSim* (**thepoint.lww.com/.vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Diagnostic Evaluation

A wide range of diagnostic studies may be performed in patients with urinary conditions. A comprehensive health history is used to determine the appropriate laboratory and diagnostic tests. The following sections review some of the specific tests that might be used.

The nurse educates the patient about the purpose, what to expect, and any possible side effects related to these examinations prior to testing. The nurse should also note trends in results, because they provide information about disease progression as well as the patient's response to therapy.

Most patients undergoing urologic testing or imaging studies are apprehensive, even those who have had these tests in the past. Patients frequently feel discomfort and embarrassment about such a private and personal function as voiding. Voiding in the presence of others can frequently cause guarding, a natural reflex that inhibits voiding due to situational anxiety. Because the outcomes of these studies determine the plan of care, the nurse must help the patient relax by providing as much privacy and explanation about the procedure as possible (see Chart 47-4). In addition, Chart 47-5 provides a plan of nursing care for the patient undergoing diagnostic testing.

Chart 47-4 PATIENT EDUCATION

Before and After Urodynamic Testing

The nurse instructs the patient on what to expect before, during, and after the procedure:
Preprocedure

- An in-depth interview will be conducted. Questions related to your urologic symptoms and voiding habits will be asked.

During the Procedure

- You will be asked to describe sensations felt.
- You might be asked to change positions (e.g., from supine to sitting or standing).
- You may be asked to cough or perform the Valsalva maneuver (bear down).
- You will probably need to have one or two urethral catheters inserted so that bladder pressure and bladder filling can be measured. Another catheter may be placed in the rectum or vagina to measure abdominal pressure.
- You may also have electrodes (surface, wire, or needle) placed in the perianal area for electromyography. This may be uncomfortable initially during insertion and later during position changes.
- Your bladder will be filled through the urethral catheter one or more times.

After the Procedure

- You may experience urinary frequency, urgency, or dysuria from the urethral catheters. Avoid caffeinated, carbonated, and alcoholic beverages because they can further irritate the bladder. These symptoms usually decrease or subside by the day after the procedure.
- You might notice slight hematuria (blood-tinged urine) right after the procedure (especially in men with benign prostatic hyperplasia). Drinking fluids will help to clear the hematuria.
- If the urinary meatus is irritated, a warm sitz bath may be helpful.
- Be alert to signs of a urinary tract infection. Contact your primary provider if you experience fever, chills, lower back pain, or continued dysuria and hematuria.
- If you receive an antibiotic medication before the procedure, you should continue taking the complete course of medication after the procedure. This is a measure to prevent infection.

Urinalysis and Urine Culture

The urinalysis provides important clinical information about kidney function and helps diagnose other diseases, such as diabetes. The urine culture determines whether bacteria are present in the urine, as well as their strains and concentration. Urine culture and sensitivity also identify the antimicrobial therapy that is best suited for the particular strains identified, taking into consideration the antibiotic agents that have the best rate of resolution in that particular geographic region. Appropriate evaluation of any abnormality can assist in detecting serious underlying diseases.

Chart 47-5 PLAN OF NURSING CARE

Care of the Patient Undergoing Diagnostic Testing of the Renal–Urologic System

NURSING DIAGNOSIS: Lack of knowledge about procedures and diagnostic tests **GOAL:** Patient demonstrates increased understanding of the procedure and tests and expected behaviors		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Assess patient's level of understanding of planned diagnostic tests 2. Provide a description of tests in language the patient can understand 3. Assess patient's understanding of test results after their completion 4. Reinforce information provided to patient about test results and implications for follow-up care	1. Provides basis for education and gives indication of patient's perception of tests 2. Understanding what is expected enhances patient adherence and cooperation 3. Apprehension may interfere with patient's ability to understand information and results provided by health care team 4. Provides opportunity for patient to clarify information and anticipate follow-up care	• States rationale for planned diagnostic tests and what tasks and behaviors are expected during the procedure • Adheres to prescribed urine collection, fluid modifications, or other procedures required for diagnostic evaluation • Restates in own words results of diagnostic tests • Asks for clarification of terms and procedures • Explains rationale for follow-up care • Participates in follow-up care

NURSING DIAGNOSIS: Acute pain associated with infection, edema, obstruction, or bleeding along urinary tract or associated with invasive diagnostic tests **GOAL:** Patient reports decrease in pain and absence of discomfort		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Assess level of pain: dysuria, burning on	1. Provides baseline for	• Reports decreasing levels

urination, abdominal or flank pain, bladder spasm 2. Encourage fluid intake (unless contraindicated) 3. Encourage warm sitz baths 4. Report increased pain to primary provider 5. Administer analgesic and antispasmodic agents for pain and spasm as prescribed 6. Assess voiding patterns and hygiene practices and provide instructions about recommended voiding patterns and hygienic practices	evaluation of pain-relief strategies and progression of dysfunction 2. Promotes dilute urine and flushing of the lower urinary tract 3. Relieves local discomfort and promotes relaxation 4. May indicate progression or recurrence of dysfunction, or untoward signs (e.g., bleeding, calculi) 5. Prescribed to relieve pain or spasm 6. Delayed emptying of the bladder and poor hygiene may contribute to pain secondary to renal or urinary tract dysfunction	of pain • Reports absence of local symptoms • States ability to start and stop urinary stream without discomfort • Increases fluid intake, if indicated • Uses sitz bath as indicated • Identifies signs and symptoms to be reported to the primary provider • Takes medications as prescribed • Does not delay in emptying bladder • Uses appropriate hygienic measures, avoids bubble baths, uses appropriate hygiene after bowel movements

NURSING DIAGNOSIS: Fear associated with potential alteration in renal function and embarrassment secondary to discussion of urinary function and invasion of genitalia

GOAL: Patient appears relaxed and reports decreased fear and anxiety

Nursing Interventions	Rationale	Expected Outcomes
1. Assess patient's level of fear and apprehension	1. A high level of fear or apprehension	• Appears relaxed with a low level

2. Explain all procedures and tests to patient	can interfere with learning and cooperation	of fear or apprehension
3. Provide privacy and respect patient's modesty by closing doors and keeping patient covered. Keep urinal and bedpan covered and out of sight	2. Knowledge about what is expected helps reduce fear and apprehension	• States rationale for tests and procedures in a calm, relaxed manner
4. Use correct terminology in a factual manner when questioning patient about urinary tract dysfunction	3. Communicates that you are aware of and accept patient's need for privacy and modesty	• Maintains usual privacy and modesty
5. Assess patient's fears about perceived changes associated with tests and other procedures	4. Conveys that you are comfortable discussing patient's urinary dysfunction and symptoms with patient	• Discusses own urinary tract dysfunction using correct terminology without overt indications of embarrassment or discomfort
6. Instruct patient in relaxation techniques	5. May uncover fears and misconceptions of the patient that can be alleviated by correct understanding	• Relates fears and concerns
	6. Promotes relaxation and assists patient in coping with uncertainty about outcomes	• Demonstrates correct understanding of procedures and possible outcomes
		• Appears relaxed with low level of fear and apprehension

TABLE 47-4 Changes in Urine Color and Possible Causes

Urine Color	Possible Cause
Colorless to pale yellow	Dilute urine due to diuretic agents, alcohol consumption, diabetes insipidus, glycosuria, excess fluid intake, chronic kidney disease
Yellow to milky white	Pyuria, infection, vaginal cream
Bright yellow	Multiple vitamin preparations
Pink to red	Hemoglobin breakdown, red blood cells, gross blood, menses, bladder or prostate surgery, beets, blackberries, medications (phenytoin, rifampin, thioridazine, cascara sagrada, senna products)
Blue, blue green	Dyes, methylene blue, *Pseudomonas* species organisms, medications (amitriptyline HCl, triamterene)
Orange to amber	Concentrated urine due to dehydration, fever, bile, excess bilirubin or carotene, medications (phenazopyridine hydrochloride, nitrofurantoin)
Brown to black	Old red blood cells, urobilinogen, bilirubin, melanin, porphyrin, extremely concentrated urine due to dehydration, medications (cascara sagrada, metronidazole, iron preparations, quinine sulfate, senna products, methyldopa, nitrofurantoin)

Adapted from Comerford, K. C., & Durkin, M. T. (Eds.). (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Components

Urine examination includes the following:

- Urine color (see Table 47-4)
- Urine clarity and odor
- Urine pH and specific gravity
- Tests to detect protein, glucose, and ketone bodies in the urine (proteinuria, renal glycosuria, and ketonuria, respectively)
- Microscopic examination of the urine sediment after centrifugation to detect hematuria, **pyuria** (white blood cells), casts (cylindruria), crystals (crystalluria), and **bacteriuria** (bacteria) (see Table 47-3)

Significance of Findings

Several abnormalities, such as hematuria and proteinuria, produce no symptoms but may be detected during a routine urinalysis using a dipstick. Normally, about one million RBCs pass into the urine daily, which is equivalent to one to three RBCs per high-power field. Hematuria (more than three RBCs per high-power field) can develop from an abnormality anywhere along the genitourinary tract and is more common in women than in men. Common causes include acute infection (cystitis, urethritis, or prostatitis), renal calculi, and neoplasm. Other causes include systemic disorders, such as bleeding disorders; malignant lesions; and medications, such as warfarin and heparin. Although hematuria may initially be detected using a dipstick test, further evaluation is necessary and more accurate with a 24-hour collection (Fischbach & Fischbach, 2018).

Proteinuria may be a benign finding, or it may signify serious disease. Occasional loss of up to 150 mg/day of protein in the urine, primarily albumin and Tamm–Horsfall protein (also known as uromodulin), is considered normal and usually does not require further evaluation. A dipstick examination, which can detect from 30 to 1000 mg/dL of protein, should be used as a screening test only, because urine concentration, pH, hematuria, and radiocontrast materials all affect the results. Because dipstick analysis does not detect protein concentrations of less than 30 mg/dL, the test cannot be used for early detection of diabetic nephropathy. Microalbuminuria (excretion of 20 to 200 mg/dL of protein in the urine) is an early sign of diabetic nephropathy. Common benign causes of transient proteinuria are fever, strenuous exercise, and prolonged standing.

Causes of persistent proteinuria include glomerular diseases, malignancies, collagen diseases, diabetes, preeclampsia, hypothyroidism, heart failure, exposure to heavy metals, and the use of medications, such as nonsteroidal anti-inflammatory drugs and angiotensin-converting enzyme inhibitors (Comerford & Durkin, 2020).

Specific Gravity

Specific gravity is an expression of the degree of concentration of the urine that measures the density of a solution compared to the density of distilled water, which is 1.000. Specific gravity is altered by the presence of blood, protein, and casts in the urine. The normal range of urine specific gravity is 1.005 to 1.025 (Fischbach & Fischbach, 2018; Norris, 2019).

Methods for determination of specific gravity include the following:

- Multiple-test dipstick (most common method), with a specific reagent area for specific gravity
- Urinometer (least accurate method), in which urine is placed in a small cylinder and the urinometer is floated in the urine; a specific gravity reading is obtained at the meniscus level of the urine
- Refractometer, an instrument used in a laboratory setting, which measures differences in the speed of light passing through air and the urine sample; this is the most accurate test

Urine specific gravity depends largely on hydration status. When fluid intake decreases, specific gravity normally increases. With high fluid intake, specific gravity decreases. In patients with kidney disease, urine specific gravity does not vary with fluid intake, and the patient's urine is said to have a fixed specific gravity. Disorders or conditions that cause decreased urine specific gravity include diabetes insipidus, glomerulonephritis, and severe renal damage. Those that can cause increased specific gravity include diabetes, nephritis, and fluid deficit.

Osmolality

Osmolality is the most accurate measurement of the kidney's ability to dilute and concentrate urine. It measures the number of solute particles in a kilogram of water. Serum and urine osmolality are measured simultaneously to assess the body's fluid status. In healthy adults, serum osmolality is 275 to 290 mOsm/kg, and normal urine osmolality is 200 to 800 mOsm/kg. For a 24-hour urine sample, the normal value is 300 to 900 mOsm/kg (Fischbach & Fischbach, 2018).

TABLE 47-5 Renal Function Tests

Test	Purpose	Normal Values
Renal Concentration		
Specific gravity	A measure of the degree of concentration of the urine.	1.005–1.025
Urine osmolality	Concentrating ability is lost early in kidney disease; hence, these test findings may disclose early defects in renal function.	300–900 mOsm/kg/24 h, 50–1200 mOsm/kg random sample
24-h Urine		
Creatinine clearance	Detects and evaluates progression of kidney disease. Test measures volume of blood cleared of endogenous creatinine in 1 min, which provides an approximation of the glomerular filtration rate. Sensitive indicator of kidney disease used to follow progression of kidney disease.	Measured in mL/min/1.73 m^2 Age (Years) / Male / Female <30 / 88–146 / 81–134 30–40 / 82–140 / 75–128 40–50 / 75–133 / 69–122 50–60 / 68–126 / 64–116 60–70 / 61–120 / 58–110 70–80 / 55–113 / 52–105
Serum		
Creatinine level	Measures effectiveness of renal function. Creatinine is the end product of muscle energy metabolism. In normal function, the level of creatinine, which is regulated and excreted by the kidneys, remains fairly constant in the body.	Males: 0.6–1.2 mg/dL (71–106 mmol/L) Females: 0.4–1.0 mg/dL (36–90 mmol/L)
BUN	Serves as index of renal function. Urea is the nitrogenous end product of protein metabolism. Test values are affected by protein intake, tissue breakdown, and fluid volume changes.	8–20 mg/dL; patients >60 yrs: 8–23 mg/dL
BUN to creatinine ratio	Evaluates hydration status. An elevated ratio is seen in hypovolemia; a normal ratio with an elevated BUN and creatinine is seen with intrinsic kidney disease.	About 10:1

BUN, blood urea nitrogen.
Adapted from Fischbach, F. T., & Fischbach, M. A. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Renal Function Tests

Renal function tests are used to evaluate the severity of kidney disease and to assess the status of the patient's kidney function. These tests also provide information about the effectiveness of the kidney in carrying out its excretory function. Renal function test results may be within normal limits until the GFR is reduced to less than 50% of normal. Renal function can be assessed most accurately if several tests are performed and their results are analyzed together. Common tests of renal function include renal concentration tests, creatinine clearance, and serum creatinine and blood **urea nitrogen** (end product of protein metabolism) levels (see Table 47-5).

Other tests for evaluating renal function that may be helpful include serum electrolyte levels as well as urinary biomarkers to detect acute kidney injury (Fischbach & Fischbach, 2018) (see Chapter 10).

Diagnostic Imaging

There are a wide range of diagnostic studies used for the assessment of kidney and urinary function.

Kidney, Ureter, and Bladder Studies

An x-ray study of the abdomen or kidneys, ureters, and bladder (KUB) may be performed to delineate the size, shape, and position of the kidneys and to reveal urinary system abnormalities (Fischbach & Fischbach, 2018).

General Ultrasonography

Ultrasonography is a noninvasive procedure that uses sound waves passed into the body through a transducer to detect abnormalities of internal tissues and organs. Abnormalities such as fluid accumulation, masses, congenital malformations, changes in organ size, and obstructions can be identified. During the test, the lower abdomen and genitalia may need to be exposed. Ultrasonography requires a full bladder; therefore, fluid intake is encouraged before the procedure.

Bladder Ultrasonography

Bladder ultrasonography is a noninvasive method of measuring urine volume in the bladder. It may be indicated for urinary frequency, inability to void after removal of an indwelling urinary catheter, measurement of postvoiding residual urine volume, inability to void postoperatively, or assessment of the need for catheterization during the initial stages of an intermittent catheterization training program. Portable, battery-operated devices are available for bedside use. The scan head is placed on the patient's abdomen and directed toward the bladder (see Fig. 47-8). These devices automatically calculate and display an estimated urine volume (Taylor, Lynn, & Bartlett, 2019).

Computed Tomography and Magnetic Resonance Imaging

Computed tomography (CT) and magnetic resonance imaging (MRI) are noninvasive techniques that provide excellent cross-sectional views of the anatomy of the kidney and urinary tract. They are used to evaluate genitourinary masses, nephrolithiasis, chronic renal infections, renal or urinary tract trauma, metastatic disease, and soft tissue abnormalities. Occasionally, an oral or intravenous (IV) radiopaque contrast agent is used in CT scanning to enhance visualization.

Nursing Interventions

Preparation includes educating the patient about relaxation techniques and explaining that they will be able to communicate with the staff by means of a microphone located inside the scanner. Many MRI suites provide headphones so that patients can listen to the music of their choice during the procedure. Nursing care guidelines for patient preparation and precautions for any imaging procedure that requires a contrast agent (contrast medium) are explained in Chart 47-6.

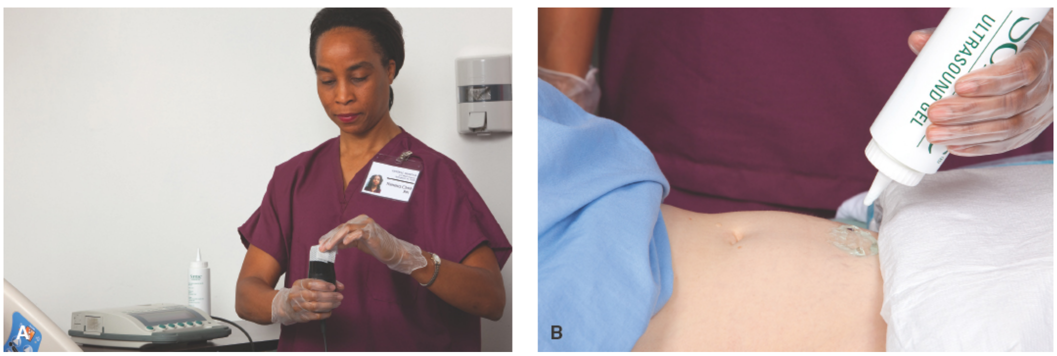


Figure 47-8 • Portable bladder ultrasound. **A.** The nurse puts on gloves and cleans the rounded end of the scan head with an alcohol pad. **B.** The nurse places ultrasound gel 2.5 cm (1 inch) superior to the symphysis pubis. (Photos by B. Proud.) Reprinted with permission from Taylor, C., Lynn, P., & Bartlett, J. L. (2019). *Fundamentals of nursing: The art and science of person-centered care* (9th ed.). Philadelphia, PA: Wolters Kluwer.

Before the patient enters the room where the MRI is to be performed, all metal objects and credit cards (the magnetic field can erase them) are removed. This includes medication patches (e.g., nicotine and nitroglycerin) that have a metal backing, which can cause burns if they are not removed. No metal objects (e.g., oxygen tanks, ventilators, stethoscopes) may be brought into the MRI room. The magnetic field is so strong that any metal-containing items will be pulled toward the magnet, causing severe injury and possible death. Patients with any type of cardiac implantable electronic device need to be screened to see if it is safe for the patient to undergo MRI (Indik, Gimbel, Abe, et al., 2017). A patient history is obtained to determine the presence of any internal objects containing metal such as aneurysm clips, orthopedic hardware, artificial heart valves, or intrauterine devices. These objects could malfunction, be dislodged, or heat up as they absorb energy. Cochlear implants are inactivated by MRI; therefore, other imaging procedures are considered. A sedative agent may be prescribed, because claustrophobia is a problem for some patients.

Prior to MRI of the urinary system, the patient needs to be informed to avoid alcohol, caffeine-containing beverages, and smoking for at least 2 hours and food for at least 1 hour prior to the scan. Patients should continue taking their usual medication, except for iron supplements, which can interfere with the imaging (Fischbach & Fischbach, 2018).

Nuclear Scans

Nuclear scans require injection of a radioisotope (a technetium 99m–labeled compound or iodine 123 [^{123}I] hippurate) into the circulatory system; the isotope is then monitored as it moves through the blood vessels of the kidneys. A scintillation camera is placed behind the kidney with the patient in a supine, prone, or seated position. Hypersensitivity to the radioisotope is rare. The technetium scan provides information about kidney perfusion. The ^{123}I-hippurate renal scan provides information about kidney function, such as GFR.

Chart 47-6

Patient Care During Urologic Testing with Contrast Agents

For some patients, contrast agents are nephrotoxic and allergenic. Emergency equipment and medications should be available in case of an anaphylactic reaction to the contrast agent. Emergency supplies include epinephrine, corticosteroids, vasopressors, oxygen, and airway and suction equipment.

The following guidelines can help the nurse respond quickly in the event of a problem.

Nursing Actions for Patient Preparation

- Obtain the patient's allergy history with emphasis on allergy to iodine, shellfish, and other seafood, because many contrast agents contain iodine.
- Notify primary provider and radiologist if the patient is allergic or suspected to be allergic to iodine.
- Obtain health history. Contrast agents should be used with great caution in older patients and in patients who have multiple myeloma, renal impairment, or volume depletion.
- Obtain medication history. Nephrotoxic medications such as vancomycin, amphotericin B, metformin, and nonsteroidal anti-inflammatory drugs should be discontinued before contrast media administration.
- The use of both nonionic low osmolar contrast media (LOCM, e.g., iohexol) and ionic high osmolar contrast media (HOCM, e.g., diatrizoate), is indicated in patients with renal impairment and other risk factors to prevent contrast-induced nephropathy.
- Check kidney function in patients who are at risk. Patients should receive IV hydration prior to the procedure.
- Inform the patient that they may experience a temporary feeling of warmth, flushing of the face, and an unusual flavor (similar to that of seafood) in the mouth when the contrast agent is infused.

Nursing Actions During and Post Procedure

- Monitor patient closely for allergic reaction, and monitor urine output.
- Maintain hydration status.

Adapted from Andreucci, M., Solomon, R., & Tasanarong, A. (2014). Side effects of radiographic contrast media: Pathogenesis, risk factors, and prevention. Retrieved on 3/17/2020 at: www.hindawi.com/journals/bmri/2014/741018

Nuclear scans are used to evaluate acute and chronic kidney injury, renal masses, and blood flow before and after kidney transplantation. The radioisotope is injected at a specified time to achieve the proper concentration in the kidneys. After the procedure is completed, the patient is encouraged to drink fluids to promote excretion of the radioisotope by the kidneys.

Intravenous Urography

IV urography includes various tests such as excretory urography, intravenous pyelography (IVP), and infusion drip pyelography. A radiopaque contrast agent is given IV. An IVP shows the kidneys, ureter, and bladder via x-ray imaging as the dye moves through the upper and then the lower urinary system. A nephrotomogram may be carried out as part of the study to visualize different layers of the kidney and the diffuse structures within each layer and to differentiate solid masses or lesions from cysts in the kidneys or urinary tract.

IV urography may be used as the initial assessment of many suspected urologic conditions, especially lesions in the kidneys and ureters. It also provides an approximate estimate of renal function. After the contrast agent (sodium diatrizoate or meglumine diatrizoate) is given IV, multiple x-rays are obtained to visualize drainage structures in the upper and lower urinary systems.

Infusion drip pyelography requires IV infusion of a large volume of a dilute contrast agent to opacify the renal parenchyma and fill the urinary tract. This examination method is useful when prolonged opacification of the drainage structures is desired so that tomograms (body-section radiography) can be made. Images are obtained at specified intervals after the start of the infusion. These images show the filled and distended collecting system. The patient preparation is the same as for excretory urography, except fluids are not restricted.

Retrograde Pyelography

In retrograde pyelography, catheters are advanced through the ureters into the renal pelvis by means of cystoscopy. A contrast agent is then injected. Retrograde pyelography is usually performed if IV urography provides inadequate visualization of the collecting systems. It may also be used before extracorporeal shock wave lithotripsy and in patients with urologic cancer who need follow-up and have an allergy to IV contrast agents. Possible complications include infection, hematuria, and perforation of the ureter. Retrograde pyelography is used infrequently because of improved techniques in excretory urography.

Cystography

Cystography aids in evaluating vesicoureteral reflux (backflow of urine from the bladder into one or both ureters) and in assessing for bladder injury. A catheter is inserted into the bladder, and a contrast agent is instilled to outline the bladder wall. The contrast agent may leak through a small bladder perforation stemming from bladder injury, but such leakage is usually harmless. Cystography can also be performed with simultaneous pressure recordings inside the bladder.

Voiding Cystourethrography

Voiding cystourethrography uses fluoroscopy to visualize the lower urinary tract and assess urine storage in the bladder. It is commonly used as a diagnostic tool to identify vesicoureteral reflux. A urethral catheter is inserted, and a contrast agent is instilled into the bladder. When the bladder is full and the patient feels the urge to void, the catheter is removed, and the patient voids.

Renal Angiography

A renal angiogram, or renal arteriogram, provides an image of the renal arteries. The femoral (or axillary) artery is pierced with a needle, and a catheter is threaded up through the femoral and iliac arteries into the aorta or renal artery. A contrast agent is injected to opacify the renal arterial supply. Angiography is used to evaluate renal blood flow in suspected renal trauma, to differentiate renal cysts from tumors, and to evaluate hypertension. It is used preoperatively for renal transplantation.

Nursing Interventions

Before the procedure, a laxative may be prescribed to evacuate the colon so that unobstructed x-rays can be obtained. Injection sites (groin for femoral approach or axilla for axillary approach) may be shaved. The peripheral pulse sites (radial, femoral, and dorsalis pedis) are marked for easy access during postprocedural assessment. See Chart 47-6 for considerations for the patient receiving a contrast agent.

After the procedure, vital signs are monitored until stable. If the axillary artery was the injection site, blood pressure measurements are taken on the opposite arm. The injection site is examined for swelling and hematoma. Peripheral pulses are palpated, and the color and temperature of the involved extremity are noted and compared with those of the uninvolved extremity. Cold compresses may be applied to the injection site to decrease edema and pain. Possible complications include hematoma formation, arterial thrombosis or dissection, false aneurysm formation, and altered renal function.

MAG3 Renogram

This scan is used to further evaluate kidney function in some centers by permitting visualization of renal clearance (Fischbach & Fischbach, 2018). The patient is given an injection containing a small amount of radioactive material, which will show how the kidneys are functioning. The patient needs to lie still for about 35 minutes while special cameras take images (Fischbach & Fischbach, 2018).

Urologic Endoscopic Procedures

Endourology, or urologic endoscopic procedures, can be performed in one of two ways: using a cystoscope inserted into the urethra, or percutaneously, through a small incision.

The cystoscopic examination is used to directly visualize the urethra and bladder. The cystoscope, which is inserted through the urethra into the bladder, has an optical lens system that provides a magnified, illuminated view of the bladder (see Fig. 47-9). The use of high-intensity light and interchangeable lenses allows excellent visualization and permits still and motion pictures to be taken. The cystoscope is manipulated to allow complete visualization of the urethra and bladder as well as the ureteral orifices and prostatic urethra. Small ureteral catheters can be passed through the cystoscope for assessment of the ureters and the pelvis of each kidney.

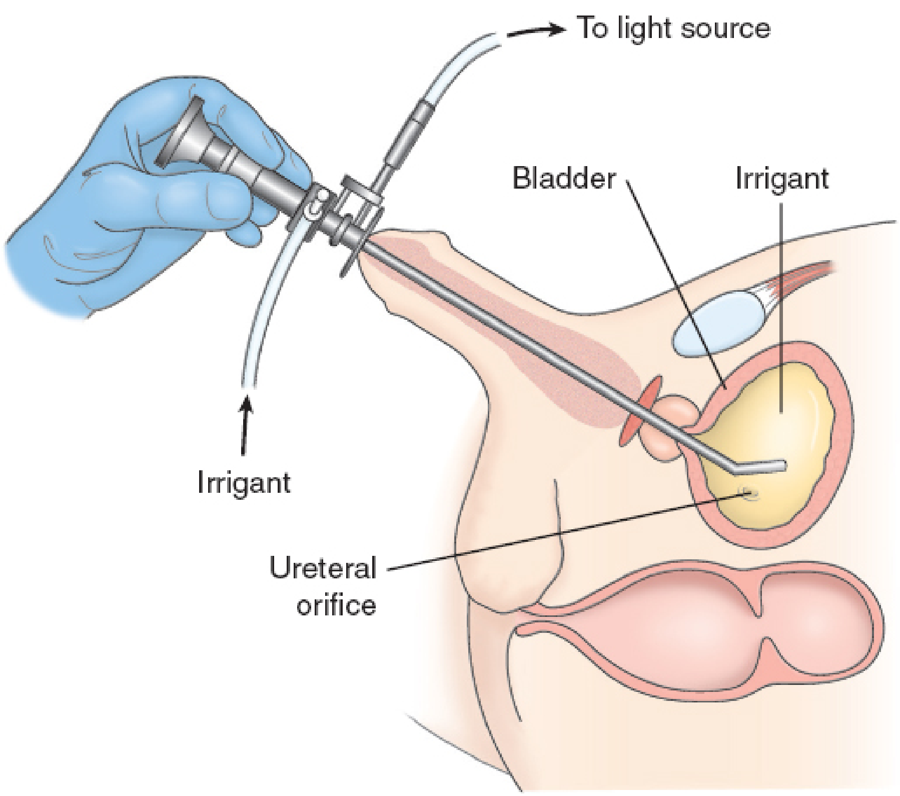


Figure 47-9 • Cystoscopic examination. A rigid or semirigid cystoscope is introduced into the bladder. The upper cord is an electric line for the light at the distal end of the cystoscope. The lower tubing leads from a reservoir of sterile irrigant that is used to inflate the bladder.

The cystoscope also allows the urologist to obtain a urine specimen from each kidney to evaluate its function. Cup forceps can be inserted through the cystoscope for biopsy. Calculi may be removed from the urethra, bladder, and ureter using cystoscopy. If a lower tract cystoscopy is performed, the patient is usually conscious, and the procedure is usually no more uncomfortable than a catheterization. To minimize posttest urethral discomfort, viscous lidocaine is given several minutes before the study. If the cystoscopy includes examination of the upper tracts, a sedative agent may be given before the procedure. General anesthesia is usually given to ensure that there are no involuntary muscle spasms when the scope is being passed through the ureters or kidneys.

Nursing Interventions

The nurse describes the procedure to the patient and family to prepare them and to allay their fears. If an upper cystoscopy is to be performed, the patient is usually restricted to nothing by mouth (NPO) for several hours beforehand.

Postprocedural management is directed at relieving any discomfort resulting from the examination. Some burning on voiding, blood-tinged urine, and urinary frequency from trauma to the mucous membranes can be expected. Moist heat to the lower abdomen and warm sitz baths are helpful in relieving pain and relaxing the muscles.

After a cystoscopic examination, the patient with obstructive pathology may experience urine retention if the instruments used during the examination caused edema. The nurse carefully monitors the patient with prostatic hyperplasia for urine retention. Warm sitz baths and antispasmodic medication, such as flavoxate, may be prescribed to relieve temporary urine retention caused by poor relaxation of the urinary sphincter; however, intermittent catheterization may be necessary for a few hours after the examination. The nurse monitors the patient for signs and symptoms of UTI. Because edema of the urethra secondary to local trauma may obstruct urine flow, the patient is also monitored for signs and symptoms of obstruction.

Biopsy

Renal and Ureteral Brush Biopsy

Brush biopsy techniques provide specific information when abnormal x-ray findings of the ureter or renal pelvis raise questions about whether a defect is a tumor, a stone, a blood clot, or an artifact. First, a cystoscopic examination is conducted. Then, a ureteral catheter is introduced, followed by a biopsy brush that is passed through the catheter. The suspected lesion is brushed back and forth to obtain cells and surface tissue fragments for histologic analysis.

Kidney Biopsy

Biopsy of the kidney is used to help diagnose and evaluate the extent of kidney disease. Indications for biopsy include unexplained acute kidney injury, persistent proteinuria or hematuria, transplant rejection, and glomerulopathies. A small section of renal cortex is obtained either percutaneously (needle biopsy) or by open biopsy through a small flank incision. Before the biopsy is carried out, coagulation studies are conducted to identify any risk of postbiopsy bleeding. Contraindications to kidney biopsy include bleeding tendencies, uncontrolled hypertension, sepsis, a solitary kidney, large polycystic kidneys, kidney neoplasm, UTI, and morbid obesity.

The patient may be prescribed a fasting regimen 6 to 8 hours before the test. An IV line is established. A urine specimen is obtained and saved for comparison with the postbiopsy specimen.

If a needle biopsy is to be performed, the patient is instructed to breathe in and hold that breath (to prevent the kidney from moving) while the needle is being inserted. The sedated patient is placed in a prone position with a sandbag under the abdomen. The skin at the biopsy site is infiltrated with a local anesthetic agent. The biopsy needle is introduced just inside the renal capsule of the outer quadrant of the kidney. The location of the needle may be confirmed by fluoroscopy or by ultrasound, in which case a special probe is used.

With open biopsy, a small incision is made over the kidney, allowing direct visualization. Preparation for an open biopsy is similar to that for any major abdominal surgery.

Nursing Interventions

After a biopsy procedure, nursing care includes monitoring vital signs to detect signs and symptoms of bleeding or infection (Fischbach & Fischbach, 2018). The nurse should assess for other signs and symptoms of internal bleeding such as pallor, dizziness, and flank or back pain. IV fluids may be given to help clear the kidneys and prevent clot formation. Urine may contain blood (usually clearing in 24 to 48 hours) from oozing at the site. Bed rest should be maintained and pressure dressings applied for prescribed periods of time to control bleeding. Puncture sites should be examined for signs and symptoms of infection. Analgesic agents should be given as prescribed and needed for pain.

CRITICAL THINKING EXERCISES

1 pq A 53-year-old female is scheduled for urodynamic testing. Describe your priorities for educating this patient about aspects of care during and after this procedure.

2 ebp You make a home visit to a 72-year-old male who had a cystoscopic examination the day before your visit. He complains of difficulty urinating since his return home. Identify assessments and possible interventions that you would use to evaluate and manage the patient's symptoms. Identify the evidence for the assessments and nursing interventions you chose and the strength of that evidence.

REFERENCES

*Asterisk indicates nursing research.

Books

Ball, J. W., Dains, J. E., Flynn, J. A., et al. (2019). *Seidel's guide to physical examination* (9th ed.). St. Louis, MO: Elsevier.

Comerford, K. C., & Durkin, M. T. (Eds.). (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Eliopoulos, C. (2018). *Gerontological nursing* (9th ed.). Philadelphia, PA: Wolters Kluwer.

Fischbach, F. T., & Fischbach, M. A. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Russell, S. S. (2017). Physiology of the kidney. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.

Taylor, C., Lynn, P., & Bartlett, J. L. (2019). *Fundamentals of nursing: The art and science of person-centered care* (9th ed.). Philadelphia, PA: Wolters Kluwer.

Verlander, J. W., & Clapp, W. L. (2019). Anatomy of the kidney. In A. S. L. Yu, G. M. Certow, V. Luyckx, et al. (Eds.). *Brenner and Rector's the kidney* (11th ed.). Philadelphia, PA: Elsevier.

Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.

Journals and Electronic Documents

Andreucci, M., Solomon, R., & Tasanarong, A. (2014). Side effects of radiographic contrast media: Pathogenesis, risk factors, and prevention. *BioMed Research International*. Retrieved on 3/17/2020 at: www.hindawi.com/journals/bmri/2014/741018

*Chen, S., Chen, P., Chen, G., et al. (2018). Portable bladder ultrasound reduces incidence of urinary tract infection and shortens hospital length of stay in patients with acute ischemic stroke. *Journal of Cardiovascular Nursing*, *31*(6), 551–558.

Emmett, M., & Palmer, B. F. (2018). Serum osmol gap. *UpToDate*. Retrieved on 6/14/2019 at: www.uptodate.com/contents/serum-osmol-gap

Indik, J. H., Gimbel, J. R., Abe, H., et al. (2017). 2017 HRS expert consensus statement on magnetic resonance imaging and radiation exposure in patients with cardiovascular implantable electronic devices. *Heart Rhythm*, *14*(7), e97–e153.

Resources

American Association of Kidney Patients (AAKP), www.aakp.org

National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, www.niddk.nih.gov

National Kidney Foundation, www.kidney.org

48 Management of Patients with Kidney Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the key factors associated with the development of kidney disorders.
2. Explain the pathophysiology, clinical manifestations, medical management, and nursing management for patients with kidney disorders.
3. Differentiate between causes and understand the nursing management of patients with chronic kidney disease and acute kidney injury.
4. Compare and contrast the renal replacement therapies, including hemodialysis, peritoneal dialysis, continuous renal replacement therapies, and kidney transplantation.
5. Identify the nursing management of the hospitalized patient who is undergoing dialysis.
6. Develop a postoperative plan of nursing care for the patient undergoing kidney surgery and transplantation.

NURSING CONCEPTS

Comfort
Elimination
Fluids and Electrolytes
Infection
Inflammation
Nutrition
Patient Education
Safety
Sexuality

GLOSSARY

acute kidney injury (AKI): rapid loss of renal function due to damage to the kidneys; formerly called acute renal failure

acute nephritic syndrome: type of kidney disease with glomerular inflammation

acute tubular necrosis (ATN): type of acute kidney injury in which there is damage to the kidney tubules

anuria: total urine output less than 50 mL in 24 hours

arteriovenous fistula: type of vascular access for dialysis which is created by surgically connecting an artery to a vein

arteriovenous graft: type of surgically created vascular access for dialysis by which a piece of biologic, semibiologic, or synthetic graft material connects the patient's artery to a vein

azotemia: abnormal concentration of nitrogenous waste products in the blood

chronic kidney disease (CKD): kidney damage or a decrease in the glomerular filtration rate lasting for 3 or more months

continuous ambulatory peritoneal dialysis (CAPD): method of peritoneal dialysis whereby a patient manually performs a prescribed number of exchanges or cycles throughout the day

continuous cyclic peritoneal dialysis (CCPD): method of peritoneal dialysis in which a peritoneal dialysis machine (cycler) automatically performs exchanges, usually while the patient sleeps

continuous renal replacement therapy (CRRT): method used to replace normal kidney function in patients who are hemodynamically unstable by circulating the patient's blood through a hemofilter and returning it to the patient

dialysate: the electrolyte solution that circulates through the dialyzer in hemodialysis and through the peritoneal membrane in peritoneal dialysis

dialyzer: artificial kidney; contains a semipermeable membrane through which particles of a certain size can pass

diffusion: movement of solutes (waste products) from an area of higher concentration to an area of lower concentration

effluent: term used to describe the drained fluid from a peritoneal dialysis exchange

end-stage kidney disease (ESKD): final stage of chronic kidney disease that results in retention of uremic waste products and the need for renal replacement therapies; formerly called end-stage renal disease (ESRD)

exchange: denotes a complete cycle including fill, dwell, and drain phases of peritoneal dialysis

glomerular filtration rate (GFR): amount of plasma filtered through the glomeruli per unit of time

glomerulonephritis: inflammation of the glomerular capillaries

hemodialysis (HD): procedure during which a patient’s blood is circulated through a dialyzer to remove waste products and excess fluid

interstitial nephritis: inflammation within the renal tissue

nephrosclerosis: hardening of the renal arteries

nephrotic syndrome: type of kidney disease with increased glomerular permeability and massive proteinuria

nephrotoxic: any substance, medication, or action that is toxic to kidney tissue

oliguria: urine output less than 400 mL in 24 hours or less than 0.5 mL/kg/h over 6 hours

osmosis: movement of water through a semipermeable membrane from an area of lower solute concentration to an area of higher solute concentration

peritoneal dialysis (PD): procedure that uses the lining of the patient’s peritoneal cavity, the peritoneal membrane, as the semipermeable membrane for exchange of fluid and solutes

peritonitis: inflammation of the peritoneal membrane

polyuria: excessive urine production

ultrafiltration: process whereby water is removed from the blood by means of a pressure gradient between the patient’s blood and the dialysate

uremia: an excess of urea and other nitrogenous wastes in the blood

urinary casts: proteins secreted by damaged kidney tubules

The kidneys and urinary system help regulate the body’s internal environment and are essential for the maintenance of life. Nurses working in all clinical settings will encounter patients with various kidney injuries and diseases and need to be knowledgeable about these disorders. This chapter provides an overview of electrolyte imbalances and systemic manifestations that are common in patients with kidney disorders. The main causes are discussed, together with management strategies to prevent damage and preserve renal function. Chronic kidney disease (CKD) and acute kidney injury (AKI) are discussed, as is the care of patients with other renal conditions requiring dialysis, continuous renal replacement therapy (CRRT), transplantation, and kidney surgery.

FLUID AND ELECTROLYTE IMBALANCES IN KIDNEY DISORDERS

Patients with kidney disorders commonly experience fluid and electrolyte imbalances and require careful assessment and close monitoring for signs of potential problems. The patient whose fluid intake exceeds the ability of the kidneys to excrete fluid is said to have fluid overload. If fluid intake is inadequate, the patient is said to be volume depleted and may show signs and symptoms of fluid volume deficit. The intake and output (I&O) record, a key monitoring tool, is used to document important fluid parameters, including the amount of fluid taken in (orally or parenterally), the volume of urine excreted, and other fluid losses (diarrhea, vomiting, diaphoresis). Patient weight is considered a more accurate indication of volume status than I&O, due to the challenges and multiple variables involved in accurately monitoring I&O. Documenting trends in weight is a key assessment strategy essential for determining the daily fluid allowance and indicating signs of fluid volume excess or deficit.

Quality and Safety Nursing Alert

The most accurate indicator of fluid loss or gain in patients who are acutely ill is weight. An accurate daily weight must be obtained and recorded. A 1-kg weight gain is equal to 1 L (1000 mL) of retained fluid.

Clinical Manifestations

The signs and symptoms of common fluid and electrolyte disturbances that can occur in patients with kidney disorders and general management strategies are listed in Table 48-1. The nurse continually assesses, monitors, and informs appropriate members of the health care team if the patient exhibits any of these signs. Management strategies for fluid and electrolyte disturbances in kidney disease are discussed in greater depth later in this chapter (see Chapter 10 for more discussion of fluid and electrolyte disturbances).

Gerontologic Considerations

With aging, the kidney is less able to respond to acute fluid and electrolyte changes. Older adult patients may develop atypical and nonspecific signs and symptoms of altered renal function and fluid and electrolyte imbalances. A fluid balance deficit in older adults can lead to falls, medication toxicity, constipation, urinary tract and respiratory tract infections, delirium, seizures, electrolyte imbalances, hyperthermia, and delayed wound healing. Recognition of acute changes in fluid and electrolytes is further hampered by their association with preexisting disorders and the misconception that they are normal changes of aging (Hain, 2017).

KIDNEY DISORDERS

Chronic Kidney Disease

Chronic kidney disease (CKD) is an umbrella term that describes kidney damage or a decrease in the glomerular filtration rate (GFR) lasting for 3 or more months. CKD is associated with decreased quality of life, increased health care expenditures, and premature death. Untreated CKD can result in **end-stage kidney disease (ESKD**, formerly known as end-stage renal disease [ESRD]), which is the final stage of CKD. ESKD results in retention of uremic waste products and the need for renal replacement therapy (RRT), such as dialysis or kidney transplantation (Chicca, 2020). Risk factors include cardiovascular disease, diabetes, hypertension, and obesity.

TABLE 48-1 Common Fluid and Electrolyte Disturbances in Kidney Disorders

Disturbance	Manifestations	General Management Strategies
Fluid volume deficit	Acute weight loss ≥5%, decreased skin turgor, dry mucous membranes, oliguria or anuria, increased hematocrit, BUN level increased out of proportion to creatinine level, hypothermia	Fluid challenge, fluid replacement orally or parenterally
Fluid volume excess	Acute weight gain ≥5%, edema, crackles, shortness of breath, decreased BUN, decreased hematocrit, distended neck veins	Fluid and sodium restriction, diuretic agents, dialysis
Hyponatremia (sodium deficit)	Nausea, malaise, lethargy, headache, abdominal cramps, apprehension, seizures	Diet, normal saline or hypertonic saline solutions
Hypernatremia (sodium excess)	Dry, sticky mucous membranes, thirst, rough dry tongue, fever, restlessness, weakness, disorientation	Fluids, diuretic agents, dietary restriction
Hypokalemia (potassium deficit)	Anorexia, abdominal distention, paralytic ileus, muscle weakness, ECG changes, arrhythmias	Diet, oral or parenteral potassium replacement therapy
Hyperkalemia (potassium excess)	Diarrhea, colic, nausea, irritability, muscle weakness, ECG changes	Dietary restriction, diuretics, IV glucose, insulin and sodium bicarbonate, cation-exchange resin, calcium gluconate, dialysis
Hypocalcemia (calcium deficit)	Abdominal and muscle cramps, stridor, carpopedal spasm, hyperactive reflexes, tetany, positive Chvostek or Trousseau sign, tingling of fingers and around mouth, ECG changes	Diet, oral or parenteral calcium salt replacement
Hypercalcemia (calcium excess)	Deep bone pain, flank pain, muscle weakness, depressed deep tendon reflexes, constipation, nausea and vomiting, confusion, impaired memory, polyuria, polydipsia, ECG changes	Fluid replacement, etidronate, pamidronate, mithramycin, calcitonin, corticosteroids, phosphate salts
Metabolic acidosis (bicarbonate deficit)	Headache, confusion, drowsiness, increased respiratory rate and depth, nausea and vomiting, warm flushed skin	Bicarbonate replacement, dialysis
Metabolic alkalosis (bicarbonate excess)	Depressed respirations, muscle hypertonicity, dizziness, tingling of fingers and toes	Fluid replacement if volume depleted; ensure adequate chloride
Hypoalbuminemia	Chronic weight loss, emotional	Diet, dietary supplements,

(protein deficit)	depression, pallor, fatigue, soft flabby muscles	hyperalimentation, albumin
Hypomagnesemia (magnesium deficit)	Dysphagia, muscle cramps, hyperactive reflexes, tetany, positive Chvostek or Trousseau sign, tingling of fingers, arrhythmias, vertigo	Diet, oral or parenteral magnesium replacement therapy
Hypermagnesemia (magnesium excess)	Facial flushing, nausea and vomiting, sensation of warmth, drowsiness, depressed deep tendon reflexes, muscle weakness, respiratory depression, cardiac arrest	Calcium gluconate, mechanical ventilation, dialysis
Hypophosphatemia (phosphorus deficit)	Deep bone pain, flank pain, muscle weakness and pain, paresthesia, apprehension, confusion, seizures	Diet, oral or parenteral phosphorus supplementation therapy

BUN, blood urea nitrogen; ECG, electrocardiographic; IV, intravenous.

Adapted from Fischbach, F., & Fischbach, M. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Recent research reported that 15% of the adult U.S. population, 37 million people or 1 in 7 individuals, have CKD and 9 of 10 affected individuals are unaware of their disease (Centers for Disease Control and Prevention [CDC], 2019). On December 31, 2017, there were more than 746,000 Americans diagnosed with ESKD (United States Renal Data System [USRDS], 2019). The majority of people with CKD will die of a cardiovascular event (heart attack or stroke) prior to reaching ESKD (Subbiah, Chhabra, & Mahajan, 2016).

Diabetes and hypertension cause approximately 70% of cases of CKD (Chicca, 2020). About one in three adults with diabetes may have CKD (CDC, 2019). Diabetes is the leading cause of kidney disease in patients starting RRT. About one in five adults with hypertension may have CKD (CDC, 2019). Other causes include glomerulonephritis, pyelonephritis; polycystic, hereditary, or congenital disorders; and renal cancers.

Pathophysiology

In the early stages of CKD, there can be significant damage to the kidneys without signs or symptoms. The pathophysiology of CKD is not yet clearly understood, but the damage to the kidneys is thought to be caused by prolonged acute inflammation that is not organ specific and thus has subtle systemic manifestations.

Stages of Chronic Kidney Disease

CKD has been classified into five stages by the National Kidney Foundation (NKF) (see Chart 48-1). Stage 5 results when the kidneys cannot remove the body’s metabolic wastes or perform their regulatory functions; thus, RRT is required to sustain life. Screening and early intervention are important, because not all patients progress to stage 5 CKD. Patients with CKD are at increased risk for cardiovascular disease, which is the leading cause of morbidity and mortality (Carey & Whelton, 2018). Treatment of hypertension, anemia, and hyperglycemia and detection of proteinuria all help to slow disease progression and improve patient outcomes (Brooks, 2017).

Chart 48-1

Stages of Chronic Kidney Disease

Stages are based on the GFR. The normal GFR is 125 mL/min/1.73 m^2.

Stage 1

GFR ≥90 mL/min/1.73 m^2
Kidney damage with normal or increased GFR

Stage 2

GFR = 60–89 mL/min/1.73 m^2
Mild decrease in GFR

Stage 3

GFR = 30–59 mL/min/1.73 m^2
Moderate decrease in GFR

Stage 4

GFR = 15–29 mL/min/1.73 m^2
Severe decrease in GFR

Stage 5

GFR <15 mL/min/1.73 m^2
End-stage kidney disease or chronic kidney disease

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

GFR, glomerular filtration rate.

Clinical Manifestations

Elevated serum creatinine levels indicate underlying kidney disease; as the creatinine level increases, symptoms of CKD begin. Those with CKD are one of the most symptomatic groups among patients with chronic diseases (Kalfoss, Schick-Makaroff, & Molzahn, 2019). Anemia, due to decreased erythropoietin production by the kidney, metabolic acidosis, and abnormalities in calcium and phosphorus balance herald the development of CKD (Brooks, 2017). Fluid retention, evidenced by both edema and congestive heart failure, develops. As the disease progresses, abnormalities in electrolytes occur, heart failure worsens, and hypertension becomes more difficult to control, often due to fluid volume excess (Ku, Lee, Wei, et al., 2019).

Assessment and Diagnostic Findings

The **glomerular filtration rate (GFR)** is the amount of plasma filtered through the glomeruli per unit of time. Creatinine clearance is a measure of the amount of creatinine the kidneys are able to clear in a 24-hour period. Normal values differ in men and women. Calculation of GFR, an important assessment parameter in CKD, is discussed in Chapter 47.

Medical Management

The management of patients with CKD includes treatment of the underlying causes. Regular clinical and laboratory assessment is important to keep the blood pressure below 125 to 130/80 mm Hg (Ku et al., 2019). Controlling cardiovascular risk factors, treating hyperglycemia, managing anemia, encouraging smoking cessation, weight loss, and exercise programs as well as reducing salt and alcohol intake and minimizing nephrotoxins all slow progression toward ESKD. Medical management also includes early referral for initiation of RRT as indicated by the patient's renal status. Patient engagement and education are essential as many of these factors are under the patient's control.

Gerontologic Considerations

Changes in kidney function with normal aging increase the susceptibility of older patients to kidney dysfunction and kidney disease (Hain, 2017). With aging, the number of nephrons decline. In addition, the incidence of systemic diseases, such as atherosclerosis, hypertension, heart failure, diabetes, and cancer, increases with advancing age, predisposing older adults to kidney disease associated with these disorders. Therefore, acute problems need to be prevented if possible or recognized and treated quickly to avoid kidney damage. Nurses in all settings need to be alert to signs and symptoms of kidney dysfunction in older patients.

Older patients frequently take multiple prescription and over-the-counter medications. Because alterations in renal blood flow, glomerular filtration, and renal clearance increase the risk of medication-associated changes in renal function, precautions are indicated with all medications. When older patients undergo extensive diagnostic tests or when new medications (e.g., diuretic agents) are added, precautions must be taken to prevent dehydration, which can compromise marginal renal function and exacerbate preexisting kidney dysfunction (Hain, 2017).

Nephrosclerosis

Nephrosclerosis (hardening of the renal arteries) is most often due to prolonged hypertension, diabetes, the aging process, and other factors. Individuals with nephrosclerosis generally experience slowly elevating blood urea nitrogen (BUN) and creatinine, and mild proteinuria (spilling of protein in the urine). Nephrosclerosis is a major cause of CKD and ESKD secondary to many disorders. Groups at increased risk include African Americans, those with uncontrolled hypertension, and individuals with underlying CKD, especially those with diabetic nephropathy. African American patients have an approximate eightfold elevation in the risk of hypertension-induced ESKD (Mann & Hilgers, 2019).

Pathophysiology

There are two forms of nephrosclerosis: acute hypertensive and benign. Acute hypertensive nephrosclerosis is often associated with significant and prolonged hypertension. Damage is caused by decreased blood flow to the kidney resulting in patchy necrosis of the renal parenchyma. Over time, fibrosis occurs and glomeruli are destroyed. Untreated, the disease process can progress rapidly. Benign nephrosclerosis can be found in older adults, associated with atherosclerosis, hypertension, and diabetes (Parikh, Haddad, & Hebert, 2019).

Assessment and Diagnostic Findings

Symptoms are rare early in the disease, even though the urine usually contains protein and occasional casts. CKD and associated signs and symptoms occur late in the disease.

Medical Management

Treatment of nephrosclerosis is antihypertensive therapy. An angiotensin-converting enzyme (ACE) inhibitor, alone or in combination with other antihypertensive medications, significantly reduces its incidence. See Chapter 27 for additional information on hypertension.

Primary Glomerular Diseases

Diseases that destroy the glomerulus of the kidney are the third most common cause of stage 5 CKD (USRDS, 2019). The glomeruli (a Greek word meaning "filter") are the multiple small blood vessels within the nephron that remove urea from the blood. There are two major categories of glomerular diseases: glomerulonephritis and glomerulosclerosis. Primary glomerular diseases are within the kidney itself, while secondary glomerular kidney disease is a result of systemic disease, such as diabetes or lupus nephritis. Primary glomerulonephritis means that the kidney is inflamed, often due to an autoimmune disorder (Norris, 2019).

Antigen–antibody complexes form in the blood and become trapped in the glomerular capillaries (the filtering portion of the kidney), inducing an inflammatory response. Immunoglobulin G (IgG)—the major immunoglobulin (antibody) found in the blood—can be detected in the glomerular capillary walls. The major clinical manifestations of glomerular injury include proteinuria, hematuria, decreased GFR, decreased excretion of sodium, edema, and hypertension (Mahaffey, 2017) (see Chart 48-2).

Chart 48-2

Terms Typically Used When Describing Glomerular Disease

Primary: Disease is mainly in glomeruli
Secondary: Glomerular diseases that are the consequence of systemic disease
Idiopathic: Cause is unknown
Acute: Occurs over days or weeks
Chronic: Occurs over months or years
Rapidly progressing: Constant, rapid loss of renal function with better chance of recovery with early diagnosis
Diffuse: Involves all glomeruli
Focal: Involves some glomeruli
Segmental: Involves portions of individual glomeruli
Membranous: Evidence of thickened glomerular capillary walls
Proliferative: Number of glomerular cells involved is increasing

Acute Nephritic Syndrome

Glomerulonephritis is an inflammation of the glomerular capillaries that can occur in acute and chronic forms. **Acute nephritic syndrome** is a type of acute glomerulonephritis. In acute nephritic syndrome, hematuria due to glomerular bleeding is seen as well as pus and cellular and granular casts in the urine. Variable proteinuria is noted. A decreased glomerular filtration rate is seen in severe cases of nephritic glomerular injury (Mahaffey, 2017; Norris, 2019).

Pathophysiology

Primary glomerular diseases include postinfectious glomerulonephritis, rapidly progressive glomerulonephritis, membrane proliferative glomerulonephritis, and membranous glomerulonephritis. Postinfectious causes are group A beta-hemolytic streptococcal infection of the throat that precedes the onset of glomerulonephritis by 2 to 3 weeks (see Fig. 48-1). Postinfectious glomerulonephritis may also follow impetigo (infection of the skin) and acute viral infections (upper respiratory tract infections, mumps, varicella zoster virus, Epstein–Barr virus, hepatitis B, and human immune deficiency virus [HIV] infection). In some patients, antigens outside the body (e.g., medications, foreign serum) initiate the process, resulting in antigen–antibody complexes being deposited in the glomeruli. In other patients, the kidney tissue itself serves as the inciting antigen (autoimmune phenomenon). With early diagnosis and treatment, the kidney damage is generally reversible (Mahaffey, 2017).

Physiology/Pathophysiology

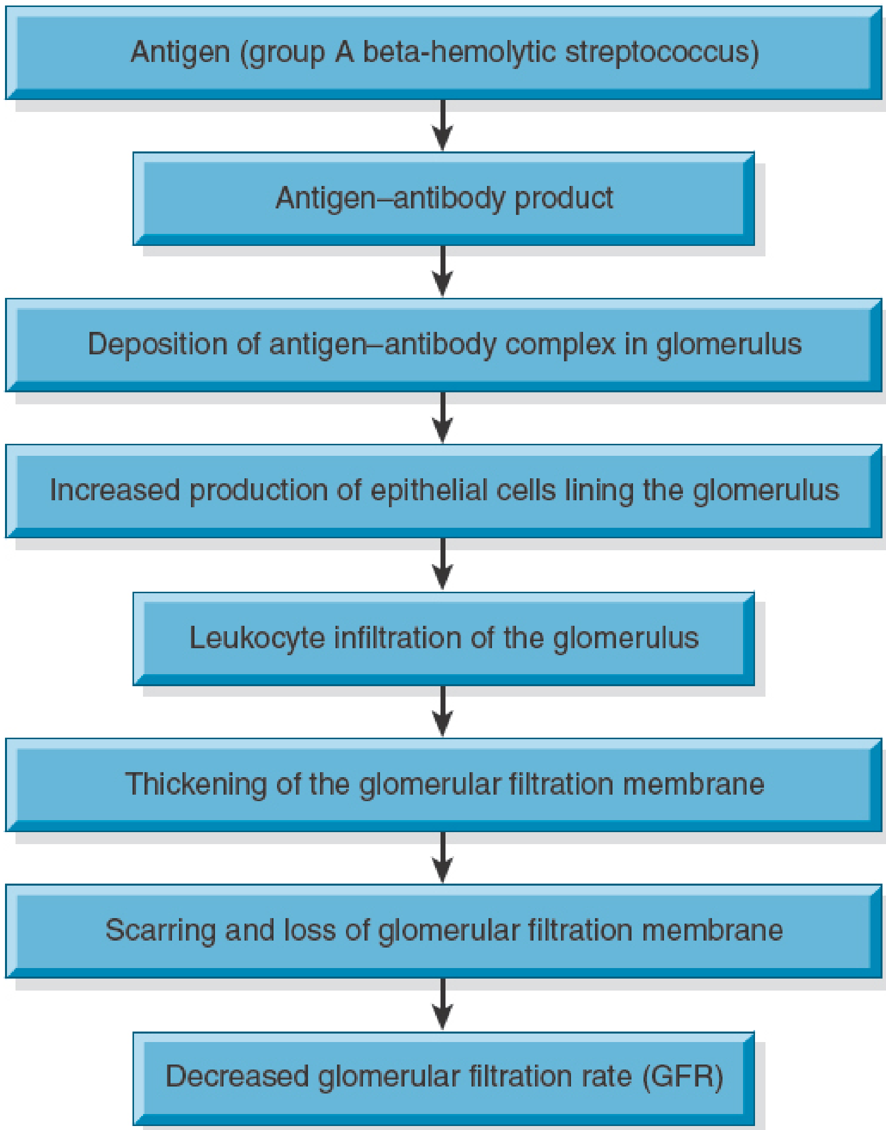


Figure 48-1 • Sequence of events in acute nephritic syndrome.

Clinical Manifestations

The primary presenting features of an acute glomerular inflammation are hematuria, edema, **azotemia** (an abnormal concentration of nitrogenous wastes in the blood), and **proteinuria** (excess protein in the urine) (Mahaffey, 2017; Norris, 2019). The hematuria may be microscopic (identifiable only through microscopic examination) or macroscopic (visible to the eye). The urine may appear cola-colored because of red blood cells (RBCs) and protein plugs or casts; RBC casts indicate glomerular injury. Glomerulonephritis may be mild and the hematuria discovered incidentally through a routine urinalysis, or the disease may be severe, with AKI and oliguria.

Some degree of edema and hypertension is present in most patients. Marked proteinuria due to the increased permeability of the glomerular membrane may also occur, with associated pitting edema, hypoalbuminemia, hyperlipidemia, and fatty casts in the urine. BUN and serum creatinine levels may increase as urine output decreases. In addition, anemia may be present.

In the more severe form of the disease, patients also complain of headache, malaise, and flank pain. Older patients may experience circulatory overload with dyspnea, engorged neck veins, cardiomegaly, and pulmonary edema. Atypical symptoms include confusion, somnolence, and seizures, which are often confused with the symptoms of a primary neurologic disorder.

Assessment and Diagnostic Findings

In acute nephritic syndrome, the kidneys become large, edematous, and congested. All renal tissues, including the glomeruli, tubules, and blood vessels, are affected to varying degrees. Patients with an immunoglobulin A (IgA) nephropathy have an elevated serum IgA and low to normal complement levels. Electron microscopy and immunofluorescent analysis help identify the nature of the lesion; however, a kidney biopsy may be needed for definitive diagnosis. See Chapter 47 for discussion of kidney biopsy.

If the patient improves, the amount of urine will increase and the urinary protein and sediment will diminish. Some patients develop severe **uremia** (an excess of urea and other nitrogenous wastes in the blood) within weeks and require dialysis for survival. Others, after a period of apparent recovery, insidiously develop chronic glomerulonephritis.

Complications

Complications of acute glomerulonephritis include hypertensive encephalopathy, heart failure, and pulmonary edema. Hypertensive encephalopathy is a medical emergency, and therapy is directed toward reducing the blood pressure without impairing renal function. This can occur in acute nephritic syndrome or preeclampsia with chronic hypertension of greater than 130/80 mm Hg.

Rapidly progressive glomerulonephritis is characterized by a rapid decline in renal function. Without treatment, ESKD develops in a matter of weeks or months. Signs and symptoms are similar to those of acute glomerulonephritis (hematuria and proteinuria), but the course of the disease is more severe and rapid. Crescent-shaped cells accumulate in Bowman space, disrupting the filtering surface. Therapeutic plasma exchange and treatment with high-dose corticosteroids, cytotoxic agents or monoclonal antibodies have been used to reduce the inflammatory response.

Dialysis is initiated in acute glomerulonephritis if signs and symptoms of uremia are severe. However, the prognosis for patients with acute nephritic syndrome is excellent and it rarely causes CKD (Mahaffey, 2017).

Medical Management

Management consists primarily of treating symptoms, attempting to preserve kidney function, and treating complications promptly. Treatment may include prescribing corticosteroids, managing hypertension, and controlling proteinuria. Pharmacologic therapy depends on the cause of acute glomerulonephritis. If residual streptococcal infection is suspected, penicillin is the agent of choice. However, other antibiotic agents may be prescribed. Dietary protein may be restricted when renal insufficiency and nitrogen retention (elevated BUN) develop. Sodium is restricted when the patient has hypertension, edema, and heart failure.

Nursing Management

Although most patients with acute uncomplicated glomerulonephritis are cared for as outpatients, nursing care is important in every setting.

Providing Care in the Hospital

In a hospital setting, carbohydrates are given liberally to provide energy and reduce the catabolism of protein. I&O is carefully measured and recorded. Fluids are prescribed based on the patient's fluid losses and daily body weight. Insensible fluid loss through the lungs (300 mL) and skin (500 mL) is considered when estimating fluid loss (see Chapter 10, Table 10-2) (Norris, 2019). If treatment is effective, diuresis will begin, resulting in decreased edema and blood pressure. Proteinuria and microscopic hematuria may persist for many months. Other nursing interventions focus on patient education about the disease process, explanations of laboratory and other diagnostic tests, and preparation for safe and effective self-care at home.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Patient education is directed toward managing symptoms and monitoring for complications. Fluid and diet restrictions must be reviewed with the patient to avoid worsening of edema and hypertension. The patient is instructed verbally and in writing to notify the primary provider if symptoms of kidney disease occur (e.g., fatigue, nausea, vomiting, loss of appetite, diminishing urine output) or at the first sign of any infection.

Continuing and Transitional Care

The importance of follow-up evaluations of blood pressure, laboratory blood studies for BUN and creatinine levels, and urinalysis for protein, to determine if the disease has progressed, is stressed to the patient. A referral for transitional, home, or community-based care may be indicated. A home visit from a nurse provides an opportunity for careful assessment of the patient's progress and detection of early signs and symptoms of renal insufficiency. If corticosteroids, immunosuppressant agents, or antibiotic medications are prescribed, the nurse uses the opportunity to review the dosages, desired actions, and adverse effects of medications and the precautions to be taken.

Chronic Glomerulonephritis

Chronic glomerulonephritis may be due to repeated episodes of acute nephritic syndrome, hypertensive nephrosclerosis, hyperlipidemia, chronic tubulointerstitial injury, or hemodynamically mediated glomerular sclerosis. Secondary glomerular diseases that can have systemic effects include systemic lupus erythematosus, Goodpasture syndrome (caused by antibodies to the glomerular basement membrane), and diabetic glomerulosclerosis (Mahaffey, 2017).

Pathophysiology

The kidneys are reduced to as little as one fifth their normal size (consisting largely of fibrous tissue). The cortex layer shrinks to 1 to 2 mm in thickness or less. Bands of scar tissue distort the remaining cortex, making the surface of the kidney rough and irregular. Numerous glomeruli and their tubules become scarred, and the branches of the renal artery are thickened. The resulting severe glomerular damage can progress to stage 5 CKD and require RRT. Patients who initially have impaired kidney function or notable proteinuria tend to have increased progression of kidney disease (Parikh et al., 2019).

Clinical Manifestations

The symptoms of chronic glomerulonephritis vary. Some patients with severe disease have no symptoms at all for many years. The condition may be discovered when hypertension or elevated BUN and serum creatinine levels or proteinuria are detected. Most patients report general symptoms, such as loss of weight and strength, increasing irritability, and nocturia (an increased need to urinate at night). Headaches, dizziness, and digestive disturbances are also common. Early diagnosis and treatment are key to preventing CKD and ESKD and the development of late complications.

As chronic glomerulonephritis progresses, signs and symptoms of CKD may develop. With undiagnosed or untreated disease, the patient appears poorly nourished, with a yellow-gray pigmentation of the skin and periorbital and peripheral (dependent) edema. Blood pressure may be normal or severely elevated. Retinal findings include hemorrhage, exudate, narrowed tortuous arterioles, and papilledema. Anemia causes pale mucous membranes. Cardiomegaly, a gallop rhythm, distended neck veins, and other signs and symptoms of heart failure may be present. Crackles can be heard in the bases of the lungs.

Peripheral neuropathy with diminished deep tendon reflexes and neurosensory changes occur late in the disease. The patient becomes confused and demonstrates a limited attention span. Additional late findings include evidence of pericarditis with a pericardial friction rub and pulsus paradoxus (difference in blood pressure during inspiration and expiration of greater than 10 mm Hg). Pleural effusions may be seen on chest x-ray.

Assessment and Diagnostic Findings

A number of laboratory abnormalities occur. Urinalysis reveals a fixed specific gravity of about 1.010, variable proteinuria, and **urinary casts** (proteins secreted by damaged kidney tubules). As kidney disease progresses and the GFR falls below 50 mL/min, the following changes occur:

- Anemia secondary to decreased erythropoiesis (production of RBCs)
- Decreased serum calcium level (calcium binds to phosphorus to compensate for elevated serum phosphorus levels)
- Hyperkalemia due to decreased urinary potassium excretion, acidosis, catabolism, and potassium intake from food and medications
- Hypoalbuminemia with edema secondary to protein loss through the damaged glomerular membrane
- Increased serum phosphorus level due to decreased renal excretion of phosphorus
- Impaired nerve conduction due to electrolyte abnormalities and uremia resulting in peripheral neuropathy
- Mental status changes
- Metabolic acidosis from decreased acid secretion by the kidney and inability to regenerate bicarbonate

Chest x-rays may show cardiac enlargement and pulmonary edema due to volume overload. The electrocardiogram (ECG) may be normal or may indicate left ventricular hypertrophy associated with hypertension and signs of electrolyte disturbances, such as tall, tented (or peaked) T waves associated with hyperkalemia. Renal ultrasound shows decreased renal mass in both kidneys (Norris, 2019).

Medical Management

Management of symptoms guides the treatment. If the patient has hypertension, efforts are made to reduce the blood pressure with sodium and water restriction, antihypertensive agents, or both. Weight is monitored daily, and diuretic medications are prescribed to treat fluid overload. Proteins of high-biologic value (eggs, meats, fish) are provided to promote good nutritional status. Adequate calories are provided to spare protein for tissue growth and repair. Urinary tract infections (UTIs) must be treated promptly to prevent further kidney damage. Nonsteroidal anti-inflammatory drugs (NSAIDs) are avoided as well as other nephrotoxic medications and diagnostic studies which necessitate the administration of intravenous (IV) contrast dye (Nahar, 2017).

Dialysis is initiated early in the course of the disease to keep the patient in optimal physical condition, prevent fluid and electrolyte imbalances, and minimize the risk of complications of kidney disease. The course of dialysis is smoother if treatment begins before the patient develops complications.

Nursing Management

Whether the patient is hospitalized or cared for in the home, the nurse observes the patient for common fluid and electrolyte disturbances in kidney disease (see Table 48-1). Changes in fluid and electrolyte status and in cardiac and neurologic status are promptly reported to the primary provider. Throughout the course of the disease and treatment, the nurse gives emotional support by providing opportunities for the patient and family to verbalize their concerns, have their questions answered, and explore their options (Mahaffey, 2017).

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

The nurse has a major role in educating the patient and family about the prescribed treatment plan and the risks associated with nonadherence. Instructions to the patient include explanations and scheduling for follow-up evaluations: blood pressure, urinalysis for protein and casts, and laboratory studies of BUN and serum creatinine levels. If long-term dialysis is needed, the nurse educates the patient and family about the procedure, how to care for the access site, dietary and fluid restrictions, and other necessary lifestyle modifications. These topics are discussed later in this chapter.

Periodic hospitalization, visits to the outpatient clinic or office, and home care referrals provide the nurse in each setting with the opportunity for careful assessment of the patient's progress and continued education about changes to report to the primary provider (worsening signs and symptoms of kidney disease, such as nausea, vomiting, loss of appetite, and diminished urine output). Specific education may include explanations of recommended diet and fluid modifications; medications (purpose, desired effects, adverse effects, dosage, and administration schedule); and encouragement to achieve and maintain a healthy weight (Chicca, 2020). The nurse consults with the renal dietitian for detailed dietary education.

Continuing and Transitional Care

Periodic laboratory evaluations of creatinine clearance and BUN and serum creatinine levels are carried out to assess residual renal function and the need for dialysis or transplantation. If dialysis is initiated, the patient and family require considerable assistance and support in dealing with therapy and its long-term implications. The patient and family are reminded of the importance of participation in health promotion activities, including health screening. The patient is instructed to inform all health care providers about the diagnosis of glomerulonephritis so that all medical management, including pharmacologic therapy, is based on altered renal function.

Nephrotic Syndrome

Nephrotic syndrome is a type of kidney disease characterized by increased glomerular permeability and is manifested by massive proteinuria (Mahaffey, 2017). Clinical findings include proteinuria (a marked increase in protein [particularly albumin] in the urine), hypoalbuminemia (a decrease in albumin in the blood), diffuse edema, high serum cholesterol, and hyperlipidemia (elevated low-density lipoproteins). A hypercoagulable state is often present and the patient has an increased risk of deep venous thrombosis, renal vein thrombosis, and pulmonary embolism (Kelepouris & Rovin, 2019).

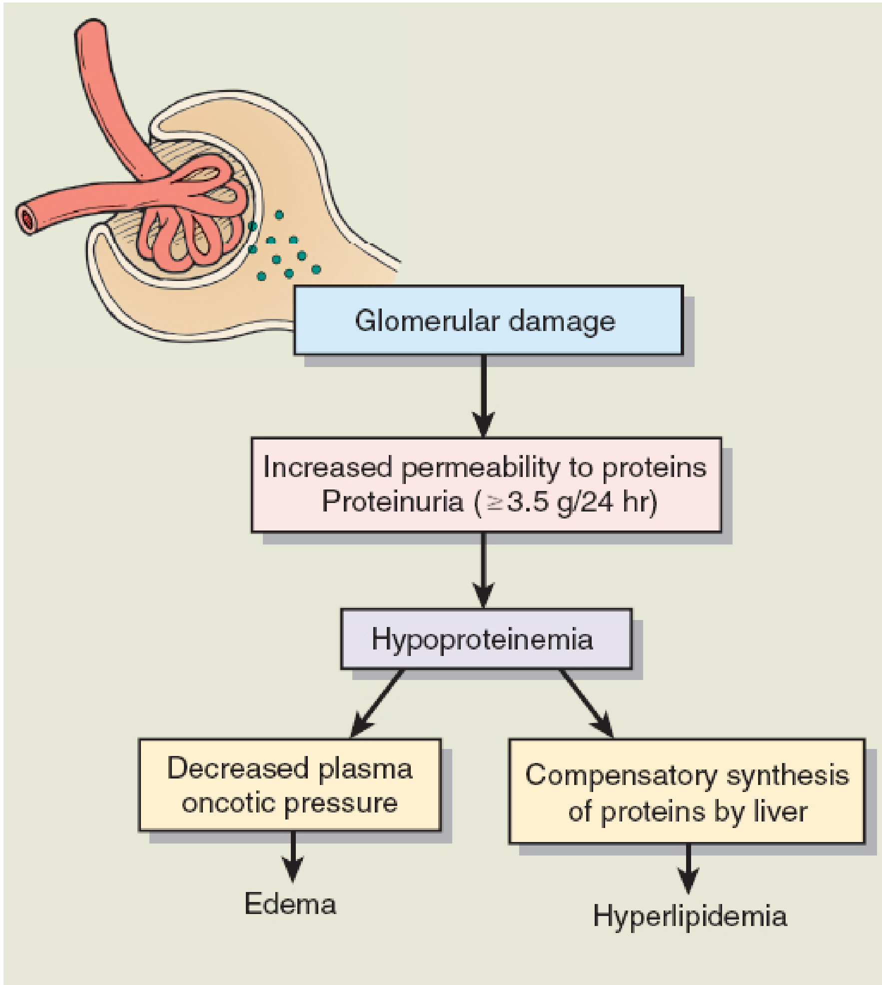


Figure 48-2 • Pathophysiology of the nephrotic syndrome. Reprinted with permission from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed., Fig. 33-14). Philadelphia, PA: Wolters Kluwer.

The syndrome is apparent in any condition that seriously damages the glomerular capillary membrane and results in increased glomerular permeability to plasma proteins. Although the liver is capable of increasing the production of albumin, it cannot keep up with the daily loss of albumin through the kidneys. Thus, hypoalbuminemia results (see Fig. 48-2).

Pathophysiology

Nephrotic syndrome occurs with many intrinsic kidney diseases and systemic diseases that cause glomerular damage. It is not a specific glomerular disease but a constellation of clinical findings that result from the glomerular damage.

Clinical Manifestations

The major manifestation of nephrotic syndrome is edema. It is usually soft and pitting and commonly occurs around the eyes (periorbital), in dependent areas (sacrum, ankles, and hands), and in the abdomen (ascites). Patients may also exhibit irritability, headache, and malaise.

Assessment and Diagnostic Findings

Proteinuria (predominately albumin) exceeding 3.5 g/day is the hallmark of the diagnosis of nephrotic syndrome. Protein excretion can be measured on a 24-hour urine collection; the normal value is less than 150 mg/day (Kelepouris & Rovin, 2019). Urine protein electrophoresis and immunofixation may be performed to categorize the type of proteinuria. The urine may also contain increased white blood cells (WBCs) as well as granular and epithelial casts. A needle biopsy of the kidney may be performed for histologic examination of renal tissue to confirm the diagnosis.

Complications

Complications of nephrotic syndrome include infection (due to a deficient immune response), thromboembolism (especially of the renal vein and deep veins of the legs), pulmonary embolism, AKI (due to hypovolemia), and accelerated atherosclerosis (due to hyperlipidemia).

Medical Management

Treatment is focused on addressing the underlying disease state causing proteinuria, slowing progression of CKD, and relieving symptoms. Typical treatment includes diuretic agents for edema, ACE inhibitors to reduce proteinuria, lipid-lowering agents for hyperlipidemia, and dietary sodium restriction (approximately 2 g of sodium/day) (Kelepouris & Rovin, 2019).

Nursing Management

In the early stages of nephrotic syndrome, nursing management is similar to that of the patient with acute glomerulonephritis, but as the condition worsens, management is similar to that of the patient with ESKD (see the following section).

Patients with nephrotic syndrome need adequate education about the importance of following all medication and dietary regimens so that their condition can remain stable for as long as possible. Patients must be educated about the importance of promptly communicating any health-related change to their primary providers so that appropriate medication and dietary changes can be made before further changes occur within the glomeruli.

Polycystic Kidney Disease

Polycystic kidney disease (PKD) is a genetic disorder characterized by the growth of numerous fluid-filled cysts in the kidneys, which destroy the nephrons. PKD cysts can profoundly enlarge the kidneys while replacing much of the normal structure, resulting in reduced kidney function and leading to kidney failure (Mahaffey, 2017).

Pathophysiology

Patients with PKD can also have cysts in the liver and pancreas, aneurysms in blood vessels in the brain, and cardiovascular abnormalities. The number of cysts and the resulting complications distinguish PKD from the usually harmless cysts that can form in the kidneys in later years of life.

PKD is the most common inherited genetic cause of kidney failure (Bolignano, Palmer, Ruospo, et al., 2015). Two major inherited forms of PKD exist: autosomal dominant PKD and autosomal recessive PKD.

- Autosomal dominant PKD is the most common inherited form (90%). There are two subtypes. PKD1 has a mutation on chromosome 16 and is the most prevalent form with 78% of patients having this mutation. The second subtype is PKD2 with a mutation on chromosome 4. PKD2 progresses more slowly than PKD1. The average age for patients to progress to ESKD is 54.3 years among patients with PKD1 versus 74.0 years among patients with PKD2 (Torres & Bennett, 2019).
- Autosomal recessive PKD is a rare inherited form (10%) of PKD. Symptoms of autosomal recessive PKD begin in the earliest months of life or in utero. Since the gene is recessive, both parents are carriers but neither parent is affected (Mahaffey, 2017).

Clinical Manifestations

Signs and symptoms of PKD result from loss of renal function and the increasing size of the kidneys as the cysts grow. Kidney damage can result in hematuria, hypertension, and development of renal calculi with associated UTIs and proteinuria. As the cysts grow in size and number, the patient reports increasing abdominal fullness and flank pain (back and lower sides).

Assessment and Diagnostic Findings

PKD is a genetic disease; therefore, a careful evaluation of family history is necessary. Palpation of the abdomen will often reveal enlarged cystic kidneys. Ultrasound imaging of the kidneys is the preferred technique for diagnosis.

Genetic testing is performed if imaging results are uncertain (Torres & Bennett, 2019).

Medical Management

PKD has no cure, but tolvaptan slows the decrease in kidney function in patients with PKD. The most common side effects are **polyuria** (excessive urine production) and rare, but potentially serious liver injury, which is most often reversible when the drug is stopped (Comerford & Durkin, 2020). Other treatments are largely supportive and include blood pressure control, pain management, and antibiotic agents to resolve infections. Once the kidneys fail, RRT is indicated (see later discussion in chapter). Genetic studies and counseling may be indicated, particularly when screening family members for potential kidney donation (Torres & Bennett, 2019).

RENAL CANCER

Renal cancer is relatively rare in the United States and accounts for about 4.2% of all cancers. However, an increased incidence of renal cancer at all stages has been noted in the past two decades (National Cancer Institute, 2019). This increase may be due to improved detection as a result of incidental findings during other diagnostic tests. The incidence of renal cell carcinoma is higher in men and in individuals with an increased body mass index. Tobacco use continues to be a significant risk factor (see Chart 48-3). In addition, African Americans have higher rates of renal cancer than Caucasians (Conde & Workman, 2017).

Ninety percent of renal cancers derive from the renal parenchyma and are known as renal cell carcinomas or renal adenocarcinomas. Between 70% and 80% of all renal cell carcinomas are clear cell carcinoma (also known as conventional or nonpapillary) and arise from the proximal renal tubule. The next most prevalent form (10%) is papillary renal cell carcinomas (American Cancer Society [ACS], 2020). These tumors may metastasize to the lungs, abdominal and mediastinal lymph nodes, brain, bone, and liver; metastatic disease is seen in 30% of patients at diagnosis (ACS, 2020).

Chart 48-3 RISK FACTORS

Renal Cancer

African American Race
Certain medications such as diuretics and other medications for hypertension
Genetic factors
Hypertension
Male gender
Obesity
Occupational exposure to industrial chemicals, such as heavy metals (cadmium), some herbicides, and organic solvents (e.g., trichloroethylene)
Smoking

Adapted from American Cancer Society (ACS). (2020). Kidney cancer. Retrieved on 1/11/2020 at: www.cancer.org/cancer/kidney-cancer/causes-risks-prevention/what-causes.html

Staging is based on tumor size, lymph node involvement, and distant metastasis. The 5-year survival rate based on the stage of renal cancer at diagnosis is 92% with only local involvement, 65% with regional spread, and 12% with distant metastases (Conde & Workman, 2017). Although enhanced imaging techniques account for improved detection of early-stage kidney cancer, it is unknown why the rate of late-stage, metastatic renal cancers is high. Over 50% of renal cancers are found incidentally on radiologic studies in individuals who have no symptoms (Conde & Workman, 2017).

Clinical Manifestations

Many renal tumors produce no symptoms and are discovered on a routine physical examination as a palpable abdominal or flank mass. Signs and symptoms, which occur in only 10% of patients, include hematuria, pain, and a mass in the flank. The usual sign that first calls attention to the tumor is painless hematuria, which may be either intermittent and microscopic, or continuous and overt (gross hematuria) (Conde & Workman, 2017). There may be a dull pain in the back from the pressure produced by compression of the ureter, extension of the tumor into the perirenal area, or hemorrhage into the kidney tissue. Colicky pains occur if a clot or mass of tumor cells passes down the ureter. Symptoms from metastasis may be the first manifestations of a renal tumor and may include unexplained weight loss, fatigue, and anemia.

Assessment and Diagnostic Findings

The diagnosis of a renal tumor may require IV urography, cystoscopic examination, renal angiograms, ultrasonography, or a CT or MRI scan (see Chapter 47). These tests may be exhausting for patients already debilitated by the systemic effects of a tumor as well as for older patients and those who are anxious about the diagnosis and outcome. The nurse assists the patient to prepare physically and psychologically for these procedures and monitors carefully for signs and symptoms of dehydration and impaired coping.

Medical Management

The goal of medical management is to detect the tumor early and to eradicate tumors before metastasis occurs. Treatment most often includes a combination of surgery and pharmacologic management. Radiation therapy may be used for palliation in patients who are not candidates for surgery or other treatments or in those with metastatic disease (ACS, 2020).

Surgical Management

Nephrectomy

Open, laparoscopic, or robotic surgical procedures are utilized for radical and partial nephrectomies (ACS, 2020). A radical nephrectomy is the primary treatment if the tumor can be removed and if the tumor has spread to the inferior vena cava (Conde & Workman, 2017). This includes removal of the kidney (and tumor), adrenal gland, surrounding perinephric fat and Gerota fascia, and lymph nodes. Laparoscopic nephrectomy can be performed for removal of the kidney with a small tumor. This procedure incurs less morbidity and a shorter recovery time. Radiation therapy, hormonal therapy, or immunotherapy may be used along with surgery. Nephron-sparing surgery, or partial nephrectomy, is increasingly being used to treat patients with bilateral tumors, cancer of a functional single kidney, and for small local tumors with a normal contralateral kidney. This is the preferred surgery for local disease as well as for those individuals with risk factors for CKD. The success rate of partial nephrectomies is excellent with operative morbidity and mortality both low (Richie, Atkins, & Chen, 2019).

Renal Artery Embolization

In patients with metastatic renal carcinoma, the renal artery may be occluded to impede the blood supply to the tumor and thus kill the tumor cells. After angiographic studies are completed, a catheter is advanced into the renal artery, and embolizing materials (e.g., Gelfoam, autologous blood clot, steel coils) are injected into the artery and carried with the arterial blood flow to occlude the tumor vessels mechanically. This decreases the local blood supply, making nephrectomy easier. After renal artery embolization and tumor infarction, a characteristic symptom complex called postinfarction syndrome occurs, lasting

2 to 3 days. The patient has pain localized to the flank and abdomen, elevated temperature, and gastrointestinal (GI) symptoms. Pain is treated with parenteral analgesic agents, and acetaminophen is given to control fever. Antiemetic medications, restriction of oral intake, and IV fluids are used to treat the GI symptoms.

Minimally Invasive Technologies

Radiofrequency ablation, cryoablation, or microwave ablation are minimally invasive technologies performed by urologists or interventional radiologists. They are used instead of surgery in select patients for many types of tumors, including renal cell carcinomas. In renal cell carcinomas these nephron-sparing procedures can be used for either small, localized renal tumors, if patients are poor surgical candidates and/or to preserve renal function. In these procedures, temperature extremes are used to kill tumor cells (Hines & Goldberg, 2018).

Pharmacologic Therapy

Depending on the stage of the tumor, partial or radical nephrectomy may be followed by treatment with immunotherapy. Standard chemotherapy has not improved survival rates and is only used for those patients in whom immunotherapy has not been successful (ACS, 2020). For stage IV clear cell renal cell carcinomas, treatment with biologic response modifiers such as interleukin 2 (IL-2) and interferon has largely been replaced by targeted therapies, antiangiogenic therapy, and checkpoint inhibitors (George & Jonasch, 2019).

Experimental approaches to stimulate the host immune recognition of tumor through autologous tumor cell immunotherapy are being actively pursued in patients with stage IV renal cell carcinomas (George & Jonasch, 2019).

Nursing Management

The patient with a renal tumor usually undergoes extensive diagnostic and therapeutic procedures. Treatments may include surgery, radiation therapy, and immunotherapy. After surgery, the patient usually has catheters and drains in place to maintain a patent urinary tract, to remove drainage, and to permit accurate measurement of urine output. Because of the location of the surgical incision, the patient's position during surgery, and the nature of the surgical procedure, pain and muscle soreness are common. Pharmacologic management may include immunotherapy agents. Therefore, patients are monitored for infection.

The patient requires frequent analgesia during the postoperative period and assistance with turning, coughing, the use of incentive spirometry, and deep breathing to prevent atelectasis and other pulmonary complications (see Chapter 19). The patient and family require assistance and support to cope with the diagnosis and uncertain prognosis. See discussion later in this chapter of postoperative care of the patient undergoing kidney surgery and Chapter 12 for discussion of care of the patient with cancer.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

The nurse educates the patient and family about how to inspect and care for the incision and to perform other general postoperative care including activity, lifting and driving restrictions, and pain management. Instructions are provided about when to notify the primary provider about problems (e.g., fever, respiratory difficulty, wound drainage, blood in the urine, pain or swelling of the legs).

The nurse encourages the patient to eat a healthy diet and to drink adequate liquids to avoid constipation and to maintain an adequate urine volume. Stool softeners, mild stimulants (e.g., senna), and polyethylene glycol may also be prescribed to avoid constipation. Education and emotional support are provided related to the diagnosis, treatment, and continuing care because many patients are concerned about the loss of the other kidney, the possible need for dialysis, or the recurrence of cancer.

Continuing and Transitional Care

Follow-up care is essential to detect any signs of metastases and to reassure the patient and family about the patient's status and well-being. The patient who has had surgery for renal carcinoma should have a yearly physical examination and chest x-ray, because late metastases are not uncommon (George & Jonasch, 2019). All subsequent symptoms should be evaluated with possible metastases in mind.

If follow-up immunotherapy is necessary, the patient and family are informed about the treatment plan or immunotherapy protocol, what to expect with each visit, and when to notify the primary provider. Evaluation of remaining renal function (creatinine clearance, BUN, and serum creatinine levels) may also be carried out periodically. A home health nurse may monitor the patient's physical status and psychological well-being and coordinate other indicated services and resources.

KIDNEY DISEASE

Kidney disease results when the kidneys cannot remove the body's metabolic wastes or perform their regulatory functions. The substances normally eliminated in the urine accumulate in the body fluids as a result of impaired renal excretion, affecting endocrine and metabolic functions as well as resulting in fluid, electrolyte, and acid–base disturbances. Kidney disease is a systemic disease and a final common pathway of many different kidney and urinary tract diseases. The impact of kidney failure in the United States continues to increase due to the aging of the U.S. population and the increasing incidence of obesity and diabetes (USRDS, 2019).

Acute Kidney Injury

Acute kidney injury (AKI) is a rapid loss of renal function due to damage to the kidneys. Depending on the duration and severity of AKI, a wide range of potentially life-threatening metabolic complications can occur, including metabolic acidosis as well as fluid and electrolyte imbalances. Treatment is aimed at replacing renal function temporarily to minimize potentially lethal complications and reduce potential causes of increased kidney injury with the goal of minimizing long-term loss of renal function.

AKI is a problem seen in patients who are hospitalized and those in outpatient settings. A widely accepted criterion for AKI is a 50% or greater increase in serum creatinine above baseline (normal creatinine is less than 1 mg/dL) (The Acute Dialysis Quality Initiative, 2004). Urine volume may be normal, or changes may occur including nonoliguria (greater than 800 mL/day), **oliguria** (less than 400 mL/day or 0.5 mL/kg/h over 6 hours), or **anuria** (less than 50 mL/day) (Odom, 2017).

COVID-19 Considerations

The coronavirus disease 2019 (COVID-19) pandemic began in Wuhan, China, in late 2019. Since that time, several risks for both severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and pathogenesis to COVID-19 have been identified (see Chapter 66, Chart 66-8). Findings from a retrospective, single-center study of 1392 patients hospitalized with COVID-19 in Wuhan, China, reported that 7% developed AKI during hospitalization (Cheng, Luo, Wang, et al., 2020). Factors associated with high risk of developing AKI included more severe disease, a high serum creatinine at baseline, lymphopenia, and elevated D-dimer level (Cheng et al., 2020). Patients who developed AKI were more likely to be admitted to an intensive care unit and had a higher mortality rate compared to patients who did not develop AKI. Of those patients who survived to be discharged from the hospital, 68% recovered from AKI (Cheng et al., 2020).

Pathophysiology

Although the pathogenesis of AKI and oliguria is not always known, many times there is a specific underlying cause. Some of the factors may be reversible if identified and treated promptly, before kidney function is impaired. This is true of the following conditions that reduce blood flow to the kidney and impair kidney function: hypovolemia; hypotension; reduced cardiac output and heart failure; obstruction of the kidney or lower urinary tract by tumor, blood clot, or kidney stone; and bilateral obstruction of the renal arteries or veins. If these conditions are treated and corrected before the kidneys are permanently damaged, the increased BUN and creatinine levels, oliguria, and other signs may be reversed.

Although renal stones are not a common cause of AKI, some recurrent types may increase the risk of AKI. Some hereditary stone diseases (see Chapter 49), primary struvite stones, and infection-related urolithiasis associated with anatomic and functional urinary tract anomalies and spinal cord injury may cause repeated bouts of obstruction as well as crystal-specific damage to tubular epithelial cells and interstitial renal cells (Odom, 2017).

Classifications of Acute Kidney Injury

The term acute kidney injury has replaced the term acute renal failure because it better describes this syndrome, in both those who require RRT and also in those patients who experience minor changes in renal function. Classification criteria for AKI include assessment of three grades of severity and two outcome-level classifications. This 5-point system is known as the RIFLE classification system. RIFLE stands for *risk, injury, failure, loss, and ESKD* (Bellomo et al., 2004). Risk, injury, and failure are considered grades of AKI severity, whereas loss and ESKD are considered outcomes of loss that require some form of RRT, at least temporarily (Bellomo et al., 2004). Table 48-2 lists the classification criteria for the RIFLE system for AKI (Bellomo et al., 2004). This classification system is used by health care professionals to identify kidney injury and improve patient outcomes. A diagnosis of AKI results in significantly longer hospital stays, has an increased mortality rate, and is a major risk factor for the development of CKD (Medel-Herrero, Mitchell, & Moyce, 2019).

Categories of Acute Kidney Injury

The major categories of AKI are prerenal (hypoperfusion of kidney), intrarenal (actual damage to kidney tissue), and postrenal (obstruction to urine flow). Prerenal AKI, which occurs in 60% to 70% of cases, is the result of impaired blood flow that leads to hypoperfusion of the kidney commonly caused by volume depletion (burns, hemorrhage, GI losses), hypotension (sepsis, shock), and obstruction of renal vessels, ultimately leading to a decrease in the GFR (Odom, 2017). Intrarenal or intrinsic AKI is the result of actual parenchymal damage to the glomeruli or kidney tubules. **Acute tubular necrosis (ATN)**, or

AKI in which there is damage to the kidney tubules, is the most common type of intrinsic AKI. Characteristics of ATN are intratubular obstruction, tubular back leak (abnormal reabsorption of filtrate and decreased urine flow through the tubule), vasoconstriction, and changes in glomerular permeability. These processes result in a decrease of GFR, progressive azotemia, and fluid and electrolyte imbalances. CKD, diabetes, heart failure, hypertension, and cirrhosis can contribute to ATN. Postrenal AKI usually results from obstruction distal to the kidney by conditions such as renal calculi, strictures, blood clots, benign prostatic hyperplasia, malignancies, and pregnancy. Pressure rises in the kidney tubules, and eventually the GFR decreases. Common causes of each type of AKI are further summarized in Chart 48-4.

TABLE 48-2 The RIFLE Classification for Acute Kidney Injury

Class	GFR Criteria	Urinary Output Criteria
R (Risk)	Increased serum creatinine 1.5 × baseline OR GFR decreased ≥25%	0.5 mL/kg/h for 6 hrs
I (Injury)	Increased serum creatinine 2 × baseline OR GFR decreased ≥50%	0.5 mL/kg/h for 12 hrs
F (Failure)	Increased serum creatinine 3 × baseline OR GFR decreased ≥75% OR Serum creatinine ≥354 mmol/L with an acute rise of at least 44 mmol/L	<0.3 mL/kg/h for 24 hrs OR Anuria for 12 hrs
L (Loss)	Persistent acute kidney injury = complete loss of kidney function >4 wks	
E (ESKD)	ESKD >3 mo	

ESKD, end-stage kidney disease; GFR, glomerular filtration rate.

Adapted from Bellomo, R., Ronco, C., Kellum, J. A., et al. (2004). Acute renal failure-definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. *Critical Care*, *8*, B204.

Phases of Acute Kidney Injury

There are four phases of AKI: initiation, oliguria, diuresis, and recovery.

- The initiation period begins with the initial insult and ends when oliguria develops.
- The oliguria period is accompanied by an increase in the serum concentration of substances usually excreted by the kidneys (urea, creatinine, uric acid, organic acids, phosphorus, and the intracellular

cations [potassium and magnesium]). The minimum amount of urine needed to rid the body of normal metabolic waste products is approximately 400 mL in 24 hours or 0.5 mL/kg/h over 6 hours. In this phase, uremic symptoms first appear and life-threatening conditions such as hyperkalemia develop.

- The diuresis period is marked by a gradual increase in urine output, which signals that glomerular filtration has started to recover. Laboratory values stabilize and eventually decrease. Although the volume of urinary output may reach normal or elevated levels, renal function may still be markedly abnormal, since the filtration of urea and creatinine has not yet commenced. Because uremic symptoms may still be present, the need for expert medical and nursing management continues. The patient must be observed closely for dehydration during this phase; if dehydration occurs, the uremic symptoms are likely to increase and an elevated serum BUN and creatinine will be noted.
- The recovery period signals the improvement of renal function and may take 3 to 12 months. Laboratory values return to the patient's normal level. Although a permanent 1% to 3% reduction in the GFR may occur, it is not clinically significant. However, in those patients with preexisting CKD, an episode of AKI may necessitate beginning CRRT.

Chart 48-4

Causes of Acute Kidney Injury

Prerenal Failure

- Volume depletion resulting from:
  - Gastrointestinal losses (vomiting, diarrhea, nasogastric suction)
  - Hemorrhage
  - Renal losses (diuretic agents, osmotic diuresis)
- Impaired cardiac efficiency resulting from:
  - Arrhythmias
  - Cardiogenic shock
  - Heart failure
  - Myocardial infarction
- Vasodilation resulting from:
  - Anaphylaxis
  - Antihypertensive medications or other medications that cause vasodilation
  - Sepsis

Intrarenal Failure

- Prolonged renal ischemia resulting from:
  - Hemoglobinuria (transfusion reaction, hemolytic anemia)
  - Pigment nephropathy (associated with the breakdown of blood cells containing pigments that in turn occlude kidney structures)
  - Rhabdomyolysis/myoglobinuria (trauma, crush injuries, burns)
- Nephrotoxic agents such as:
  - Aminoglycoside antibiotics (gentamicin, tobramycin)
  - Angiotensin-converting enzyme inhibitors
  - Heavy metals (lead, mercury)
  - Nonsteroidal anti-inflammatory drugs
  - Radiopaque contrast agents
  - Solvents and chemicals (ethylene glycol, carbon tetrachloride, arsenic)
- Infectious processes such as:
  - Acute glomerulonephritis
  - Acute pyelonephritis

Postrenal Failure

- Urinary tract obstruction, including:
  - Benign prostatic hyperplasia
  - Blood clots
  - Calculi (stones)
  - Strictures
  - Tumors

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Some patients have decreased renal function with increasing nitrogen retention but actually excrete normal amounts of urine (1 to 2 L/day). This is the nonoliguric form of kidney injury and occurs predominantly after exposure of the patient to **nephrotoxic** agents (any substance or medication that damages kidney tissue), burns and traumatic injury.

Clinical Manifestations

Almost every system of the body is affected with failure of the normal renal regulatory mechanisms. The patient may appear critically ill and lethargic. Central nervous system signs and symptoms include drowsiness, headache, muscle twitching, and seizures. Table 48-3 summarizes common clinical characteristics in all three categories of AKI.

TABLE 48-3 Comparing Clinical Characteristics of Acute Kidney Injury

Characteristics	Categories		
	Prerenal	Intrarenal	Postrenal
Etiology	Hypoperfusion due to shock, hypovolemia	Parenchymal damage	Obstruction
Blood urea nitrogen value	↑ (out of normal 20:1 proportion to creatinine)	↑	↑
Creatinine	↑	↑	↑
Urine output	↓	Varies, often ↓	Varies, may be ↓, or sudden anuria
Urine sodium	↓ to <20 mEq/L	↑ to >40 mEq/L	Varies, often ↓ to ≤20 mEq/L
Urinary sediment	Normal, few hyaline casts	Abnormal casts and debris	Usually normal
Urine osmolality	↑ to 500 mOsm	~350 mOsm, similar to serum	Varies, ↑ or equal to serum
Urine specific gravity	↑	Low normal	Varies

↑, increased; ↓, decreased.

Assessment and Diagnostic Findings

Assessment of the patient with AKI includes evaluation for changes in the urine, diagnostic tests that evaluate the kidney contour, and a variety of laboratory values. See Chapter 47 for information about the normal characteristics of urine, diagnostic findings, and laboratory values in the renal system.

In AKI, urine output varies from scanty to a normal volume, hematuria may be present, and the urine has a low specific gravity (compared with a normal value of 1.010 to 1.025). One of the earliest manifestations of tubular damage is the inability to concentrate the urine (Odom, 2017). Patients with prerenal azotemia have a decreased amount of sodium in the urine (less than 20 mEq/L) and normal urinary sediment. Patients with intrarenal azotemia usually have increased urinary sodium levels greater than 40 mEq/L with **urinary casts** and other cellular debris.

Ultrasonography is a critical component of the evaluation of patients with kidney disease. A renal sonogram or a noncontrast CT scan may show evidence of anatomic changes.

The BUN level increases steadily at a rate that depends on the degree of catabolism (breakdown of protein), renal perfusion, and protein intake. Serum creatinine levels are useful in monitoring kidney function and disease progression and increase with glomerular damage.

With a decline in the GFR, oliguria, and anuria, patients are at high risk for hyperkalemia. Protein catabolism results in the release of cellular potassium into the body fluids, causing severe hyperkalemia (high serum potassium levels). Hyperkalemia may lead to cardiac arrhythmias, such as ventricular tachycardia and cardiac arrest. Sources of potassium include normal tissue catabolism, dietary intake, blood in the GI tract, or blood transfusion and other sources (e.g., IV infusions, potassium penicillin, and extracellular shift in response to metabolic acidosis).

Progressive metabolic acidosis occurs in kidney disease because patients cannot eliminate the daily metabolic load of acid-type substances produced by the normal metabolic processes. In addition, normal renal buffering mechanisms fail. This is reflected by decreased serum carbon dioxide (CO_2) and pH levels.

Blood phosphorus concentrations may increase; calcium levels may be low due to decreased absorption of calcium from the intestine and as a compensatory mechanism for the elevated blood phosphate levels. Anemia is another common laboratory finding in AKI, as a result of reduced erythropoietin production, uremic GI lesions, reduced RBC lifespan, and blood loss from the GI tract.

Prevention

AKI has a high mortality rate that ranges from 10% to 80%. Factors that influence mortality include severity of kidney injury, level and availability of medical care, requirements for RRT, increased age, increased number of comorbid conditions, and preexisting kidney and vascular diseases and respiratory failure (Odom, 2017). Therefore, prevention of AKI is essential (see Chart 48-5).

A careful history is obtained to identify exposure to nephrotoxic agents or environmental toxins. The kidneys are susceptible to the adverse effects of medications because the metabolic by-products of most medications are excreted by the kidneys. Patients taking nephrotoxic medications (e.g., aminoglycosides, such as gentamicin and tobramycin, polymyxin B, amphotericin B, vancomycin, amikacin, cyclosporine, tacrolimus) should have drug levels monitored closely, since high serum levels will cause changes in renal function. Kidney function needs to be monitored prior to initiation of these medications and during therapy (Schira, 2017).

Chart 48-5

Preventing Acute Kidney Injury

- Continually assess renal function (urine output, laboratory values) when appropriate.
- Monitor central venous and arterial pressures and hourly urine output of patients who are critically ill to detect the onset of kidney dysfunction as early as possible.
- Pay special attention to wounds, burns, and other precursors of sepsis.
- Prevent and treat infections promptly. Infections can produce progressive kidney damage.
- Prevent and treat hypotensive shock promptly with blood and fluid replacement.
- Provide adequate hydration to patients at risk for dehydration, including:
    - Before, during, and after surgery
    - Patients undergoing intensive diagnostic studies requiring fluid restriction and contrast agents (e.g., barium enema, IV pyelograms), especially older patients who may have marginal renal reserve or CKD
    - Patients with neoplastic disorders or disorders of metabolism (e.g., gout) and those receiving chemotherapy with potential tumor lysis syndrome
    - Patients with skeletal muscle injuries (e.g., crush injuries, compartment syndrome)
    - Patients with heat-induced illnesses (e.g., heat stroke, heat exhaustion)
- To prevent infections from ascending in the urinary tract, give meticulous care to patients with indwelling catheters. Remove catheters as soon as possible.
- To prevent toxic drug effects, closely monitor dosage, duration of use, and blood levels of all medications metabolized or excreted by the kidneys.

Chronic use of analgesic agents, particularly NSAIDs, may cause **interstitial nephritis** (inflammation within the renal tissue) and papillary necrosis. Patients with heart failure or cirrhosis with ascites are at particular risk for NSAID-induced kidney disease. Increased age, preexisting kidney disease, diabetes, and the simultaneous administration of several nephrotoxic agents increase the risk of kidney damage (Schira, 2017; Schonder, 2017).

Contrast-induced acute kidney injury is a major cause of hospital-acquired AKI. However, this is potentially preventable in many, but not all, cases. Patients at high risk for the development of contrast-induced AKI are those with CKD and/or elevated creatinine due to dehydration. Those who need to undergo a coronary interventional procedure, which requires larger amounts of contrast media to be given, are at the greatest risk. Limiting the patient's exposure to contrast agents and nephrotoxic medications will reduce the risk of contrasted-induced AKI. Prehydration with IV normal saline is considered the most effective method to prevent contrast-induced AKI. N-acetylcysteine administration is no longer recommended as a preventative measure (Nahar, 2017).

Gerontologic Considerations

About half of all patients who develop AKI during hospitalization are older than 60 years and 40% have diabetes (Pavkov, Harding, & Burrows, 2018). The etiology of AKI in older adults includes prerenal causes such as dehydration, intrarenal causes such as nephrotoxic agents (e.g., medications, contrast agents), and complications of major surgery (Hain, 2017). Suppression of thirst, enforced bed rest, lack of access to drinking water, and confusion all contribute to the older patient's failure to consume adequate fluids and may lead to dehydration, further compromising already decreased renal function.

AKI in older adults is also often seen in the community setting. Nurses in the ambulatory setting need to be aware of the risk to patients taking medications that could result in damage to the kidney either through reduced circulation or nephrotoxicity. Outpatient procedures that require fasting or a bowel preparation may cause dehydration and, therefore, patients undergoing such procedures need careful monitoring.

Medical Management

The kidneys have a remarkable ability to recover from insult. The objectives of treatment for AKI are to restore normal chemical balance and prevent complications until repair of renal tissue and restoration of renal function can occur. Management includes eliminating the underlying cause; maintaining fluid balance; avoiding fluid excesses; and, when indicated, providing RRT. Prerenal azotemia is treated by optimizing renal perfusion, whereas postrenal failure is treated by relieving the obstruction. Intrarenal or intrinsic azotemia is treated with supportive therapy, with removal of causative agents, aggressive management of pre- and postrenal failure, and avoidance of associated risk factors. Shock and infection, if present, are treated promptly (see Chapter 11). The patient who has had a crush injury, compartment syndrome, or heat-induced illness with subsequent myoglobinuria (myoglobin in the urine) is treated for rhabdomyolysis (Odom, 2017) (see Chapter 67).

Maintenance of fluid balance is based on daily body weight, serial measurements of central venous pressure, serum and urine concentrations, fluid intake and output, blood pressure, and the clinical status of the patient. The parenteral and oral intake and the output of urine, gastric drainage, stools, wound drainage, and perspiration are calculated and are used as the basis for fluid replacement. The insensible fluid produced through the normal metabolic processes and lost through the skin and lungs is also considered in fluid management.

Fluid excesses can be detected by the clinical findings of dyspnea, tachycardia, and distended neck veins. The patient's lungs are auscultated for moist crackles. Because pulmonary edema may be caused by excessive administration of parenteral fluids, extreme caution must be used to prevent fluid overload. The development of generalized edema is assessed by examining the presacral and pretibial areas several times daily. Furosemide or bumetanide, both loop diuretics, may be prescribed to initiate diuresis, although there is no consensus regarding the use of loop diuretics in AKI (Odom, 2017).

Adequate renal blood flow in patients with prerenal causes of AKI may be restored by IV fluids or transfusions of blood products. If AKI is caused by hypovolemia secondary to hypoproteinemia, an infusion of albumin may be prescribed. Dialysis may be initiated to prevent complications of AKI, such as hyperkalemia, metabolic acidosis, pericarditis, and pulmonary edema. Dialysis corrects many biochemical abnormalities; allows for liberalization of fluid, protein, and sodium intake; diminishes bleeding tendencies; and promotes wound healing. **Hemodialysis (HD)** (a procedure that circulates the patient's blood through an artificial kidney [dialyzer] to remove waste products and excess fluid), **peritoneal dialysis (PD)**; a procedure that uses the patient's peritoneal membrane (the lining of the peritoneal cavity) as the semipermeable membrane to exchange fluid and solutes, or a variety of **continuous renal replacement therapy (CRRT)** (methods used to replace normal kidney function by circulating the patient's blood through a hemofilter) may be performed (Odom, 2017). These and other treatment modalities for patients with renal dysfunction are discussed later in this chapter.

Pharmacologic Therapy

Hyperkalemia is the most life-threatening of the fluid and electrolyte changes that occur in patients with kidney disorders. Therefore, the patient is monitored for hyperkalemia through serial serum electrolyte levels (potassium value greater than 5.0 mEq/L [5 mmol/L]), ECG changes (tall, tented, or peaked T waves), and changes in clinical status (see Chapter 10). Other symptoms of hyperkalemia include irritability, abdominal cramping, diarrhea, paresthesia, and generalized muscle weakness. Muscle weakness may present as slurred speech, difficulty breathing, paresthesia, and paralysis. As the potassium level increases, both cardiac and other muscular function declines, making this a medical emergency.

The elevated potassium levels may be reduced by administering cation-exchange resins such as sodium polystyrene sulfonate orally or by retention enema that works by exchanging sodium ions for potassium ions in the intestinal tract. The slow onset of action of more than 6 hours limits its use to those patients without emergent hyperkalemia causing ECG changes. Sorbitol may be given in combination with sodium polystyrene sulfonate to induce a diarrhea-type effect (by inducing water loss in the GI tract). If a sodium polystyrene sulfonate retention enema is given (the colon is the major site of potassium exchange), a rectal catheter with a balloon may be used to facilitate retention if necessary (Schonder, 2017). Afterward, a cleansing enema may be prescribed to remove remaining medication as a precaution against fecal impaction.

If the patient is experiencing ECG changes, IV dextrose 50%, insulin, and calcium replacement may be given to shift potassium back into the cells. Since the medications are administered IV, they take effect quickly. The shift of potassium into the intracellular space is temporary, so arrangements for dialysis need to be made on an emergent basis. The capillary glucose level is monitored for hypoglycemia with insulin administration (Ross, Nissenson, & Daugirdas, 2015).

Many medications are eliminated through the kidneys; therefore, dosages must be reduced when a patient has AKI. Examples of commonly used agents that require adjustment are antibiotic medications (especially aminoglycosides), digoxin, phenytoin, ACE inhibitors, and magnesium-containing agents.

In patients with severe acidosis, the arterial blood gases and serum bicarbonate levels must be monitored because the patient may require sodium bicarbonate therapy or dialysis. If respiratory problems develop, appropriate ventilatory measures must be instituted. The elevated serum phosphorus level may be controlled with phosphate-binding agents (e.g., calcium or lanthanum carbonate) that help prevent a continuing rise in serum phosphorus levels by binding with the phosphate from food in the intestinal tract and eliminating it in the stool, thus preventing absorption (Schonder, 2017).

Nutritional Therapy

AKI causes severe nutritional imbalances (because nausea and vomiting contribute to inadequate dietary intake), impaired glucose use and protein synthesis, and increased tissue catabolism. The patient is weighed daily and loses 0.2 to 0.5 kg (0.5 to 1 lb) daily if the nitrogen balance is negative (i.e., caloric intake falls below caloric requirements). If the patient gains or does not lose weight or develops hypertension, fluid retention should be suspected.

Nutritional support is based on the underlying cause of AKI, the catabolic response, the type and frequency of RRT, comorbidities, and nutritional status. Replacement of dietary proteins is individualized to provide the maximum benefit and minimize uremic symptoms. Caloric requirements are met with high-carbohydrate meals, because carbohydrates have a protein-sparing effect (i.e., in a high-carbohydrate diet, protein is not used for meeting energy requirements but is "spared" for growth and tissue healing). Foods and fluids containing sodium, potassium, or phosphorus (e.g., bananas, citrus fruits and juices, dairy foods) are restricted.

The oliguric phase of AKI may last 10 to 14 days and is followed by the diuretic phase, at which time urine output begins to increase, signaling the patient is in the recovery phase (Odom, 2017). Results of blood chemistry tests are used to determine the amounts of sodium, potassium, and water needed for replacement, along with assessment for over- or under hydration (daily weights). Following the diuretic phase, the patient is placed on a high-protein, high-calorie diet and is encouraged to resume activities gradually.

Nursing Management

The nurse has an important role in caring for the patient with AKI. The nurse monitors for complications, participates in emergency treatment of fluid and electrolyte imbalances, assesses the patient's progress and response to treatment, and provides physical and emotional support. In addition, the nurse keeps family members informed about the patient's condition, helps them understand the treatments, and provides psychological support. Although the development of AKI may be the most serious problem, the nurse continues to provide nursing care indicated for the primary disorder (e.g., burns, shock, trauma, obstruction of the urinary tract).

Monitoring Fluid and Electrolyte Balance

Because of the serious fluid and electrolyte imbalances that can occur with AKI, the nurse monitors the patient's serum electrolyte levels and physical indicators of these complications during all phases of the disorder. IV solutions must be carefully selected based on the patient's fluid and electrolyte status. The patient's cardiac function and musculoskeletal status are monitored closely for signs of hyperkalemia.

Quality and Safety Nursing Alert

Hyperkalemia is the most immediate life-threatening imbalance seen in AKI. Parenteral fluids, all oral intake, and all medications are screened carefully to ensure that sources of potassium are not inadvertently given or consumed.

The nurse monitors fluid status by paying careful attention to fluid intake (IV medications should be given in the smallest volume possible), urine output, apparent edema, distention of the jugular veins, alterations in heart sounds and breath sounds, and increasing difficulty in breathing. Accurate daily weights, as well as I&O records, are essential. Indicators of deteriorating fluid and electrolyte status are reported immediately to the primary provider, and preparation is made for emergency treatment. Severe fluid and electrolyte disturbances may be treated with HD, PD, or CRRT.

Reducing Metabolic Rate

The nurse takes steps to reduce the patient's metabolic rate. Fever and infection, both of which increase the metabolic rate and catabolism, are prevented and treated promptly; blood, urine and wound cultures are ordered as indicated.

Promoting Pulmonary Function

Attention is given to pulmonary function, and the patient is assisted to turn, cough, and take deep breaths frequently to prevent atelectasis and respiratory tract infection. Drowsiness and lethargy may prevent the patient from moving and turning without encouragement and assistance.

Preventing Infection

Asepsis is essential with invasive lines and catheters to minimize the risk of infection and increased metabolism. An indwelling urinary catheter is avoided whenever possible due to the high risk of UTI associated with its use, but may be required to provide ongoing data required to accurately monitor fluid I&O.

Providing Skin Care

The skin may be dry or susceptible to breakdown as a result of edema; therefore, meticulous skin care is important. In addition, excoriation and itching of the skin may result from the deposit of irritating toxins in the patient's tissues. Bathing the patient with cool water, frequent turning, and keeping the skin clean and well moisturized and the fingernails trimmed to avoid scratching are often comforting and prevent skin breakdown.

Providing Psychosocial Support

The patient with AKI may require treatment with HD, PD, or CRRT. The length of time that these treatments are necessary varies with the cause and extent of damage to the kidneys. The patient and family need assistance, explanation, and support during this period. The purpose of the treatment is explained to the patient and family by the primary provider. However, high levels of anxiety and fear may necessitate repeated explanation and clarification by the nurse. The family members may initially be afraid to touch and talk to the patient during these procedures but should be encouraged and assisted to do so.

In an intensive care setting, many of the nurse's functions are devoted to the technical aspects of patient care; however, it is essential that the psychological needs and other concerns of the patient and family be addressed. Continued assessment of the patient for complications of AKI and precipitating causes is essential (Odom, 2017).

End-Stage Kidney Disease or Chronic Kidney Disease

When a patient has sustained enough kidney damage to require RRT on a permanent basis, the patient has moved into the fifth or final stage of CKD, also referred to as ESKD. In 2017, 86.9% of patients newly diagnosed with ESKD began RRT with HD, 10.1% started with PD, and 2.9% received a preemptive kidney transplant. A preemptive transplant is when a patient undergoes kidney transplantation from a living donor before dialysis is initiated. Of great concern is that 33% of patients diagnosed with ESKD had received little or no pre-ESKD nephrology care and 19.2% received no nephrology care prior to requiring RRT. As of December 31, 2017, 62.7% of all patients previously diagnosed with ESKD were receiving HD therapy, 7.1% were being treated with PD, and 29.9% had a functioning kidney transplant. Among patients being treated with HD, 98.0% used in-center HD (USRDS, 2019).

In July 2019, the President, the U.S. Department of Health and Human Services (HHS) Secretary, and the Administrator of the Centers for Medicare and Medicaid Services (CMS) issued an Executive Order, with the goal of improving the lives of Americans with ESKD by expanding treatment options and reducing health care costs. As part of this Executive Order, a mandatory payment model promotes moving patients from in-center to home dialysis (both PD and home HD) and increasing the number of patients receiving kidney transplants. There is much work and policy development that will need to be done to reach this goal by the projected date of 2025 (Kear, Bednarski, Smith, et al., 2019).

Pathophysiology

As renal function declines, the end products of protein metabolism (normally excreted in urine) accumulate in the blood. Uremia develops and adversely affects every system in the body. The greater the buildup of waste products, the more pronounced the symptoms.

The rate of decline in renal function and progression of ESKD is related to the underlying disorder, the urinary excretion of protein, and the presence of hypertension. The disease tends to progress more rapidly in patients who excrete significant amounts of protein or have elevated blood pressure than in those without these conditions (Mahaffey, 2017).

Clinical Manifestations

Because virtually every body system is affected in ESKD, patients exhibit a number of signs and symptoms. The severity of these signs and symptoms depends in part on the degree of renal impairment, other underlying conditions, and the patient's age. Cardiovascular disease is the predominant cause of death in patients with ESKD (Subbiah et al., 2016). Peripheral neuropathy, a disorder of the peripheral nervous system, is present in some patients, especially those with diabetes. Patients complain of severe pain and discomfort. Restless leg syndrome and burning feet can occur in the early stage of uremic peripheral neuropathy. The precise mechanisms for many of these systemic signs and symptoms have not been identified. However, it is generally thought that the accumulation of uremic waste products is the probable cause. Chart 48-6 summarizes the systemic signs and symptoms.

Assessment and Diagnostic Findings

Glomerular Filtration Rate

As the GFR decreases (due to nonfunctioning glomeruli), the creatinine clearance decreases, whereas the serum creatinine and BUN levels increase. Serum creatinine is a more sensitive indicator of renal function than BUN. The BUN is affected not only by kidney disease but also by protein intake in the diet, catabolism (tissue and RBC breakdown), parenteral nutrition, and medications such as corticosteroids.

Sodium and Water Retention

The kidney cannot concentrate or dilute the urine normally in ESKD. Appropriate responses by the kidney to changes in the daily intake of water and electrolytes, therefore, do not occur. Some patients retain sodium and water, increasing the risk for edema, heart failure, and hypertension. Hypertension may also result from activation of the renin–angiotensin–aldosterone axis and the concomitant increased aldosterone secretion. Other patients have a tendency to lose sodium and run the risk of developing hypotension and hypovolemia. Vomiting and diarrhea may cause water depletion, which may worsen the uremic state.

Acidosis

Metabolic acidosis occurs in ESKD because the kidneys are unable to excrete increased loads of acid. Decreased acid secretion results from the inability of the kidney tubules to excrete ammonia (NH_3^-) and to reabsorb sodium bicarbonate (HCO_3^-). There is also decreased excretion of phosphorus and other organic acids.

Anemia

Anemia develops as a result of inadequate erythropoietin production, the shortened lifespan of RBCs, nutritional deficiencies, and the patient's tendency to bleed, particularly from the GI tract. Erythropoietin, a substance normally produced by the kidneys, stimulates bone marrow to produce RBCs. In ESKD, erythropoietin production decreases and profound anemia results, producing fatigue, angina, and shortness of breath (Evans, 2017).

Calcium and Phosphorus Imbalance

Another abnormality seen in ESKD is a disorder in calcium and phosphorus metabolism. Serum calcium and phosphate levels have a reciprocal relationship in the body: As one increases, the other decreases. With a decrease in filtration through the glomerulus of the kidney, there is an increase in the serum phosphorus level and a reciprocal or corresponding decrease in the serum calcium level. The decreased serum calcium level causes increased secretion of parathormone from the parathyroid glands. However, in kidney disease, the body cannot respond normally to the increased secretion of parathormone. As a result, calcium leaves the bone, often producing bone changes and bone disease as well as calcification of major blood vessels in the body. In addition, the active metabolite of vitamin D (1,25-dihydroxycholecalciferol) normally manufactured by the kidney decreases as kidney disease progresses (Brooks, 2017). Uremic bone disease, often called renal osteodystrophy, develops from the complex changes in calcium, phosphate, and parathormone balance. There is also evidence of calcification of blood vessels.

Chart 48-6 ASSESSMENT

Assessing for End-Stage Kidney Disease

Be alert to the following signs and symptoms:

Neurologic

- Asterixis
- Behavior changes
- Burning of soles of feet
- Confusion
- Disorientation
- Inability to concentrate
- Restlessness of legs
- Seizures
- Tremors
- Weakness and fatigue

Integumentary

- Coarse, thinning hair
- Dry, flaky skin
- Ecchymosis
- Gray-bronze skin color
- Pruritus
- Purpura
- Thin, brittle nails

Cardiovascular

- Engorged neck veins
- Hyperkalemia
- Hyperlipidemia
- Hypertension
- Pericardial effusion
- Pericardial friction rub
- Pericardial tamponade
- Pericarditis
- Periorbital edema
- Pitting edema (feet, hands, sacrum)

Pulmonary

- Crackles
- Depressed cough reflex
- Kussmaul-type respirations
- Pleuritic pain
- Shortness of breath

- Tachypnea
- Thick, tenacious sputum
- Uremic pneumonitis

Gastrointestinal

- Ammonia odor to breath ("uremic fetor")
- Anorexia, nausea, and vomiting
- Bleeding from gastrointestinal tract
- Constipation or diarrhea
- Hiccups
- Metallic taste
- Mouth ulcerations and bleeding

Hematologic

- Anemia
- Thrombocytopenia

Reproductive

- Amenorrhea
- Decreased libido
- Infertility
- Testicular atrophy

Musculoskeletal

- Bone fractures
- Bone pain
- Foot drop
- Loss of muscle strength
- Muscle cramps
- Renal osteodystrophy

Adapted from Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.

Complications

There are a number of potential complications of ESKD that necessitate a collaborative approach to care. These include the following:

- Anemia due to decreased erythropoietin production, decreased RBC lifespan, bleeding in the GI tract from irritating toxins and ulcer formation, and blood loss in the dialysis circuit and dialyzer after HD has been completed

- Bone disease and metastatic and vascular calcifications due to retention of phosphorus, low serum calcium levels, and abnormal vitamin D metabolism
- Hyperkalemia due to decreased excretion, metabolic acidosis, catabolism, and excessive potassium intake from diet, medications, or IV solutions
- Hypertension due to sodium and water retention and malfunction of the renin–angiotensin–aldosterone system
- Pericarditis, pericardial effusion, and pericardial tamponade due to retention of uremic waste products and inadequate dialysis

Medical Management

The goal of management is to maintain kidney function and homeostasis for as long as possible. All factors that contribute to ESKD and all factors that are reversible (e.g., obstruction) are identified and treated. Management is accomplished primarily with medications and diet therapy, although dialysis may also be needed to decrease the level of uremic waste products in the blood and to control electrolyte balance. The close collaboration of a renal dietitian is essential in dietary therapy.

Pharmacologic Therapy

Complications can be prevented or delayed with the appropriate medication. Phosphate-binding agents, calcium and vitamin D supplements, antihypertensive and cardiac medications, as well as recombinant human erythropoietin are frequently prescribed (Parikh et al., 2019).

Calcium and Phosphorus Binders

Hyperphosphatemia and hypocalcemia are treated with medications that bind dietary phosphorus in the GI tract. Binders such as calcium carbonate or calcium acetate are prescribed, but there is a risk of hypercalcemia. If calcium is high or the calcium–phosphorus product exceeds 55 mg/dL, a polymeric phosphate binder such as sevelamer carbonate may be prescribed (Schonder, 2017). This medication binds dietary phosphorus in the intestinal tract; one to four tablets are given with the first bite of food to be effective.

Antihypertensive and Cardiovascular Agents

Hypertension is managed by intravascular volume control and a variety of antihypertensive agents (Schonder, 2017). Heart failure and pulmonary edema may also require treatment with fluid restriction, low-sodium diets, diuretic agents, inotropic agents, and dialysis. The metabolic acidosis of ESKD usually produces no symptoms and requires no treatment. However, sodium bicarbonate supplements or dialysis may be needed to correct the acidosis if it causes symptoms.

Erythropoietin

Anemia associated with ESKD is treated with erythrocyte-stimulating agents (recombinant human erythropoietin). Patients with anemia present with nonspecific symptoms, such as malaise, general fatigability, and decreased activity tolerance. Erythrocyte stimulation therapy is initiated to achieve a target hemoglobin of 10 to 11 g/dL, which generally alleviates many of the symptoms of anemia without causing an increased risk of death and cardiovascular complications (Evans, 2017; Schonder, 2017).

Recombinant human erythropoietin may be administered IV or subcutaneously once or three times a week in ESKD. It will take 2 to 6 weeks for the hemoglobin to increase. Therefore, the medication is not indicated for patients who need immediate correction of severe anemia. Adverse effects seen with erythropoietin therapy include hypertension (especially during early stages of treatment), increased clotting of vascular access sites, seizures, cardiovascular events, and depletion of body iron stores (Evans, 2017; Schonder, 2017).

Management involves adjustment of heparin to prevent clotting of the lines during HD treatments and monitoring of hemoglobin and hematocrit, serum iron and transferrin levels. Prior to beginning therapy, iron studies are indicated and if iron deficiency is noted, a course of IV iron is prescribed since adequate stores of iron are needed for an adequate response. In addition, vitamin deficiencies are ruled out including folate or vitamin B_{12}. Common iron supplements include iron sucrose and ferric gluconate (Evans, 2017).

In addition, the patient's blood pressure and serum potassium level are monitored to detect hypertension and increasing serum potassium levels, which may occur with therapy and the increasing RBC mass. Recombinant erythropoietin therapy should be used cautiously in patients with uncontrolled hypertension (Schonder, 2017). The occurrence of hypertension requires initiation or adjustment of the patient's antihypertensive therapy.

Patients who have received erythropoietin therapy have reported decreased levels of fatigue, increased feelings of well-being, better tolerance of dialysis, higher-energy levels, and improved exercise tolerance (Evans, 2017). In addition, this therapy has decreased the need for transfusion and its associated risks, including bloodborne infectious disease, antibody formation, and iron overload (Evans, 2017).

Nutritional Therapy

A referral to a renal dietitian is essential. Dietary intervention is necessary with deterioration of renal function and includes careful regulation of protein intake, fluid intake to balance fluid losses, and restriction of potassium and sodium. At the same time, adequate caloric intake and vitamin supplementation must be ensured. Patients on dialysis need a higher intake of protein than healthy adults and current protein recommendations for stable patients on HD is 1.2 g/kg/day and PD is 1.2 to 1.3 g/kg/day (National Kidney Foundation Kidney Disease Outcomes Quality Initiative [NKF KDOQI], 2000). The allowed protein must be of high-biologic value (eggs, meats, fish). High–biologic-value proteins are those that are complete proteins and supply the essential amino acids necessary for growth and cell repair.

Usually, the fluid allowance per day for patients who receive in-center HD who are anuric is about 1000 mL daily. For those who produce urine, recommendations are individualized based on the patient's 24-hour urinary volume. This is done in order to limit interdialytic weight gains to less than 4% of estimated dry weight (Gonyea, 2017). Adequate calories are supplied by carbohydrates, protein, and fat to prevent wasting. In addition, the patient on dialysis loses water-soluble vitamins during the dialysis treatment, so an oral vitamin B and C supplement is prescribed to be taken after dialysis.

Hyperkalemia is usually prevented by ensuring adequate dialysis treatments with potassium removal and careful restriction of diet, medications, and fluids for their potassium content.

Dialysis

The patient with increasing symptoms of kidney disease is referred to a dialysis and transplantation center early in the course of progressive kidney disease. Dialysis is usually initiated when the patient cannot maintain a reasonable quality of life with conservative treatment.

Nursing Management

The patient with ESKD requires astute nursing care to avoid the complications of reduced renal function and the stresses and anxieties of dealing with a life-threatening illness.

Nursing care is directed toward assessing fluid status and identifying potential sources of imbalance, working with a renal dietitian to implement a dietary program to ensure proper nutritional intake within the limits of the treatment regimen, and engaging the patient by encouraging increased self-care and greater independence. It is extremely important to provide explanations and information to the patient and family concerning ESKD, treatment options, and potential complications. A great deal of emotional support is needed by the patient and family because of the numerous changes experienced. A social worker is also a vital part of the interprofessional care at the dialysis center. Specific interventions, along with rationale and evaluation criteria, are presented in more detail in the plan of nursing care for the patient with ESKD (see Chart 48-7).

Chart 48-7 PLAN OF NURSING CARE

The Patient with End-Stage Kidney Disease

NURSING DIAGNOSIS: Hypervolaemia associated with decreased urine output, dietary excesses, and retention of sodium and water
GOAL: Maintenance of ideal body weight without excess fluid

Nursing Interventions	Rationale	Expected Outcomes
1. Assess fluid status: a. Daily weight b. Intake and output balance c. Skin turgor and presence of edema d. Distention of neck veins e. Blood pressure, pulse rate, and rhythm f. Respiratory rate and effort	1. Assessment provides baseline and ongoing database for monitoring changes and evaluating interventions.	• Demonstrates no rapid weight changes • Maintains dietary and fluid restrictions • Exhibits normal skin turgor without edema • Exhibits normal vital signs • Exhibits no neck vein distention • Reports no difficulty breathing or shortness of breath • Performs oral hygiene frequently • Reports decreased thirst • Reports decreased dryness of oral mucous membranes
2. Limit fluid intake to prescribed volume.	2. Fluid restriction will be determined on basis of weight, urine output, and response to therapy.	
3. Identify potential sources of fluid: a. Medications and fluids used to take or administer medications: oral and IV b. Foods	3. Unrecognized sources of excess fluids may be identified.	
4. Explain to patient and family the rationale for fluid restriction.	4. Understanding promotes patient and family cooperation with fluid restriction.	
5. Assist patient to cope with the discomforts resulting from fluid restriction.	5. Increasing patient comfort promotes adherence to dietary restrictions.	
6. Provide or encourage frequent oral hygiene.	6. Oral hygiene minimizes dryness of oral mucous membranes.	

NURSING DIAGNOSIS: Impaired nutritional intake associated with anorexia, nausea, vomiting, dietary restrictions, and altered oral mucous membranes
GOAL: Maintenance of adequate nutritional intake

Nursing Interventions	Rationale	Expected Outcomes
1. Consult with renal dietitian for recommendations regarding appropriate diet: potassium, phosphorus, sodium restrictions, and protein requirements 2. Assess nutritional status: a. Weight changes b. Laboratory values (serum electrolyte, blood urea nitrogen [BUN], creatinine, protein, transferrin, and iron levels) (see Appendix A on thePoint) 3. Assess patient's nutritional dietary patterns: a. Diet history b. Food preferences c. Calorie counts 4. Assess for factors contributing to altered nutritional intake: a. Anorexia, nausea, or vomiting b. Diet unpalatable to patient c. Depression d. Lack of understanding of dietary restrictions e. Stomatitis 5. Provide patient's food preferences within dietary restrictions.	1. Involve multidisciplinary team in patient management. 2. Baseline data allow for monitoring of changes and evaluating effectiveness of interventions. 3. Past and present dietary patterns are considered in planning meals. 4. Information about other factors that may be altered or eliminated to promote adequate dietary intake is provided. 5. Increased dietary intake is encouraged. 6. Complete proteins are provided for positive nitrogen balance needed for growth and healing. 7. Reduces source of restricted foods and proteins and provides calories for energy, sparing protein for tissue growth and healing. 8. Ingestion of medications just before meals may produce anorexia	• Consumes protein of high-biologic value • Chooses foods within dietary restrictions that are appealing • Consumes high-calorie foods within dietary restrictions • Explains in own words rationale for dietary restrictions and relationship to urea and creatinine levels • Takes medications on schedule that does not produce anorexia or feeling of fullness • Consults written lists of acceptable foods • Reports increased appetite at meals

6. Promote intake of high–biologic-value protein foods: eggs, fish, meats. 7. Encourage high-calorie, low-phosphorus, low-sodium, and low-potassium snacks between meals. 8. Alter schedule of medications so that they are not given immediately before meals (except for phosphate binders which are given with the first bite of food). 9. Explain rationale for dietary restrictions and relationship to kidney disease and increased urea and serum creatinine levels. 10. Provide written lists of foods allowed and suggestions for improving their taste without the use of sodium or potassium. 11. Provide pleasant surroundings at mealtimes. 12. Weigh patient daily. 13. Assess for evidence of inadequate protein intake: a. Edema formation b. Delayed wound healing c. Decreased serum albumin levels	and feeling of fullness. 9. Promotes patient understanding of relationships between diet and urea and creatinine levels to kidney disease. 10. Lists provide a positive approach to dietary restrictions and a reference for patient and family to use when at home. 11. Unpleasant factors that contribute to patient's anorexia are eliminated. 12. Allows monitoring of fluid and nutritional status. 13. Inadequate protein intake can lead to decreased albumin and other proteins, edema formation, and delay in wound healing.	• Exhibits no rapid increases or decreases in weight • Demonstrates normal skin turgor without edema; wound healing and acceptable plasma albumin levels

NURSING DIAGNOSIS: Lack of knowledge regarding condition and treatment

GOAL: Increased knowledge about condition and related treatment

Nursing Interventions	Rationale	Expected Outcomes
1. Assess understanding of cause of kidney disease, consequences of kidney disease, and its treatment: a. Cause of patient's kidney disease b. Meaning of kidney disease c. Understanding of renal function d. Relationship of fluid and dietary restrictions to kidney disease e. Rationale for treatment (HD, PD, transplantation) 2. Provide explanation of renal function and consequences of kidney disease at patient's level of understanding and guided by patient's readiness to learn. 3. Assist patient to identify ways to incorporate changes related to illness and its treatment into lifestyle. 4. Provide oral and written information as appropriate about: a. Renal function and failure b. Fluid and dietary restrictions c. Medications d. Reportable problems, signs,	1. Provides baseline for further explanations and education. 2. Patient can learn about kidney disease and treatment as they become ready to understand and accept the diagnosis and consequences. 3. Patient can see that their life does not have to revolve around the disease. 4. Provides patient with information that can be used for further clarification at home.	• Verbalizes relationship of cause of kidney disease to consequences • Explains fluid and dietary restrictions as they relate to failure of kidney's regulatory functions • States in own words relationship of kidney disease and need for treatment • Asks questions about treatment options, indicating readiness to learn • Verbalizes plans to continue as normal a life as possible • Uses written information and instructions to clarify questions and seek

and symptoms e. Follow-up schedule f. Community resources g. Treatment options	additional information

NURSING DIAGNOSIS: Activity intolerance associated with fatigue, anemia, retention of waste products, and dialysis procedure
GOAL: Participation in activity within tolerance

Nursing Interventions	Rationale	Expected Outcomes
1. Assess factors contributing to activity intolerance: a. Fatigue b. Anemia c. Fluid and electrolyte imbalances d. Retention of waste products e. Depression	1. Indicates factors contributing to severity of fatigue.	• Participates in increasing levels of activity and exercise • Reports increased sense of well-being • Alternates rest and activity • Participates in selected self-care activities
2. Promote independence in self-care activities as tolerated; assist if fatigued.	2. Promotes improved self-esteem.	
3. Encourage alternating activity with rest.	3. Promotes activity and exercise within limits and adequate rest.	
4. Encourage patient to rest after dialysis treatments.	4. Adequate rest is encouraged after dialysis treatments, which are exhausting to many patients.	

NURSING DIAGNOSIS: Risk for situational low self-esteem associated with dependency, role changes, change in body image, and change in sexual function
GOAL: Improved self-esteem

Nursing Interventions	Rationale	Expected Outcomes
1. Assess patient's and family's responses and reactions to illness and treatment.	1. Provides data about problems encountered by patient and family in coping with changes in life.	• Identifies previously used coping styles that have been effective and those no longer possible due to disease and treatment
2. Assess relationship of patient and significant family members.	2. Identifies strengths and supports of patient and family.	

3. Assess usual coping patterns of patient and family members.	3. Coping patterns that may have been effective in past may be harmful in view of restrictions imposed by disease and treatment.	(alcohol or drug use; extreme physical exertion)
4. Encourage open discussion of concerns about changes produced by disease and treatment: a. Role changes b. Changes in lifestyle c. Changes in occupation d. Sexual changes e. Dependence on health care team	4. Encourages patient to identify concerns and steps necessary to deal with them.	• Patient and family identify and verbalize feelings and reactions to disease and necessary changes in their lives
5. Explore alternative ways of sexual expression other than penile-vaginal intercourse.	5. Alternative forms of sexual expression may be acceptable.	• Seeks professional counseling, if necessary, to cope with changes resulting from kidney disease
6. Discuss role of giving and receiving love, warmth, and affection.	6. Sexuality means different things to different people, depending on stage of maturity.	• Reports satisfaction with method of sexual expression
7. Consult with medical social worker (MSW), psychiatry for unresolved problems	7. Collaborate with interprofessional team for unresolved patient care issues.	

COLLABORATIVE PROBLEMS: Hyperkalemia; pericarditis, pericardial effusion, and pericardial tamponade; hypertension; anemia; bone disease and metastatic calcifications

GOAL: Absence of complications

Nursing Interventions	Rationale	Expected Outcomes
Hyperkalemia		
1. Monitor serum potassium levels.	1. Hyperkalemia causes potentially	• Has normal potassium level

Notify primary provider if level is at or approaching >5.5 mEq/L, and prepare to treat hyperkalemia. 2. Assess patient for muscle weakness, diarrhea, electrocardiographic (ECG) changes (tall-tented T waves and widened QRS).	life-threatening changes in the body. 2. Cardiovascular signs and symptoms are characteristic of hyperkalemia.	Experiences no • muscle weakness or diarrhea • Exhibits normal ECG pattern • Vital signs are within normal limits
Pericarditis, Pericardial Effusion, and Pericardial Tamponade		
1. Assess patient for fever, chest pain, and a pericardial friction rub (signs of pericarditis); if present, notify primary provider. 2. If patient has pericarditis, assess for the following every 4 hours: a. Paradoxical pulse, >10 mm Hg b. Extreme hypotension c. Weak or absent peripheral pulses d. Altered level of consciousness e. Jugular venous distention 3. Prepare patient for echocardiogram to aid in diagnosis of pericardial effusion and cardiac tamponade.	1. Patients with chronic kidney disease may develop pericarditis due to uremia; fever, chest pain, and a pericardial friction rub are classic signs. 2. Pericardial effusion is a common sequela of pericarditis. Signs of an effusion include a paradoxical pulse (>10 mm Hg drop in blood pressure during inspiration) and signs of shock due to compression of the heart by a large effusion. Cardiac tamponade, which may be fatal, exists when the patient is severely compromised hemodynamically. 3. Echocardiogram is useful in visualizing pericardial effusions and cardiac tamponade.	• Has strong and equal peripheral pulses • Absence of a paradoxical pulse • Absence of pericardial effusion or tamponade on cardiac ultrasound • Has normal heart sounds

4. If cardiac tamponade develops, prepare patient for emergency pericardiocentesis.	4. Cardiac tamponade is a life-threatening condition, with a high mortality rate. Immediate drainage of fluid from the pericardial space via a pericardial window procedure is essential.	
Hypertension		
1. Monitor and record blood pressure as indicated. 2. Administer antihypertensive medications as prescribed. 3. Encourage adherence to dietary and fluid restriction therapy. 4. Instruct patient to report signs of fluid overload, vision changes, headaches, edema, or seizures.	1. Provides objective data for monitoring. Elevated levels may indicate nonadherence to the treatment regimen. 2. Antihypertensive medications play a key role in treatment of hypertension associated with chronic kidney disease. 3. Adherence to diet and fluid restrictions and dialysis schedule prevents excess fluid and sodium accumulation. 4. These are indications of inadequate control of hypertension and the need to alter therapy.	• Blood pressure and weight within normal limits • Reports no headaches, visual problems, or seizures • Edema is absent • Demonstrates adherence to dietary and fluid restrictions
Anemia		
1. Monitor red blood cell (RBC) count and hemoglobin	1. Provides assessment of degree of anemia.	• Patient has a normal skin color without pallor

and hematocrit levels as indicated. 2. Administer medications as prescribed, including iron and folic acid supplements, an erythrocyte-stimulating agent, and multivitamins. 3. Avoid drawing unnecessary blood specimens. 4. Educate patient to prevent bleeding: Avoid vigorous nose blowing and contact sports, and use a soft toothbrush. 5. Administer blood component therapy as indicated.	2. RBCs need iron, folic acid, and vitamins to be produced. An erythrocyte-stimulating agent stimulates the bone marrow to produce RBCs. 3. Anemia is worsened by drawing numerous specimens. 4. Bleeding from anywhere in the body worsens anemia. 5. Blood component therapy may be needed if the patient has symptoms.	• Exhibits hemoglobin levels within acceptable limits • Experiences no bleeding from any site
Bone Disease and Metastatic Calcifications		
1. Administer the following medications as prescribed: phosphate binders, calcium supplements, vitamin D supplements, calcimimetics. 2. Monitor serum laboratory values as indicated (calcium, phosphorus, ionized parathyroid [iPTH] hormone), and report abnormal findings to primary provider.	1. Chronic kidney disease causes numerous physiologic changes affecting calcium, phosphorus, and vitamin D metabolism. 2. Hyperphosphatemia, hypocalcemia, and hyperparathyroidism are common in chronic kidney disease. 3. Bone demineralization increases with immobility,	• Takes phosphate binders with the first bite of food. • Exhibits serum calcium, phosphorus, and iPTH levels within acceptable ranges • Exhibits no symptoms of hypocalcemia • Has no bone demineralization on bone scan • Discusses importance of

3. Assist patient with an exercise program. 4. Consult with renal dietitian	hyperphosphatemia, hyperparathyroidism. 4. Involve interprofessional team in patient management.	maintaining activity level and exercise program

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

The nurse plays an important role in educating the patient with ESKD. Because of the extensive education needed, the home health nurse, dialysis nurse, and nurses in the hospital and outpatient settings, as well as a renal dietitian, all provide ongoing education and reinforcement while monitoring the patient's progress and adherence to the treatment regimen. The patient is instructed to check the vascular access for patency and to use appropriate precautions, such as avoiding venipuncture and blood pressure measurements on the arm with the access device. In addition, the patient and family need to know what problems to report to the primary provider. These include the following:

- Worsening signs and symptoms of kidney disease (nausea, vomiting, change in usual urine output, metallic taste in the mouth, ammonia odor on breath)
- Signs and symptoms of hyperkalemia (muscle weakness, diarrhea, abdominal cramps)
- Signs and symptoms of access problems (clotted fistula or graft, infection)

Signs and symptoms of decreasing renal function, in addition to increasing BUN and serum creatinine levels, may indicate a need to alter the dialysis prescription. The dialysis nurses also provide ongoing education and support at each treatment visit.

Continuing and Transitional Care

The importance of follow-up examinations and treatment is stressed with the patient and family because of changing physical status, renal function, and dialysis requirements. Referral for home care provides the home health nurse with the opportunity to assess the patient's environment, emotional status, and the coping strategies used by the patient and family to deal with the changes in family roles often associated with chronic illness.

The home health nurse also assesses the patient for further deterioration of renal function and signs and symptoms of complications resulting from the primary kidney disorder, the resulting kidney disease, and effects of treatment strategies (e.g., dialysis, medications, dietary restrictions). Patients need education and reinforcement of the dietary restrictions required, including fluid, sodium, potassium, and phosphorus restriction. Reminders about the need for health promotion activities and health screening are an important part of nursing care for the patient with kidney disease.

Gerontologic Considerations

Diabetes, hypertension, chronic glomerulonephritis, interstitial nephritis, and urinary tract obstruction are among the causes for ESKD in older adults. The fastest growing group of patients with CKD is older adults who also have more comorbidities (Brooks, 2017). The signs and symptoms of kidney disease in older adults are often nonspecific. The occurrence of symptoms of other disorders (heart failure, dementia) can mask the symptoms of kidney disease and delay or prevent diagnosis and treatment (Hain, 2017).

HD and PD are used effectively in treating older patients with ESKD. Initiation of dialysis among older adults has increased in the past decade as baby boomers have come of age. Implementation of palliative care has also increased among patients who choose not to start dialysis or who decide to stop dialysis. Although there is no specific age limitation for kidney transplantation, concomitant disorders (e.g., coronary artery disease, peripheral vascular disease) have made it a less common treatment for older adults. However, in the United States, when adults age 60 and older who have significant comorbidities are ruled out (i.e., not considered to be suitable) as transplant candidates, those who do receive a kidney transplant survive longer than patients on dialysis and those who remain on the transplant waiting list (Bunnapradist, Abdalla, & Reddy, 2017).

Some older patients elect not to undergo dialysis or transplantation. Conservative management and palliative care, also known as supportive care, including nutritional therapy, fluid control, and medications such as phosphate binders, may be considered in patients who are not suitable for or elect not to have dialysis or transplantation (Molzahn & Schick-Makaroff, 2017). Palliative care for the patient with ESKD focuses on relieving suffering, promoting health-related quality of life, and facilitating dignity at the end-of-life (see Chapter 13).

RENAL REPLACEMENT THERAPY (RRT)

The use of RRT becomes necessary when the kidneys can no longer remove wastes, maintain electrolytes, and regulate fluid balance. This can occur rapidly or over a long period of time, and the need for replacement therapy can be acute (short term) or chronic (long term). RRT includes the various types of dialysis and kidney transplantation.

Dialysis

Types of dialysis include HD, CRRT, and PD. Acute or urgent dialysis is indicated when there is a high and increasing level of serum potassium, fluid overload, or impending pulmonary edema, increasing acidosis, pericarditis, and advanced uremia. It may also be used to remove medications or toxins (poisoning or medication overdose) from the blood or for edema or hypertension that does not respond to other treatment, and hyperkalemia.

Chronic or maintenance dialysis is indicated in advanced CKD and ESKD in the following instances: the presence of uremic signs and symptoms affecting all body systems (nausea and vomiting, severe anorexia, increasing lethargy, mental confusion), hyperkalemia, fluid overload not responsive to diuretics and fluid restriction, and a general lack of well-being. An urgent indication for dialysis in patients with kidney disease is pericardial friction rub, which is indicative of uremic pericarditis.

The decision to initiate dialysis should be reached only after thoughtful discussion among the patient, family, primary provider, and other health care team members. The nurse can assist the patient and family by answering their questions, clarifying the information provided, and supporting their decision.

Successful kidney transplantation eliminates the need for dialysis. Not only is the quality of life much improved in patients with ESKD who undergo transplantation, but physiologic function is improved as well. Patients who undergo kidney transplantation from living donors before dialysis is initiated (preemptive transplant) generally have longer survival of the transplanted kidney than patients who receive transplantation after dialysis treatment is initiated (Bunnapradist, Abdalla, & Reddy, 2017).

Hemodialysis (HD)

HD is used for patients who are acutely ill and require short-term dialysis for days to weeks until kidney function resumes, as in patients with AKI, and for patients with advanced CKD and ESKD who require long-term or permanent RRT. HD prevents death but does not cure kidney disease and does not compensate for the loss of endocrine or metabolic activities of the kidneys. Approximately 62.7% of patients requiring long-term RRT are on chronic HD (USRDS, 2019). Most patients receive intermittent HD that involves treatments three times a week with an average treatment duration of 3 to 4 hours in an outpatient setting. HD can also be performed at home by the patient and a caregiver. See later discussion on home HD.

The objectives of HD are to extract toxic nitrogenous substances from the blood and to remove excess fluid. A **dialyzer** (also referred to as an artificial kidney) is a synthetic semipermeable membrane through which blood is filtered to remove uremic toxins and a desired amount of fluid. In HD, the blood, laden with toxins and nitrogenous wastes, is diverted from the patient to a machine via the use of a blood pump to the dialyzer, where toxins are filtered from the blood and the cleansed blood is returned to the patient.

Diffusion, osmosis, and **ultrafiltration** are the principles on which HD is based (see Chapter 10). The toxins and wastes in the blood are removed by **diffusion**—that is, they move from an area of higher concentration in the blood to an area of lower concentration in the dialysate. The **dialysate** is a solution that circulates through the dialyzer, made up of all the electrolytes in their ideal extracellular concentrations. The electrolyte level in the patient's blood can be brought under control by properly adjusting the electrolytes in the dialysate solution. The semipermeable membrane impedes the diffusion of large molecules, such as RBCs and proteins.

Excess fluid is removed from the blood by **osmosis**, in which water moves from an area of low concentration potential (the blood) to an area of high concentration potential (the dialysate bath). In **ultrafiltration**, fluid moves under high pressure to an area of lower pressure. This process is much more efficient than osmosis for fluid removal and is accomplished by applying negative pressure (a suctioning-type force) to the dialysis membrane. Because patients with ESKD requiring dialysis usually cannot excrete enough water, this force is necessary to remove fluid to achieve fluid balance.

The body's buffer system is maintained using a dialysate bath made up of bicarbonate (most common) or acetate, which is metabolized to form bicarbonate. The anticoagulant heparin is given to keep blood from clotting in the extracorporeal dialysis circuit. Cleansed blood is returned to the body with the goal of removing fluid, balancing electrolytes, and managing acidosis (Hellebrand, Allen, & Hoffman, 2017).

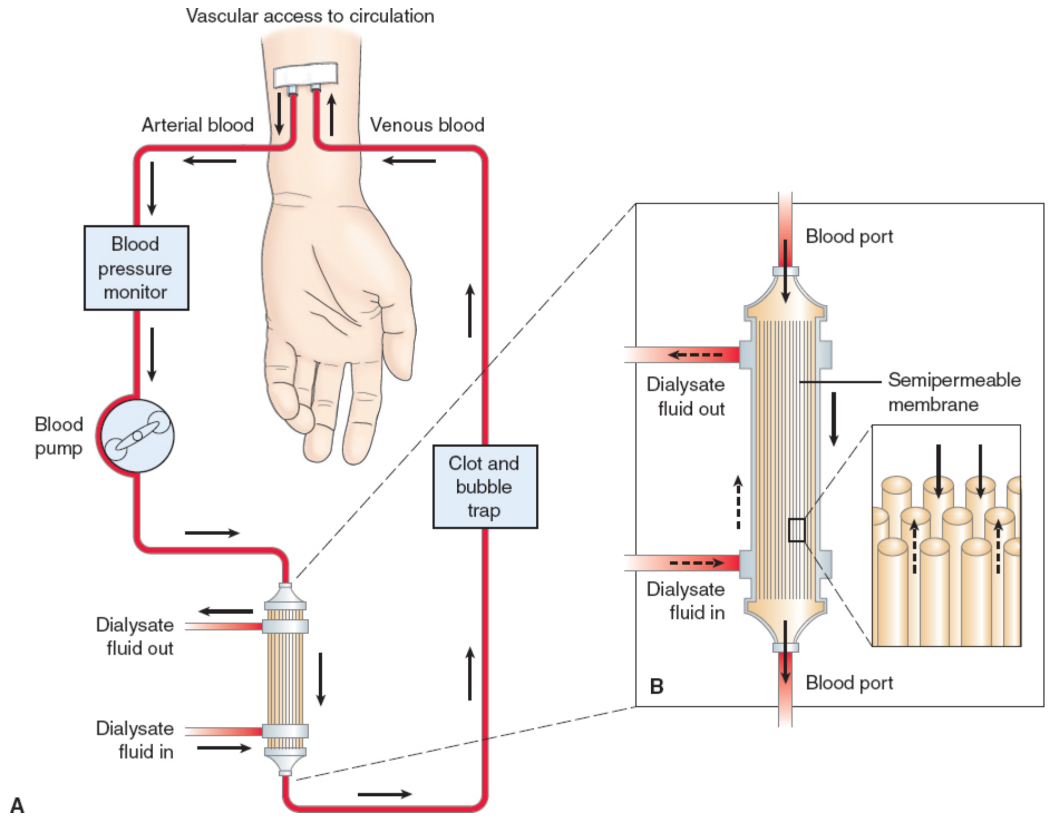


Figure 48-3 • HD system. Blood from the arteriovenous fistula or graft is pumped (**A**) into a dialyzer, where it flows through the synthetic capillary tubes (**B**), which act as the semipermeable membrane (*inset*). The dialysate, which has a particular chemical composition, flows into the dialyzer around the capillary tubes that the blood flows through. The waste products in the blood diffuse across the semipermeable membrane into the dialysate solution and flows out to the drain.

Dialyzers

Dialyzers are hollow-fiber devices containing thousands of tiny capillary tubes that carry the blood through the artificial kidney. The tubes are porous and act as a semipermeable membrane, allowing toxins, fluid, and electrolytes to pass across the membrane. The constant flow of the solution maintains the concentration gradient to facilitate the exchange of wastes from the blood across the semipermeable membrane into the dialysate solution, where they are removed and discarded (see Fig. 48-3).

Dialyzers have undergone many technologic changes in performance and biocompatibility. High-flux dialysis uses highly permeable membranes to increase the clearance of low- and mid–molecular-weight molecules. These special membranes are used with higher than traditional rates of flow for the blood entering and exiting the dialyzer (500 to 550 mL/min). High-flux dialysis increases the efficiency of treatments while shortening their duration and reducing the need for heparin.

Vascular Access

Access to the patient's vascular system must be established to allow blood to be removed, cleansed, and returned to the patient's vascular system at the rapid rates of 300 and 500 mL/min. Several types of access can be surgically created or placed during procedures performed in interventional radiology suites or at the bedside.

Vascular Access Devices

Immediate access to the patient's circulation for acute HD is achieved by inserting a double-lumen, noncuffed, large-bore catheter into the right or left internal jugular or femoral vein of either leg by the physician, nurse practitioner, or physician assistant (see Fig. 48-4). The subclavian vein is rarely used as there is an increased risk for central stenosis (Pryor & Brouwer-Maier, 2017). This method of vascular access involves some risk (e.g., hematoma, bleeding, pneumothorax, infection, thrombosis of the vein, inadequate flow). The catheter is removed when no longer needed (e.g., because the patient's condition has improved or another type of permanent access has been established). Double-lumen, cuffed catheters may also be inserted, usually by either a surgeon or interventional radiologist, into the internal jugular vein of the patient. Because these catheters have cuffs under the skin, the insertion site heals, sealing the wound and reducing the risk for ascending infection. This feature makes these catheters safe for longer-term use. However, infection rates remain high, and sepsis continues to be a common cause for hospital admission (Pryor & Brouwer-Maier, 2017).

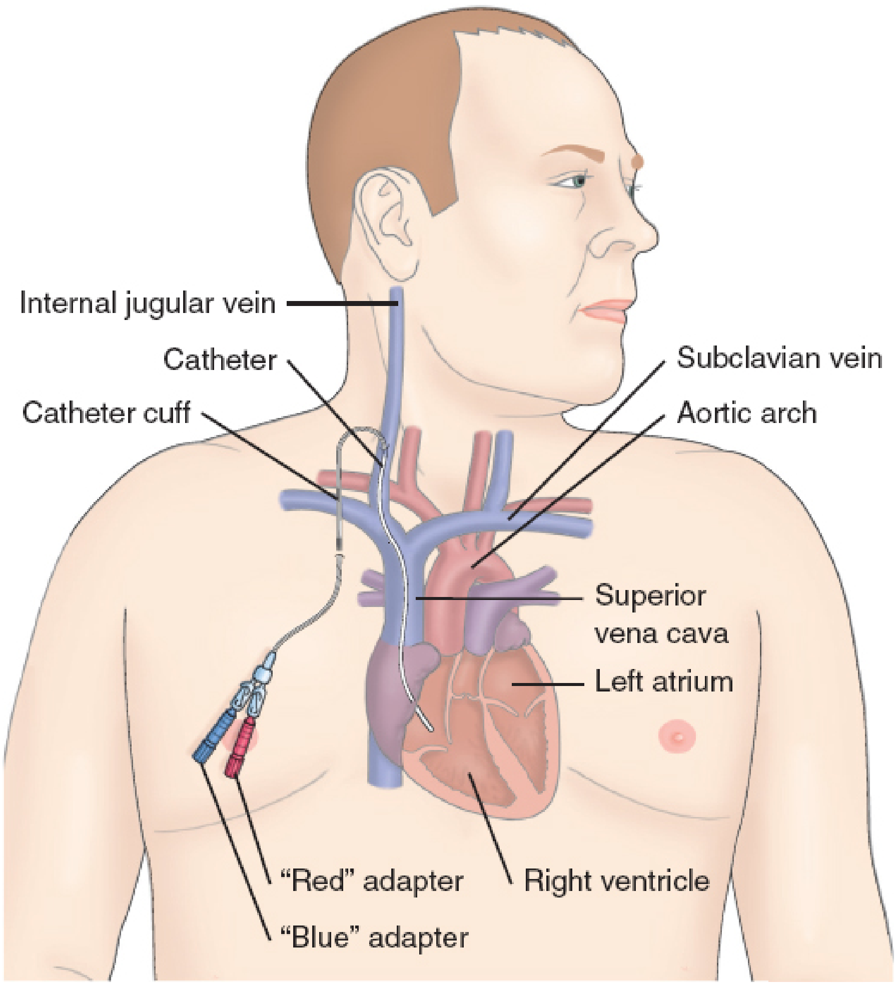


Figure 48-4 • Double-lumen, cuffed HD catheter used in acute HD. The red catheter lumen is attached to a blood line through which blood is pumped from the patient to the dialyzer. After the blood passes through the dialyzer (artificial kidney), it returns to the patient through the other lumen of the catheter.

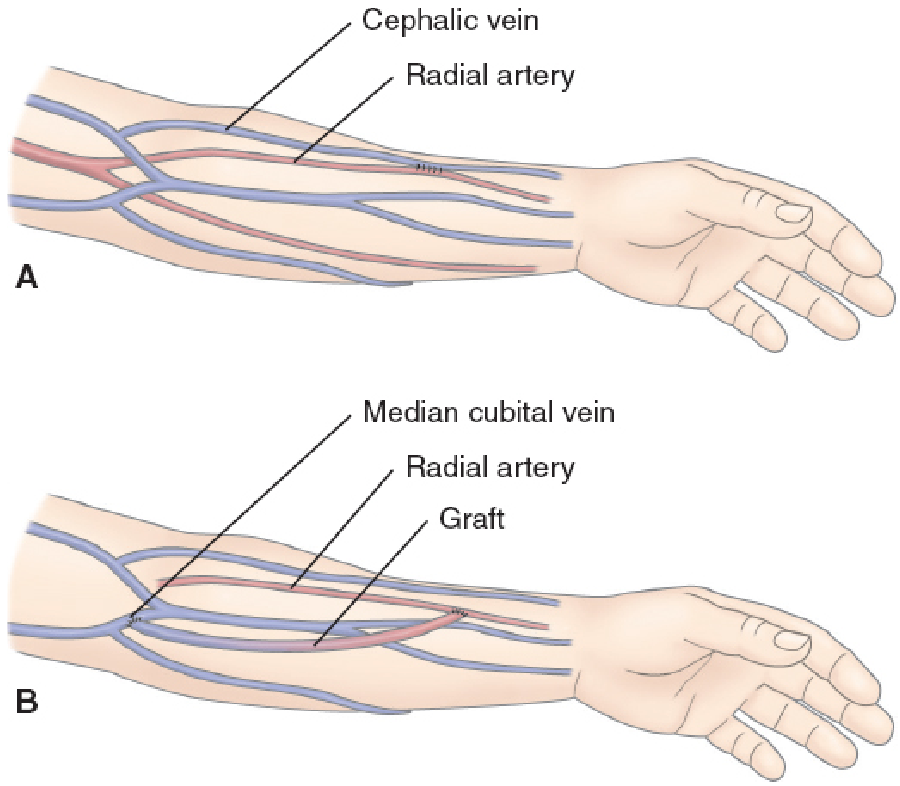


Figure 48-5 • **A.** Arteriovenous fistulas are created by anastomosing a patient's vein to an artery. This illustrates a side-to-side anastomosis. **B.** Arteriovenous grafts are established by connecting the artery and vein using synthetic tubing.

Arteriovenous Fistula

The preferred method of permanent vascular access for dialysis is an **arteriovenous fistula** (AVF) that is created surgically (usually in the forearm) by anastomosing (joining) an artery to a vein, either side to side or end to side (see Fig. 48-5A). Needles are inserted into the vessel to obtain blood flow which is adequate to pass through the dialyzer. The arterial segment of the fistula is used for outflow to the dialyzer and the venous segment for reinfusion of the dialyzed blood. This access will need time (at least 3 months) to "mature" before it can be used. As the AVF matures, the venous segment dilates due to the increased blood flow coming directly from the artery. Once sufficiently dilated, it will then accommodate two large-bore (14-, 15-, or 16-gauge) needles that are inserted for each dialysis treatment. The patient is encouraged to perform hand exercises (e.g., squeezing a rubber ball) to increase the size of these vessels to accommodate the large-bore needles. Once established, this access has the longest useful life and thus is considered the best option for vascular access for the patient requiring ongoing HD (Inglese, 2017).

Arteriovenous Graft

An **arteriovenous graft** can be created by subcutaneously interposing a biologic, semibiologic, or synthetic graft material between an artery and vein (see Fig. 48-5B). Usually, a graft is created when the patient's vessels are not suitable for creation of an AVF. Patients with compromised vascular systems (e.g., from diabetes) often require a graft because their native vessels may not be suitable for creation of an AVF. Grafts are usually placed in the arm but may be placed in the thigh or chest wall. Stenosis, infection, and thrombosis are the most common complications of this access. It is not at all uncommon to see a dialysis patient with numerous "old" or "nonfunctioning" accesses present on their arms. The patient is asked to identify the current access in use, and it is assessed carefully and regularly for the presence of a bruit and thrill.

See the Special Considerations: Nursing Management of the Patient on Dialysis Who Is Hospitalized section later in this chapter for nursing interventions and care of the patient with an arteriovenous graft or fistula.

Quality and Safety Nursing Alert

Failure of the permanent dialysis access (fistula or graft) accounts for many hospital admissions of patients undergoing chronic HD. Thus, protection of the access is of high priority. Although limb alert bracelets (Sturdivant & Johnson, 2019) are ideal to identify the access extremity, posted signs are also a good safety alert. The sign should state, "No lab draws, IVs, or blood pressures on access arm."

Complications

Although HD can prolong life, it does not alter the natural course of the underlying CKD, nor does it completely replace kidney function. The CKD complications previously discussed will continue to worsen and require treatment. With the initiation of dialysis, disturbances of lipid metabolism are accelerated and contribute to cardiovascular complications. Heart failure, coronary artery disease, angina, stroke, and peripheral vascular disease may occur and can incapacitate the patient. Cardiovascular disease remains the leading cause of death in patients receiving dialysis as well as for patients with CKD.

Many complications result from both the underlying ESKD and the HD treatments. The anemia of ESKD is compounded by blood loss during HD. Gastric ulcers may result from the physiologic stress of chronic illness, medication, and preexisting medical conditions (e.g., diabetes). Patients with uremia often report a metallic taste and nausea. Vomiting may occur during the HD treatment when rapid fluid shifts and hypotension occur. These contribute to the malnutrition seen in patients on dialysis. Disordered calcium metabolism and renal osteodystrophy can result in bone pain and fractures, interfering with mobility. As time on dialysis continues, calcification of major blood vessels has been reported and linked to hypertension and other vascular complications. Phosphorus deposits in the skin can occur and cause itching.

Many people undergoing HD experience major sleep problems that further complicate their overall health status. Early-morning or late-afternoon dialysis may be a risk factor for developing sleep disturbances.

Other complications of dialysis may include the following:

- Episodes of shortness of breath often occur as fluid accumulates between dialysis treatments.
- Hypotension may occur during the treatment as fluid is removed. Nausea and vomiting, diaphoresis, tachycardia, and dizziness are common signs of hypotension.
- Painful muscle cramping may occur, usually late in dialysis as fluid and electrolytes rapidly leave the extracellular space.
- Exsanguination may occur if blood lines separate or dialysis needles become dislodged.
- Arrhythmias may result from electrolyte and pH changes or from removal of antiarrhythmic medications during dialysis.
- Air embolism is very rare since the advent of venous air detectors, but can occur if air enters the vascular system.
- Chest pain may occur in patients with anemia or arteriosclerotic heart disease.
- Dialysis disequilibrium results from cerebral fluid shifts. Signs and symptoms include headache, nausea and vomiting, restlessness, decreased level of consciousness, and seizures. It is rare and more likely to occur in AKI or when BUN levels are very high (exceeding 150 mg/dL) and the patient is dialyzed with high blood and dialysate flows. Therefore, short treatments with low blood and dialysate flow rates are prescribed (Hellebrand et al., 2017).

COVID-19 Considerations

Patients undergoing outpatient HD are at high risk of contracting the SARS-CoV-2 virus due to comorbidities (e.g., hypertension), their relatively suppressed immune status, and more frequent hospitalizations (Wu, Li, Zhu, et al., 2020). Travel to an outpatient dialysis center three times a week also increases their risk of contracting the virus (Ajaimy & Melamed, 2020). Findings from a retrospective, single-center study of 49 patients on HD compared to 52 patients without kidney disease all hospitalized with COVID-19 pneumonia in Wuhan, China, reported that the main symptoms of fever and cough were less prevalent in patients who were undergoing HD (Wu et al., 2020). Patients on HD were also more likely to be admitted to intensive care, need ventilator support, and had a higher mortality rate compared to controls (Wu et al., 2020). These early findings suggest that patients receiving HD are not only at greater risk for COVID-19, they are also at risk for not being recognized as infected with SARS-CoV-2 at an early stage, when they may be amenable to treatment. These findings also suggest that patients on HD who are hospitalized with COVID-19 are more acutely ill and at greater risk for death compared to patients not on HD (Wu et al., 2020).

Nursing Management

The nurse in the dialysis unit has an important role in monitoring, supporting, assessing, and educating the patient. During HD, the patient, the dialyzer, and the dialysate bath require constant monitoring because numerous complications are possible, including clotting of the dialysis tubing or dialyzer, air embolism, inadequate or excessive fluid removal, hypotension, cramping, vomiting, blood leaks, contamination, and access complications. Nursing care of the patient and maintenance of the vascular access device are especially important and are discussed in the Special Considerations: Nursing Management of the Patient on Dialysis Who Is Hospitalized section.

Promoting Pharmacologic Therapy

Many medications are removed from the blood during HD. Therefore, dosage or timing of medication administration may require adjustment. Medications that are water soluble are readily removed during HD treatment, and those that are fat soluble or adhere to other substances (like albumin) are not dialyzed out very well. This is the reason some drug overdoses are treated with emergency HD and others are not.

Patients undergoing HD who require medications (e.g., cardiac glycosides, antibiotic agents, antiarrhythmic medications, antihypertensive agents) are monitored closely to ensure that blood and tissue levels of these medications are maintained without toxic accumulation. Antihypertensive therapy, often part of the regimen of patients on dialysis, is one example when communication, education, and evaluation can make a difference in patient outcomes. The patient must know when—and when not—to take the medication. For example, if an antihypertensive agent is taken on a dialysis day, hypotension may occur during dialysis, causing dangerously low blood pressure. Many medications that are taken once daily should be administered after the dialysis treatment.

Promoting Nutritional and Fluid Therapy

Diet is important for patients on HD. Goals of nutritional therapy are to minimize uremic symptoms and fluid and electrolyte imbalances; to maintain good nutritional status through adequate protein, calorie, vitamin, and mineral intake; and to enable the patient to eat a palatable and enjoyable diet. Restriction of fluid is also part of the dietary prescription because fluid accumulation may occur, leading to fluid volume excess, heart failure, and pulmonary edema.

With the initiation of HD, the patient usually requires some restriction of dietary sodium, potassium, phosphorus, and fluid intake. Close collaboration with a renal dietitian is essential in helping the patient make good food choices. Protein intake is restricted to about 1.2 g/kg ideal body weight per day; therefore, protein must be of high-biologic quality. Sodium is usually restricted to 2 g/day; the fluid prescription is individualized based on residual urine output (generally 1000 to 1500 mL/day). The goal for patients on HD is to keep their interdialytic (between dialysis treatments) weight gain less than 4% of their estimated dry weight (Gonyea, 2017). Potassium restriction depends on the amount of residual renal function and the frequency of dialysis.

Chart 48-8 NURSING RESEARCH PROFILE

Resilience in Patients Receiving Dialysis

Kim, E., Lee, Y., & Chang, S. (2019). How do patients on hemodialysis perceive and overcome hemodialysis?: Concept development of the resilience of patients on hemodialysis. *Nephrology Nursing Journal*, *46*(5), 521–530.

Purpose

This qualitative study was designed to identify and conceptualize the concept of resilience in patients receiving HD.

Design

This study was conducted in three phases. In the first phase, called the theoretical phase, a literature review was undertaken and a definition of the resilience of patients on HD was constructed. In the fieldwork phase, interviews were held with 10 patients. Qualitative data from the 10 interviews were analyzed for patterns to identify attributes of resilience for patients on HD. The last phase compared the theoretical definition with the data collected in the fieldwork phase.

Findings

The purposive patient sample included 10 participants from one HD center at a university hospital in Korea who were chosen by nurses with expertise in HD who assessed the patients to have characteristics of resilience. The length of time participants had been on HD ranged between 1 and 10 years, and 60% were female. Through in-depth interviews, the concept of the resilience of patients on HD was found to have three dimensions: a willingness to actively solve problems, building daily routine strategies continuing roles as a family member and asserting the will to grow through overcoming HD; an acceptance of the HD situation, maintaining the homeostasis of the body and deliberating on death; and a positive self-perception and positively reinterpreting human relationships.

Nursing Implications

The nurse should assess and reinforce positive coping strategies that patients are using to cope with the issues encountered with the HD routine and change in lifestyle. By identifying the concept of resilience, nurses can encourage patients to use their positive coping skills to manage the financial, psychosocial, and medical challenges they may experience. The findings of this study could be used as a foundation for intervention strategies that incorporate the inventory of patients' strengths.

Dietary restriction is an unwelcome change in lifestyle for many patients with ESKD. Patients can feel stigmatized in social situations because there may be few food choices available for their diet. If the restrictions are ignored, life-threatening complications, such as hyperkalemia and pulmonary edema, may result. Thus, the patient may feel punished for responding to basic human drives to eat and drink. The nurse and renal dietitian who care for a patient with symptoms or complications resulting from dietary indiscretion must avoid harsh, judgmental, or punitive tones when communicating with them. Regular education with reinforcement is needed to achieve these difficult changes in lifestyle.

Meeting Psychosocial Needs

Patients requiring long-term HD, as they engage in psychosocial adaptation, tend to feel mired in a cyclical routine (Lin, Han, & Pan, 2015). They often have financial problems, difficulty holding a job, waning sexual desire and impotence, clinical depression, and fear of dying. Younger patients worry about marriage, having children, and the burden that they bring to their families. The regimented lifestyle that frequent dialysis treatments and restrictions in food and fluid intake impose can be demoralizing to the patient and family. Researchers have studied how patients on HD perceive and cope with the treatment by developing resilience (Kim, Lee, & Chang, 2019). (See the Nursing Research Profile in Chart 48-8.)

Dialysis alters the lifestyle of the patient and family. The amount of time required for dialysis and primary provider visits and being chronically ill can create conflict, frustration, guilt, and depression. It may be difficult for the patient, spouse, and family to express anger and negative feelings.

The nurse needs to give the patient and family the opportunity to express feelings of anger and concern about the limitations that the disease and treatment impose, possible financial problems, and job insecurity. If anger is not expressed, it may be directed inward and lead to depression, despair, and attempts at suicide; however, if anger is projected outward to other people, it may damage family relationships.

Chart 48-9 ETHICAL DILEMMA

How Can Patient Rights Be Discerned during a Pandemic?

Case Scenario

B.J. is a 74-year-old widow with chronic kidney disease (CKD) managed with HD three times weekly in an outpatient dialysis center. She is admitted to the medical unit where you work as a staff nurse with fluid retention and dyspnea. It is reported that B.J. had been a "no show" at the dialysis center for at least the past week. As part of her therapeutic plan, she is supposed to be dialyzed while in the hospital. As you enter her room to prepare her for transport to the hospital's dialysis center, you find B.J. humming to herself, clapping her hands, and smiling. When you explain to her that she is going to be transported to the dialysis center, she says "Honey, I am not going anywhere. I want to see Jesus. It is my time and I am ready to see the Lord." You have heard from the medical social worker that this is not B.J.'s first admission to the hospital for poor adherence to her outpatient dialysis treatment. During past hospitalizations, her three adult daughters would visit her together and effectively cajole her into receiving dialysis treatments. Reportedly, the daughters have a loving and supportive relationship with each other and their mother. However, there is an outbreak of coronavirus disease 2019 (COVID-19) within your community and the hospital has responded with a no-visitor policy throughout the facility, so B.J.'s daughters may not visit her.

Discussion

The principle of autonomy is considered sacrosanct. Patients have the right to refuse treatments, even if those treatments are life-saving. However, in this particular instance, B.J. could be delirious as a manifestation of her poorly managed CKD. If she is delirious, it may be determined that she lacks the capacity to make her own decisions. Her daughters might be her surrogates and legally responsible to make health care decisions for her. However, her daughters' prohibition to visit her while she is hospitalized hampers their ability to discuss her options with her and gain her assent for treatment.

Analysis

- Describe the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Can the principle of beneficence and wishing to "do good" for B.J. trump her autonomous right to refuse treatment? Can she be forced to undergo dialysis?
- What if it is determined that B.J. lacks the capacity to make informed decisions? On the contrary, what if it is determined that B.J. is not delirious and has the capacity to refuse to be dialyzed? Describe methods that you might employ to engage B.J.'s daughters so that they might be able to communicate with her and with each other as a family unit.

- What resources might be mobilized to be of assistance to B.J., her daughters, and the health care team so that a treatment plan that preserves B.J.'s dignity during this pandemic might be devised?

References

Hulkower, A. (2020). Learning from COVID. *Hastings Center Report*, *50*(3), 16–17.

Resources

See Chapter 1, Chart 1-10 for Steps of an Ethical Analysis and Ethics Resources.

Although these feelings are normal in this situation, they are often profound. Counseling and psychotherapy may be useful. All patients receiving dialysis should be screened for depression using a standard screening tool such as the Patient Health Questionnaire 9 (PHQ-9) or the Beck Depression Inventory (BDI) (Shirazian, Grant, Aina, et al., 2017). Depression may require treatment. Referring the patient and family to a mental health provider with expertise in the care of patients receiving dialysis may also be helpful. Clinical nurse specialists, psychologists, and social workers may be helpful in assisting the patient and family to cope with the changes brought about by kidney disease and its treatment by encouraging the development of resilience (Kim et al., 2019; Lieser, 2017).

The sense of loss that the patient experiences cannot be underestimated because every aspect of a "normal life" is disrupted. Some patients use denial to deal with the array of medical problems (e.g., infections, hypertension, anemia, neuropathy). Staff who are tempted to label the patient as nonadherent must consider the impact of kidney disease and its treatment on the patient and family and the coping strategies that they may use.

Palliative care principles that focus on symptom control are becoming increasingly important as greater attention is focused on quality-of-life issues. Patients and their families are encouraged to discuss end-of-life options and to develop advanced directives or living wills (Molzahn & Schick-Makaroff, 2017) (see Chart 48-9).

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Preparing a patient for HD is essential. Assessment helps identify the learning needs of the patient and family members. In many cases, the patient is discharged home before learning needs and readiness to learn can be thoroughly evaluated; therefore, hospital-based nurses, dialysis staff, and home health nurses must work together to provide appropriate education that meets the patient’s and family’s changing needs and readiness to learn (see Chart 48-10).

The diagnosis of ESKD and the need for dialysis is a big adjustment for the patient and family. In addition, many patients with ESKD have clinical depression, and chronic uremia contributes to a shortened attention span, a decreased level of concentration, and altered perception. Therefore, education must occur in brief, 10- to 15-minute sessions, with time added for clarification, repetition, reinforcement, and questions from the patient and family. The nurse needs to convey a nonjudgmental attitude to enable the patient and family to discuss options and their feelings about those options. Team conferences are helpful for sharing information and providing every team member the opportunity to discuss the needs of the patient and family.

Chart 48-10 HOME CARE CHECKLIST

The Patient Undergoing HD

At the completion of education, the patient and/or caregiver will be able to:

- Discuss kidney disease and its effects on the body.
- State the goal and purpose of HD and its impact on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- Discuss common problems that may occur during HD and their prevention and management.
- State the name, dose, side effects, frequency, and schedule for all medications on dialysis and nondialysis days.
- Describe commonly measured laboratory values, results, and implications.
- State changes in lifestyle (e.g., diet, activity) necessary to maintain health.
  - Acknowledge dietary and fluid restrictions, rationale, and consequences of nonadherence.
  - State dietary restrictions and changes required to provide adequate protein, calorie, vitamin, and mineral intake.
- List guidelines for prevention and detection of fluid overload, meaning of “dry” weight, and how to weigh self.
- Demonstrate vascular access care, how to check patency, signs and symptoms of infection, and prevention of complications.
- Develop strategies to manage or reduce anxiety and maintain independence.
- Discuss strategies for detection, management, and relief of pruritus, neuropathy, and other potential complications of kidney disease.
- Relate how to reach primary provider with questions or complications.
- State time and date of follow-up medical appointments, therapy, and testing.
- Coordinate financial arrangements for HD and strategies to identify and obtain resources.
- Identify sources of support (e.g., friends, relatives, faith community).
- Identify the contact details for support services for patients and their caregivers/families.
- Identify the need for health promotion, disease prevention, and screening activities.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Home Hemodialysis

Most patients who undergo HD do so in an outpatient setting, but home HD is an option for some. Prior to the COVID-19 pandemic, approximately 2% of patients receiving RRT were on home HD (USRDS, 2019). Home HD requires a highly motivated patient who is willing to take responsibility for the procedure and is able to adjust each treatment to meet the body's changing needs. It also requires the commitment and cooperation of a caregiver to assist the patient. However, many patients are not comfortable imposing on others and do not wish to subject family members to the feeling that their home is being turned into a clinic. The health care team never forces a patient to use home HD, because this treatment requires changes in the home and family. Home HD must be the patient's and family's decision (Harwood & Dominski, 2017). However, more patients needing RRT are being encouraged to reassess the home dialysis option as this modality allows the patient to self-isolate and to avoid having to enter an HD center thrice weekly, thus lowering the risk of contracting the SARS-CoV-2 virus (Ajaimy & Melamed, 2020).

The patient undergoing home HD and the caregiver assisting that patient must be trained to prepare, operate, and disassemble the dialysis machine; maintain and clean the equipment; administer medications (e.g., heparin) into the machine lines; and handle emergency problems (HD dialyzer rupture, electrical or mechanical problems, hypotension, shock, and seizures) (Harwood & Dominski, 2017). Because home HD places primary responsibility for the treatment on the patient and the family member, they must understand and be capable of performing all aspects of the HD procedure.

Before home HD is initiated, the home environment, household and community resources, and ability and willingness of the patient and family to carry out this treatment are assessed. The home is surveyed to see if electrical outlets, plumbing facilities, and storage space are adequate. Modifications may be needed to enable the patient and caregiver to perform dialysis safely and to deal with emergencies.

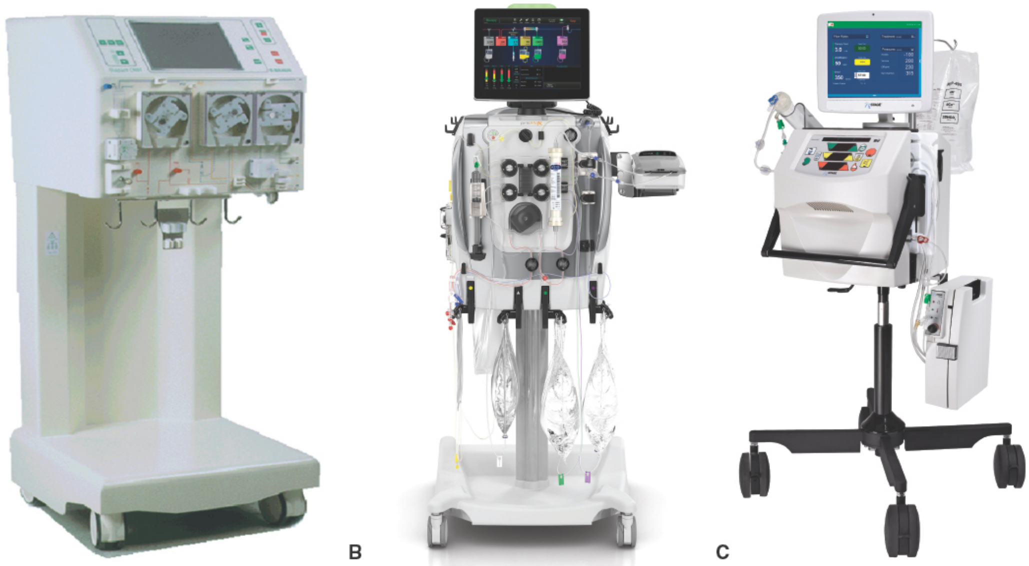
Once home HD is initiated, the home health nurse must visit periodically to evaluate adherence with the recommended techniques, to assess the patient for complications, to reinforce previous education, and to provide feedback and reassurance.

Continuing and Transitional Care

The health care team's goal in treating patients with CKD is to maximize their vocational potential, functional status, and quality of life (Browne & Johnstone, 2017). To facilitate renal rehabilitation, appropriate follow-up and monitoring by members of the health care team (physicians, dialysis nurses, renal dietitian, social worker, psychologist, home health nurses, and others as appropriate) are essential to early identification and resolution of problems. Many patients with CKD can resume relatively normal lives, doing the things that are important to them: traveling, exercising, working, or actively participating in family activities. If appropriate interventions are available early in the course of dialysis, the potential for better health improves, and the patient can remain active in family and community life. Outcome goals for renal rehabilitation include employment for those able to work, improved physical functioning of all patients, improved understanding about adaptation and options for living well, increased control over the effects of kidney disease and dialysis, and resumption of activities enjoyed before dialysis.

Continuous Renal Replacement Therapy

CRRT may be indicated for patients with acute or chronic kidney disease who are too clinically unstable for traditional HD, for patients with fluid overload secondary to oliguric (low urine output) kidney disease, and for patients whose kidneys cannot handle their acutely high metabolic or nutritional needs. Some forms of CRRT may not require dialysis machines or dialysis personnel to carry out the procedures and can be initiated quickly in the critical-care unit. Several types of CRRT are available and widely used in critical-care units (see Fig. 48-6). The methods are similar, as they require access to the circulation and blood to pass through an artificial filter. A hemofilter (an extremely porous blood filter containing a semipermeable membrane) is used in all types.



A B C

Figure 48-6 • Devices for administering continuous renal replacement therapy (CRRT) offer an integrated fluid warmer for the heating of infusion and dialysate fluids, a weighing or volumetric measuring system to reduce the possibility of error in assessing fluid balance, and a battery backup that allows treatments to continue when the patient is moved. **A.** Diapact CRRT System, B-Braun Medical, Inc., Bethlehem, PA. **B.** PrisMax, Baxter International, Inc., Chicago, Il. **C.** System One with NxView, NxStage Medical Inc. Photo courtesy of Fresenius Medical Care.

Continuous Venovenous Hemofiltration

Continuous venovenous hemofiltration (CVVH) is often used to manage AKI. Blood from a double-lumen venous catheter is pumped (using a small blood pump) through a hemofilter and then returned to the patient through a different lumen of the same catheter (Odom, 2017). CVVH provides **ultrafiltration** (continuous slow fluid removal); therefore, hemodynamic effects are mild and better tolerated by patients with unstable conditions. CVVH requires a dual-lumen venous catheter, a specialized machine, and critical-care nurses trained in management of the therapy who can set up, initiate, maintain, and terminate the system. Many hospitals have developed a collaborative approach to managing the CVVH therapy between the critical-care and nephrology nursing staff (Odom, 2017).

Continuous Venovenous Hemodialysis

Continuous venovenous hemodialysis (CVVHD) is similar to CVVH. Blood is pumped from a double-lumen venous catheter through a hemofilter and returned to the patient through a different lumen of the same catheter. In addition to the benefits of ultrafiltration, CVVHD uses a concentration gradient to facilitate the removal of uremic toxins and fluid by adding a dialysate solution into the jacket of the dialyzer, surrounding the blood in the fibers. Hemodynamic effects are usually mild and critical-care nurses can set up, initiate, maintain, and terminate the system with the support of the nephrology nursing staff (Odom, 2017).

Peritoneal Dialysis (PD)

The goals of PD are to remove toxic substances and metabolic wastes and to reestablish normal fluid and electrolyte balance. PD may be the treatment of choice for patients with kidney disease who are unable or unwilling to undergo HD or kidney transplantation. Patients who are susceptible to the rapid fluid, electrolyte, and metabolic changes that occur during HD experience fewer of these problems with the slower rate of PD. Therefore, patients with diabetes or cardiovascular disease, many older patients, and those who may be at risk for adverse effects of systemic heparin are likely candidates for PD. In addition, severe hypertension, heart failure, and pulmonary edema not responsive to usual treatment regimens have been successfully treated with PD. Fewer than 8% of patients with ESKD receive PD as their treatment modality (USRDS, 2019). Chart 48-11 discusses suitability for PD.

In PD, the peritoneal membrane that covers the abdominal organs and lines the abdominal wall serves as the semipermeable membrane. Sterile dialysate fluid, containing dextrose and electrolytes, is introduced into the peritoneal cavity through an abdominal catheter at established intervals. Once the sterile solution is in the peritoneal cavity, uremic toxins such as urea and creatinine begin to be cleared from the blood. Diffusion of these solutes occurs as waste products move from an area of higher concentration (the bloodstream) to an area of lesser concentration (the dialysate fluid) through a semipermeable membrane (the peritoneum). This movement of solute from the blood into the dialysate fluid is called clearance. Because substances cross the peritoneal membrane at different rates, adjustments in solution dwell time and volume are made to facilitate the process of clearance. Ultrafiltration occurs in PD through an osmotic gradient created by using a dialysate fluid with a higher glucose concentration than the blood.

Chart 48-11

Considerations for Peritoneal Dialysis

Although peritoneal dialysis (PD) is not suitable for all patients with end-stage kidney disease (ESKD), it is a viable therapy for those who can perform self-care and fluid exchanges and fit therapy into their own routines. Often, patients report having more energy and feeling healthier once they begin PD. Nurses can be instrumental in helping patients with ESKD find the dialysis therapy that best suits their lifestyle. Those considering PD need to understand the advantages and disadvantages along with the indications and contraindications for this form of therapy.

Advantages

- Freedom from a hemodialysis (HD) machine
- More control over daily activities
- Opportunities to eat a more liberal diet than allowed with HD; usually increased fluid allowance; improved serum hematocrit values; improved blood pressure control; avoidance of venipuncture; and improved sense of well-being.

Disadvantages

- Need for dialysis 7 days a week
- Dietary alterations related to protein and potassium losses. Patients may be encouraged to increase the intake of protein and potassium in the diet due to these losses with PD fluid exchanges

Indications

- Patient's willingness, motivation, and ability to perform dialysis at home
- Strong family or community support system (essential for success), particularly if the patient is an older adult
- Special problems with long-term HD, such as dysfunctional or failing vascular access devices, excessive thirst, severe hypertension, post-dialysis headaches, and severe anemia requiring frequent transfusion
- Interim therapy while awaiting kidney transplantation
- ESKD secondary to diabetes because hypertension, uremia, and hyperglycemia are easier to manage with PD than with HD

Contraindications

- Adhesions from previous surgery (adhesions reduce clearance of solutes) or systemic inflammatory disease
- Chronic backache and preexisting disc disease, which could be aggravated by the continuous pressure of dialysis fluid in the abdomen
- Severe arthritis or poor hand strength necessitating assistance in performing the exchange. However, patients who are blind or partially blind and those with other physical limitations can learn to perform PD

Procedure

As with other forms of treatment, the decision to begin PD is made by the patient and family in consultation with the nephrologist. With PD, the patient generally has ESKD and will need to receive ongoing treatments.

Preparing the Patient

The nurse's preparation of the patient and family for PD depends upon the assessment of the patient's physical and psychological status, mental status, previous experience with dialysis, and understanding of and familiarity with the procedure.

The nurse and surgeon or interventional radiologist or nephrologist explain the procedure to the patient. The nurse assists the provider in obtaining signed consent for insertion of the catheter. Baseline vital signs, weight, and serum electrolyte levels are recorded. Evaluation of the abdomen for placement of the catheter exit site is done to facilitate self-care. Typically, the catheter is placed on the nondominant side to allow the patient easier access to the catheter connection site when exchanges are done. The patient is instructed to empty the bladder and bowel to reduce the risk of puncture of internal organs during the insertion procedure. A prophylactic antibiotic agent will be given to prevent infection. The peritoneal catheter can be inserted in interventional radiology, in the operating room, or, rarely, at the bedside. Depending on the situation, this will need to be explained to the patient and family.

Preparing the Equipment

In addition to assembling the equipment to administer PD, the nurse consults with the physician to determine the concentration of dialysate to be used and the medications to be added. Heparin may be added to prevent fibrin formation and resultant occlusion of the peritoneal catheter. Potassium chloride may be prescribed to prevent hypokalemia. Antibiotic agents may be added to treat **peritonitis** (inflammation of the peritoneal membrane) caused by infection. Insulin is rarely added to PD fluid due to widespread use of subcutaneous insulin pumps and sliding scales (Kelman & Watson, 2017). Aseptic technique is imperative whenever medications are added to the PD solution. In a hospital setting, to prevent contamination, a pharmacist generally adds all medications to the dialysate bags in the pharmacy under a laminar flow hood. In the home setting, the nurse instructs the patient or family on how to aseptically add medications to PD fluid.

The dialysate is warmed to body temperature to prevent patient discomfort and abdominal pain and to dilate the vessels of the peritoneum to increase urea clearance. Solutions that are too cold cause pain, cramping, and vasoconstriction and reduce clearance. Dry heating (heating cabinet, incubator, or heating pad) is recommended. Methods that are never recommended include soaking the bags of solution in warm water (introduces bacteria to the exterior of the bags of solution and increases the chance of peritonitis) and using a microwave oven to heat the fluid (increases the danger of burning the peritoneum) (Kelman & Watson, 2017).

Immediately before initiating dialysis, using aseptic technique, the nurse assembles the dialysate with attached tubing and drainage bag. All PD dialysate fluid, tubing, and drainage bags are manufactured as closed systems and no spiking of solution is needed. The tubing is primed with the prepared dialysate to prevent air from entering the catheter and peritoneal cavity, which would cause abdominal discomfort and interfere with instillation and drainage of the fluid.

Inserting the Catheter

In most cases, the peritoneal catheter is inserted in the operating room or radiology suite to maintain surgical asepsis and minimize the risk of contamination. Catheters for long-term use are usually soft and flexible and made of silicone with a radiopaque strip to permit visualization on x-ray. These catheters have three sections: an intraperitoneal section, with numerous openings and an open tip to allow dialysate to flow freely; a subcutaneous section that passes from the peritoneal membrane and tunnels through muscle and subcutaneous fat to the skin; and an external section for connection to the manufacturer specific transfer set which then connects to the dialysate tubing with attached dialysate. Most adult catheters have 2 cuffs made of Dacron polyester. The cuffs stabilize the catheter, limit movement, prevent leaks, and provide a barrier against microorganisms. One cuff is placed just distal to the peritoneum, and the other cuff is placed subcutaneously. The subcutaneous tunnel (5 to 10 cm long) further protects against bacterial infection (see Fig. 48-7).

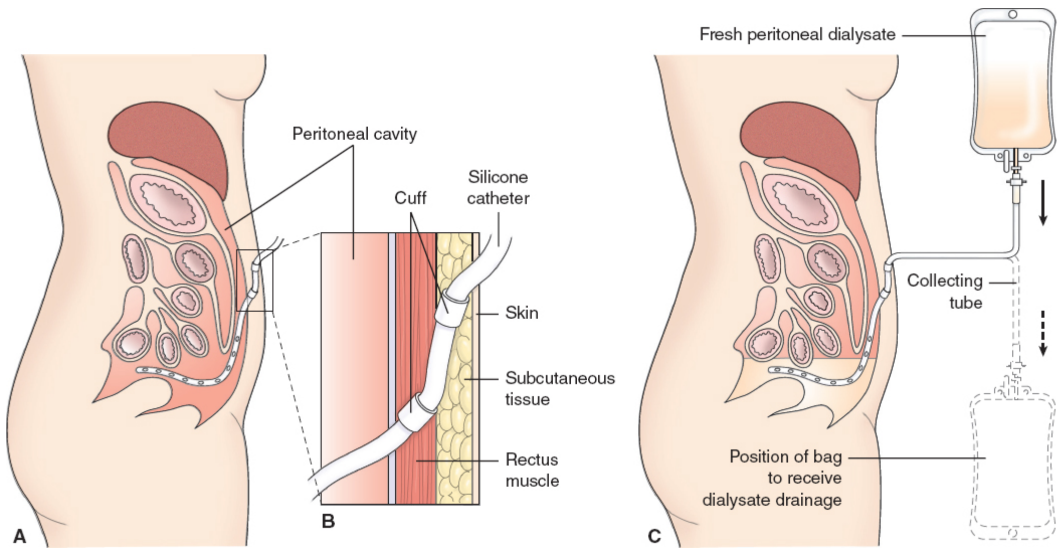


Figure 48-7 • Peritoneal dialysis. **A.** The peritoneal catheter is implanted through the abdominal wall. **B.** Dacron cuffs and a subcutaneous tunnel provide protection against bacterial infection. **C.** Continuous Ambulatory Peritoneal Dialysis (CAPD): Dialysate flows by gravity through the peritoneal catheter into the peritoneal cavity. After a prescribed period of time, the fluid is drained by gravity and discarded. New solution is then infused into the peritoneal cavity until the next drainage period. Dialysis thus continues on a 24-hour-a-day basis, during which the patient is free to move around and engage in their usual activities.

Performing the Exchange

All types of PD involve a series of exchanges or cycles. An **exchange** is the entire cycle including drainage of the **effluent** (fluid), instillation of the dialysate, and dwell. This cycle is repeated throughout the course of the dialysis.

At the end of the dwell time, the drainage portion of the exchange begins. The dialysate is infused by gravity into the peritoneal cavity. A period of about 10 minutes is usually required to infuse 2 to 3 L of fluid. A sterile cap is applied to the transfer set and the patient can perform ADLs. The prescribed dwell, or equilibration time, allows diffusion and osmosis to occur. At the end of the prescribed dwell, the patient performs hand hygiene, dons a mask, removes the sterile cap, unclamps the transfer set, and the solution drains from the peritoneal cavity by gravity through a closed system. Drainage is usually completed in 20 to 30 minutes. The drainage fluid is normally colorless or straw-colored and should not be cloudy. Bloody or pink-colored drainage may be seen in the first few exchanges after insertion of a new catheter, but should not occur after that time (Kelman & Watson, 2017).

The number of cycles or exchanges and their frequency are prescribed based on monthly laboratory values and the presence of uremic symptoms. The exchanges can be performed manually during the waking hours by the patient (continuous ambulatory peritoneal dialysis [CAPD]) or via the use of a PD machine (cycler) that automatically performs exchanges, usually while the patient is sleeping at night (continuous cycling peritoneal dialysis [CCPD]).

The removal of excess water during PD occurs because dialysate has a high dextrose concentration, making it hypertonic. An osmotic gradient is created between the blood and the dialysate solution. Dextrose solutions of 1.5%, 2.5%, and 4.25% are available in several volumes, from 1000 to 3000 mL. The higher the dextrose concentration, the greater the osmotic gradient and the more water will be removed. Selection of the appropriate solution is based on the patient's fluid status (Kelman & Watson, 2017).

Complications

Most complications of PD are often minor; however, several, if unattended, can have serious consequences.

Acute Complications

Peritonitis

Peritonitis is the most common and serious complication of PD. The first sign of peritonitis is cloudy dialysate effluent (Kelman & Watson, 2017). Diffuse abdominal pain and rebound tenderness often occur later. Hypotension and other signs of shock may also occur with advancing infection. The patient with peritonitis may be treated as an inpatient or outpatient (most common), depending on the severity of the infection and the patient's clinical status. Effluent is examined for WBC count. Gram stain and culture are used to identify the organism and guide treatment. If the effluent WBC count is greater than 100 μL (after a dwell time of at least 2 hours) with over 50% polymorphonuclear cells, then broad-spectrum antibiotic agents (aminoglycosides or cephalosporins) are usually added to subsequent exchanges until Gram stain or culture results are available for specific antibiotic sensitivity. Intraperitoneal administration of antibiotic agents is as effective as IV administration and, therefore, most often used. Antibiotic therapy continues for 14 to 21 days (Kelman & Watson, 2017). Careful selection and calculation of the antibiotic dosages are needed to prevent nephrotoxicity and further compromise of residual renal function.

During an episode of peritonitis, the patient loses large amounts of protein through the peritoneal membrane due to inflammation and increased permeability. Acute malnutrition and delayed healing and recovery from the peritonitis may result. Therefore, attention must be given to educating the patient to detect and promptly seek treatment for peritonitis.

Leakage

In general, use of the PD catheter is delayed for at least 2 weeks post insertion to allow healing to occur and to prevent leakage through the tunnel and exit site. It also allows the exit site time to heal. However, leakage of dialysate through the catheter site may occur even after a healing period. Usually, the leak stops spontaneously when dialysis is withheld for several days, giving the tissue the opportunity to heal around the catheter cuffs and to seal the insertion tunnel. During this time, it is important to reduce factors that might delay healing, such as undue abdominal muscle activity (bending, lifting over 5 lb) and straining during bowel movements. In many cases, leakage can be avoided by using small volumes (500 mL) of dialysate, gradually increasing the volume up to 2000 to 3000 mL (Payton & Kennedy, 2017).

Bleeding

Bloody effluent may be observed occasionally, especially in young, menstruating women. (The hypertonic fluid pulls blood from the uterus, through the opening in the fallopian tubes, and into the peritoneal cavity.) Bleeding is also common during the first few exchanges after a new catheter insertion because some blood enters the abdominal cavity following insertion. The bleeding most often clears up after several exchanges. In many cases, no cause can be found for the bleeding, although catheter displacement from the pelvis has occasionally been associated with bleeding. Some patients have had bloody effluent after an enema or from minor trauma. Most often, bleeding stops in 1 to 2 days and requires no specific intervention. More frequent exchanges and the addition of heparin to the dialysate during this time may be necessary to prevent blood clots from obstructing the catheter (Kelman & Watson, 2017).

Long-Term Complications

Hypertriglyceridemia, likely due to the use of glucose containing dialysate, is common in patients on long-term PD, suggesting that the therapy may contribute to atherogenesis. Cardiovascular disease is the leading cause of morbidity and mortality in patients with both CKD and ESKD, and many patients have suboptimal blood pressure control which contributes to cardiovascular disease. Beta-blockers and ACE inhibitors are often used to control hypertension, decrease proteinuria, and protect the heart, and the use of aspirin and statins should be considered (Schonder, 2017).

Other complications that may occur with long-term PD include abdominal hernias (incisional, inguinal, diaphragmatic, and umbilical), likely resulting from continuously increased intra-abdominal pressure. The persistently elevated intra-abdominal pressure also aggravates symptoms of hiatal hernia and hemorrhoids. Low back pain and anorexia from fluid in the abdomen and a constant sweet taste related to glucose absorption may also be experienced by the patient.

Mechanical problems occasionally occur and may interfere with instillation or drainage of the dialysate. Formation of clots and fibrin in the peritoneal catheter and constipation are factors that may contribute to these problems.

Approaches

PD can be performed using several different approaches: acute intermittent peritoneal dialysis, CAPD, and CCPD.

Acute Intermittent Peritoneal Dialysis

Indications for acute intermittent PD, a variation of PD, include uremic signs and symptoms (nausea, vomiting, fatigue, altered mental status), fluid overload, acidosis, and hyperkalemia. Although PD is not as efficient as HD in removing solute and fluid, it permits a more gradual change in the patient's fluid volume status and in waste product removal. Therefore, it may be the treatment of choice for the patient who is hemodynamically unstable. It can be carried out manually (the nurse warms and hangs each container of dialysate) or by a cycler machine. Exchange times range from 30 minutes to 2 hours. One example of a routine is hourly exchanges consisting of a 10-minute infusion, a 30-minute dwell time, and a 20-minute drain time. Acute intermittent PD is not indicated for long-term patient management, but for specific situations such as patients who are referred late in the course of CKD (CKD stage 5) and require immediate dialysis (Kelman & Watson, 2017).

Maintaining the PD cycle is a nursing responsibility. Aseptic technique is maintained when changing solution bags and emptying effluent bags. Vital signs, weight, I&O, laboratory values, and patient status are frequently monitored. The nurse uses a flow sheet on paper or within the electronic health record to document each exchange and records vital signs, dialysate concentration, medications added, exchange volume, dwell time, dialysate fluid balance for each exchange (fluid lost or gained), and cumulative fluid balance. The nurse also carefully assesses skin turgor and mucous membranes to evaluate fluid status and monitor the patient for edema. Daily weight is the most accurate indicator of fluid volume status. Patients receiving CAPD are generally weighed with a dwell, while those on CCPD may not carry a daytime dwell and may be weighed without a dwell. The presence of absence of a dwell during the daily weight should be documented.

Quality and Safety Nursing Alert

If the peritoneal fluid does not drain properly, the nurse can facilitate drainage by turning the patient from side to side, having the patient sit or stand, or raising the head of the bed. The peritoneal catheter should never be manipulated.

Other measures to promote drainage include checking the patency of the catheter by inspecting for kinks, closed clamps, or an air lock. The nurse monitors for complications, including peritonitis, bleeding, respiratory difficulty, and leakage of peritoneal fluid around the catheter. In addition, the nurse must ensure that the PD catheter remains secure and that the dressing remains dry and is changed on a routine basis. The patient and family are educated about the procedure and are kept informed about progress (fluid loss, weight loss, laboratory values). Emotional support and encouragement are given to the patient and family during this stressful and uncertain time.

Continuous Ambulatory Peritoneal Dialysis (CAPD)

Continuous ambulatory peritoneal dialysis (CAPD) works on the same principles as other forms of PD: diffusion and osmosis. Less extreme fluctuations in the patient's laboratory values occur with CAPD than with intermittent PD or HD because the dialysis is constantly in progress. The serum electrolyte levels often remain in the normal range.

Procedure

The patient performs exchanges four or five times a day, 24 hours a day, 7 days a week, at intervals scheduled throughout the day. Different manufacturers supply slightly different equipment. A closed Y-shaped system is most commonly used, in which a bag containing dialysate solution comes connected to one branch of the "Y" and a sterile empty bag is connected to the second branch. This leaves the third part of the "Y" open and available for connection to the transfer set on the PD catheter. To perform an exchange, the patient (or person doing the exchange) washes their hands, dons a mask, and then removes the cap from the transfer set while maintaining sterility. The open end of the "Y" set is connected to the end of the transfer set and the dialysate is drained into the attached empty sterile bag (effluent) (over about 20 to 30 minutes). Then the attached dialysate is infused, the patient clamps off the transfer set and the tubing set, disconnects the tubing set, and applies a new sterile cap to the transfer set, making it a closed system.

For some patients, depending on the characteristic of the peritoneal membrane, the longer the dwell time, the better the clearance of uremic toxins. If dwell time is excessive (e.g., overnight dwells), the patient will absorb some of the effluent back into the body simply because the osmotic gradient is lost.

Once equilibrium is reached, the movement of fluid and toxins stops (Kelman & Watson, 2017).

Complications

To reduce the risk of peritonitis, the patient (and all caregivers) must use meticulous aseptic care to avoid contaminating the catheter, fluid, or tubing and to avoid accidentally disconnecting the catheter from the tubing. Whenever a connection or disconnection is made, hand hygiene must be performed and a mask worn by anyone within 6 ft of the area to avoid contamination with airborne bacteria. Excess manipulation should be avoided, and meticulous care of the catheter exit site is provided using a standardized protocol. At home, a patient is taught to use clean technique for exit site care (Payton & Kennedy, 2017). In the hospital, due to the increased risk of infection, sterile technique is employed by the nurse and patient.

Continuous Cyclic Peritoneal Dialysis

Continuous cyclic peritoneal dialysis (CCPD) uses a machine called a cycler to provide the fluid exchanges. It is programmed to deliver an established amount of PD solution that will dwell in the peritoneal cavity for a programmed period of time before it drains from the peritoneal cavity via gravity. The cycler is also set to deliver a specific number of fluid changes in a designated period of time. Because it is programmed, it also keeps track of the total amounts removed and will sound an alarm if limits are not met. It requires that a person set up and break down the system for use, which typically takes about 30 minutes.

CCPD may combine overnight intermittent PD with a prolonged dwell time during the day. However, some patients are drained completely after completing the nighttime exchanges and do not carry a dwell during the day. This avoids reabsorption of fluid during the long daytime dwell. Every evening, the patient connects the peritoneal catheter to tubing on the cycler machine, usually just before the patient goes to sleep for the night. Because the machine is very quiet, the patient can sleep, and the extra-long tubing allows the patient to move and turn normally. In the morning, the patient disconnects from the cycler. This process is done every day to achieve the effects of dialysis required.

CCPD has a lower infection rate than other forms of PD because there are fewer opportunities for contamination with bag changes and tubing disconnections. It also allows the patient to be free from exchanges throughout the day, making it possible to engage in work and activities of daily living more freely (Kelman & Watson, 2017).

Nursing Management

Meeting Psychosocial Needs

In addition to the complications of PD described previously, patients who elect to do PD may experience altered body image because of the presence of the abdominal catheter, bag, tubing, and cycler. Waist size increases from 1 to 2 inches (or more) with fluid in the abdomen. This affects clothing selection and may make the patient feel distended or fat. The nurse may arrange for the patient to talk with other patients who have adapted well to PD. Although some patients have no psychological problems with the catheter—they think of it as their lifeline and as a life-sustaining device—other patients feel they are doing exchanges all day long and have no free time, particularly in the beginning. They may experience depression because they feel overwhelmed with the responsibility of self-care.

Patients undergoing PD may also experience altered sexuality patterns and sexual dysfunction. The patient and partner may be reluctant to engage in sexual activities, partly because of the catheter being psychologically "in the way" of sexual performance. In patients on CCPD, the presence of the dialysis cycler in the bedroom and the continual connection during the sleeping hours can also cause interference with intimacy. Although these problems may resolve with time, some problems may warrant special counseling. Questions by the nurse about concerns related to sexuality and sexual function often provide the patient with a welcome opportunity to discuss these issues and a first step toward assisting in their resolution.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Patients are educated as inpatients or outpatients to perform PD once their condition is medically stable. Education generally takes 5 days to 2 weeks. Patients are taught according to their own learning ability and knowledge level and only as much at one time as they can handle without feeling uncomfortable or becoming saturated. Education topics for the patient and family who will be performing PD at home are described in Chart 48-12. The use of an adult learning theory–based curriculum may decrease peritonitis and exit site infection rates (Kelman & Watson, 2017).

Chart 48-12 HOME CARE CHECKLIST

Peritoneal Dialysis, Continuous Ambulatory Peritoneal Dialysis, or Continuous Cycling Peritoneal Dialysis

At the completion of education, the patient and/or caregiver will be able to:

- Discuss kidney disease and its effects on the body.
- State the goal and purpose of dialysis and its impact on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- Describe the basic principles of peritoneal dialysis (PD) and exchange options such as continuous ambulatory peritoneal dialysis (CAPD), or continuous cycling peritoneal dialysis (CCPD).
- State what types of changes are needed (if any) to support home PD therapy and maintain a clean home environment and prevent infection.
- State how to contact the primary provider, the team of home care professionals overseeing care, and supply vendor.
  - Discuss ordering, storage, and inventory of dialysis supplies.
  - List emergency phone numbers.
- State the name, dose, side effects, frequency, and schedule for all medications.
  - Demonstrate procedure for adding medications to the dialysis solution.
- Demonstrate catheter and exit site care.
- Demonstrate measurement of vital signs and weight measurement.
- Discuss monitoring and management of fluid balance.
- Discuss basic principles of aseptic technique.
- Demonstrate the CAPD or CCPD exchange procedure using aseptic technique (patients receiving CCPD should also demonstrate exchange procedure in case of failure or unavailability of cycling machine) and discuss cycling machine warning signals and how to address these signals.
- Demonstrate maintenance of home dialysis records.
- Demonstrate procedure for obtaining sterile PD fluid samples.
- Discuss routine laboratory tests needed and implications of results.
- Discuss high protein diet and diet to avoid constipation, any other dietary restrictions as indicated.
- Discuss complications of PD; prevention, recognition, and management of complications.
- Describe actions in case of emergency.
- Relate how to reach primary provider with questions or complications.
- State time and date of follow-up medical appointments, therapy, and testing.
- Collaborate with renal/dialysis social worker to coordinate financial arrangements for PD and strategies to identify and obtain resources.
- Identify sources of support (e.g., friends, relatives, faith community).

- Identify the contact details for support services for patients and their caregivers/families.
- Identify the need for health promotion, disease prevention, and screening activities.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Because of protein loss with PD, the patient is instructed to eat a high-protein (1.2 to 1.3g/kg/day), low phosphorus, nutritious diet (NKF KDOQI, 2000). The patient is also encouraged to increase their daily fiber intake to help prevent constipation, which can impede the flow of dialysate into or out of the peritoneal cavity. Patients may gain 3 to 5 lb within a month of initiating PD, so they may be asked to limit their carbohydrate intake to avoid weight gain. Potassium and fluid restrictions are not usually necessary. Patients commonly lose at least 1 to 2 L of fluid over and above the volume of dialysate infused into the abdomen during a 24-hour period, permitting a moderate fluid intake.

Continuing and Transitional Care

Follow-up care through phone calls, visits to the dialysis clinic, outpatient department, and continuing home care assists patients in the transition to home and promotes their active participation in their own health care. Patients often check with the nurse to see if they are making the correct choices about dialysate or control of blood pressure, or simply to discuss a problem.

Patients may be seen by the PD team as outpatients once a month or more often if needed. The exchange procedure is evaluated at that time to reassess that strict aseptic technique is followed. Blood chemistry and effluent values are followed closely to make certain the therapy is adequate for the patient.

If a referral is made for home care, the home health nurse assesses the home environment and suggests modifications to accommodate the equipment and facilities needed to carry out PD. In addition, the nurse assesses the patient's and family's understanding of PD and evaluates their technique in performing PD. Assessments include checking for changes related to kidney disease; any complications such as peritonitis; medication management; and treatment-related problems such as heart failure, inadequate drainage, and weight gain or loss. The nurse continues to reinforce and clarify education about PD and ESKD and assesses the patient's and family's progress in coping with the procedure. This is also an opportunity to remind patients about the need to participate in appropriate health promotion activities and health screening (e.g., gynecologic examinations, colonoscopy).

Special Considerations: Nursing Management of the Patient on Dialysis Who Is Hospitalized

Whether undergoing HD or PD, the patient may be hospitalized for treatment of complications related to the dialysis treatment, the underlying kidney disorder, or health problems not related to renal dysfunction or its treatment.

Protecting Vascular Access

When the patient undergoing HD is hospitalized for any reason, care must be taken to protect the vascular access. The nurse assesses the vascular access for patency and takes precautions to ensure that the extremity with the vascular access is not used for measuring blood pressure or for obtaining blood specimens. Constricting dressings, restraints, or jewelry over the vascular access must be avoided as well (Inglese, 2017).

The bruit, or “thrill,” over the venous access site must be evaluated at least every 8 to 12 hours. Absence of a palpable thrill or audible bruit may indicate blockage or clotting in the vascular access. Clotting can occur if the patient has an infection anywhere in the body (serum viscosity increases) or if the blood pressure has dropped. When blood flow is reduced through the access for any reason (hypotension, application of blood pressure cuff or tourniquet), the access can clot. When a patient has an HD catheter, the nurse must observe for signs and symptoms of infection such as redness, swelling, drainage from the exit site, fever, and chills. The nurse must assess the integrity of the dressing and change it as needed. Patients with kidney disease are more prone to infection; therefore, appropriate infection control measures must be used for all procedures. The patient’s vascular access should not be used for any purpose other than dialysis, unless it is an emergency situation and no other access is available. In this situation, a dialysis nurse or physician should cannulate the vascular access. If accessing an HD catheter in an emergency, the catheter dwell volume should be withdrawn prior to medication or fluid administration.

Taking Precautions during Intravenous Therapy

When the patient needs IV therapy, the rate of administration must be as slow as possible to avoid volume overload in the patient with renal disease or ESKD. Accurate I&O records are essential.

Quality and Safety Nursing Alert

Because patients on dialysis cannot excrete water, rapid administration of IV fluid can result in pulmonary edema.

Monitoring Symptoms of Uremia

As metabolic end products accumulate, symptoms of uremia worsen. Patients whose metabolic rate accelerates (those receiving corticosteroid medications or parenteral nutrition, those with infections or bleeding disorders, those undergoing surgery) accumulate waste products more quickly and may require daily dialysis. These same patients are more likely than other patients receiving dialysis to experience complications.

Detecting Cardiac and Respiratory Complications

Cardiac and respiratory assessment must be conducted frequently. As fluid builds up, fluid overload, heart failure, and pulmonary edema develop. Crackles in the bases of the lungs, moist cough and frothy, blood-tinged sputum may indicate pulmonary edema.

Pericarditis may result from the accumulation of uremic toxins. If not detected and treated promptly, this serious complication may progress to pericardial effusion and cardiac tamponade. Pericarditis is detected by the patient's report of substernal chest pain, low-grade fever, and pericardial friction rub. A pulsus paradoxus (a decrease in blood pressure of more than 10 mm Hg during inspiration) is often present. When pericarditis progresses to effusion, the friction rub disappears, heart sounds become distant and muffled, ECG waves show very low voltage, and the pulsus paradoxus worsens (see Chapter 24 for further discussion of pericarditis).

The effusion may progress to life-threatening cardiac tamponade, noted by narrowing of the pulse pressure in addition to muffled or inaudible heart sounds, crushing chest pain, dyspnea, and hypotension. An emergent pericardial window procedure is performed and a chest tube is inserted to drain the pericardial effusion. The effusion fluid is sent for laboratory and cytology analysis.

Quality and Safety Nursing Alert

Although pericarditis, pericardial effusion, and cardiac tamponade can be detected by chest x-ray, they should also be detected through astute nursing assessment. Because of their clinical significance, assessment of the patient for these complications is a priority.

Controlling Electrolyte Levels and Diet

Electrolyte alterations are common, and potassium changes can be life-threatening. All IV solutions and medications to be given are evaluated for their electrolyte content. Serum laboratory values are assessed daily. If blood transfusions are required, they may be given during HD, if possible, so that excess potassium and fluid can be removed and hypervolemia is avoided. Dietary intake must also be monitored. The patient's frustrations related to dietary restrictions typically increase if the food is unappetizing. The nurse needs to recognize that this may lead to dietary indiscretion with resultant hyperkalemia.

Hypoalbuminemia is an indicator of malnutrition in patients undergoing long-term or maintenance dialysis. Although some patients can be treated with adequate nutrition alone, some patients remain hypoalbuminemic for reasons that are poorly understood.

Managing Discomfort and Pain

Complications such as pruritus and pain secondary to neuropathy must be managed. Antihistamine agents, such as diphenhydramine, are commonly used, and analgesic medications may be prescribed. However, because elimination of the metabolites of medications occurs through dialysis rather than through renal excretion, medication dosages often need to be adjusted. Keeping the skin clean and well moisturized using bath oils, superfatted soap, and creams or lotions helps promote comfort and reduce itching. Instructing the patient to keep the nails trimmed to avoid scratching and excoriation also promotes comfort.

Monitoring Blood Pressure

Hypertension in kidney disease is common. It is usually the result of fluid overload and, in part, oversecretion of renin. Many patients undergoing dialysis receive some form of antihypertensive therapy. Patients require detailed education and reinforcement of information regarding their antihypertensive regimen, because it is not uncommon for patients to need more than one antihypertensive agent. Rapid fluid fluctuations in patients receiving dialysis also create challenges to maintaining blood pressure control. Antihypertensive agents are often withheld before dialysis and administered after dialysis to avoid hypotension due to the combined effect of fluid removal with the dialysis treatment and the medication (Campoy, 2017). Typically, these patients require multiple antihypertensive agents to achieve normal blood pressure, thus adding to the total number of medications needed on an ongoing basis (Campoy, 2017).

Preventing Infection

Patients with ESKD commonly have decreased phagocytic ability with low WBC counts, low RBC counts (anemia), impaired platelet function, and are often prescribed anticoagulants to prevent heart attacks and strokes. Together, these pose a high risk of infection and potential for bleeding after even minor trauma. Preventing and controlling infection are essential because the incidence of infection is high. Infection of the vascular access site and pneumonia are common (Inglese, 2017).

Caring for the Catheter Site

Patients receiving CAPD usually know how to care for the catheter exit site. However, the hospital stay is an opportunity to assess catheter care technique and correct misperceptions or deviations from recommended technique. Recommended daily or 3 or 4 times weekly routine catheter site care is typically performed during showering or bathing (Payton & Kennedy, 2017). The exit site should not be submerged in bathwater. The most common cleaning method is soap and water; liquid soap is recommended. During care, the nurse and patient need to make sure that the catheter remains secure to avoid tension and trauma. The patient may wear a gauze dressing over the exit site.

Administering Medications

All medications and the dosage prescribed for any patient on dialysis must be closely monitored to avoid those that are toxic to the kidneys and may threaten residual renal function. Medications are also scrutinized for potassium and magnesium content; those medications that contain them are avoided. Care must be taken to evaluate all problems and symptoms that the patient reports without automatically attributing them to kidney disease or to dialysis therapy.

Providing Psychological Support

Over time, patients undergoing chronic dialysis may begin to reevaluate their status, the treatment modality, their satisfaction with life, and the impact of these factors on their families and support systems. Nurses must provide opportunities for these patients to express their feelings and reactions and to explore options. The decision to begin dialysis does not require that dialysis be continued indefinitely, and it is not uncommon for patients to consider discontinuing treatment. These feelings and reactions must be taken seriously, and the patient should have the opportunity to discuss them with the dialysis team as well as with a psychologist, psychiatrist, psychiatric nurse, trusted friend, or spiritual advisor. After a psychiatric evaluation has ruled out depression, the patient's informed decision about discontinuing treatment should be respected. If the patient is thought to be depressed, treatment for depression should be initiated and the patient stabilized prior to participating in decisions on advanced directives (Molzahn & Schick-Makaroff, 2017).

KIDNEY SURGERY

A patient may undergo surgery or procedures in the interventional radiology department to remove obstructions that affect the kidney (tumors or calculi), to insert a tube for draining the kidney (nephrostomy, ureterostomy), or to remove the kidney involved in unilateral kidney disease, renal carcinoma, or kidney transplantation.

Management of Patients Undergoing Kidney Surgery

Preoperative Considerations

Surgery is performed only after a thorough evaluation of renal function. Patient preparation to ensure that optimal renal function is maintained is essential. Fluids are encouraged to promote increased excretion of waste products before surgery unless contraindicated because of preexisting renal or cardiac dysfunction. If kidney infection is present preoperatively, broad-spectrum antimicrobial agents may be prescribed to prevent bacteremia. Antibiotic agents must be given with extreme care because many are toxic to the kidneys. Coagulation studies (prothrombin time, partial thromboplastin time, platelet count) may be indicated if the patient has a history of bruising and bleeding. The preoperative preparation is similar to that described in Chapter 14.

Because many patients facing kidney surgery are apprehensive, the nurse encourages the patient to recognize and verbalize concerns. Confidence is reinforced by establishing a relationship of trust and by providing expert care. Patients faced with the prospect of losing a kidney may think that they will have to depend on dialysis for the rest of their lives. The nurse reassures the patient and family that normal renal function can be maintained by a single healthy kidney.

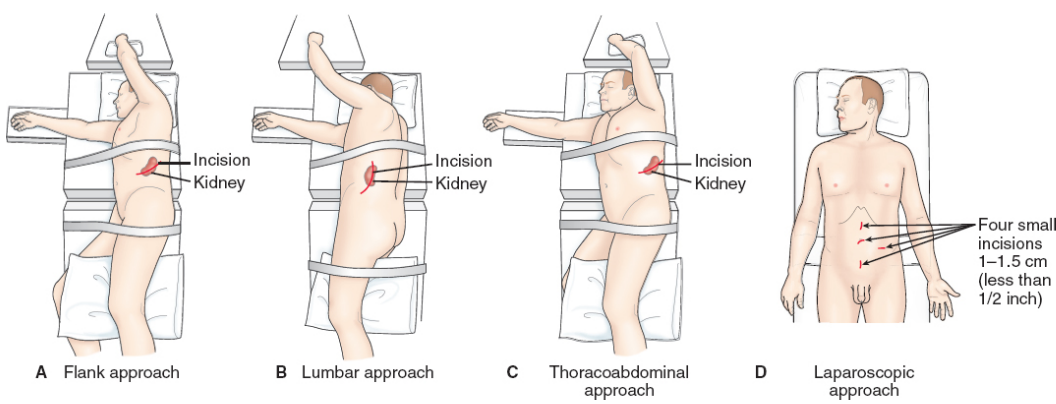


Figure 48-8 • Patient positioning and incisional approaches for nephrectomy—flank (**A**), lumbar (**B**), thoracoabdominal (**C**)—for kidney surgery are associated with significant postoperative discomfort. **(D)** Laparoscopic nephrectomy is associated with less discomfort and faster recovery times.

Perioperative Concerns

Kidney surgery requires various patient positions to expose the surgical site adequately. Three surgical approaches are common: flank, lumbar, and thoracoabdominal (see Fig. 48-8A–C). Laparoscopic urologic surgery is often performed as a less invasive option than open surgery (see Fig. 48-8D). During surgery, plans are carried out for managing altered urinary drainage. These may include inserting a nephrostomy or other drainage tube.

Postoperative Management

Because the kidney is a highly vascular organ, hemorrhage and shock are the chief potential complications of kidney surgery. Fluid and blood component replacement is frequently necessary in the immediate postoperative period to treat intraoperative blood loss.

Abdominal distention and paralytic ileus may occur after renal and ureteral surgery and are thought to be due to a reflex paralysis of intestinal peristalsis and manipulation of the colon or duodenum during surgery. Abdominal distention is relieved by decompression through a nasogastric tube. See Chapter 41 for treatment of paralytic ileus. Oral fluids are permitted when the passage of flatus is noted.

If infection occurs, antibiotics are prescribed after a culture reveals the causative organism. The toxic effects that antibiotic agents have on the kidneys (nephrotoxicity) must be kept in mind when assessing the patient. Low-dose heparin therapy may be initiated postoperatively to prevent thromboembolism in patients who have had any type of urologic surgery.

Nursing Management

In addition to those interventions listed in this section, Chart 48-13 provides a plan of nursing care for the patient undergoing kidney surgery.

Providing Immediate Postoperative Care

Immediate postoperative care of the patient who has undergone kidney surgery includes assessment of all body systems. Respiratory and circulatory status, pain level, fluid and electrolyte status, and patency and adequacy of urinary drainage systems are assessed.

Respiratory Status

As with any surgery, the use of anesthesia increases the risk of respiratory complications. Noting the location of the surgical incision assists the nurse in anticipating respiratory problems and pain. Respiratory status is assessed by monitoring the rate, depth, and pattern of respirations. The location of the incision frequently causes pain on inspiration and coughing; therefore, the patient tends to splint the chest wall and take shallow respirations. Auscultation is performed to assess normal and adventitious breath sounds.

Circulatory Status and Blood Loss

The patient’s vital signs and arterial or central venous pressure are monitored. Skin color and temperature and urine output provide information about circulatory status. The surgical incision and drainage tubes are observed frequently to help detect unexpected blood loss and hemorrhage.

Pain

Postoperative pain is a major problem for the patient because of the location of the surgical incision and patient’s position on the operating table to permit access to the kidney. The location and severity of pain are assessed before and after analgesic medications are given. Abdominal distention, which increases discomfort, is also noted.

Urinary Drainage

Urine output and drainage from tubes inserted during surgery are monitored for amount, color, and type or characteristics. Decreased or absent drainage is promptly reported to the primary provider because it may indicate obstruction that could cause pain, infection, and disruption of the suture lines.

Chart 48-13 LAN OF NURSING CARE

Care of the Patient Undergoing Kidney Surgery

NURSING DIAGNOSIS: Impaired airway clearance associated with pain of high abdominal or flank incision, abdominal discomfort, and immobility; impaired breathing pattern associated with high abdominal incision
GOAL: Improved airway clearance

Nursing Interventions	Rationale	Expected Outcomes
1. Assess respiratory status: a. Rate b. Breath sounds 2. Administer analgesic agent as prescribed. 3. Splint incision with hands or pillow to assist patient in coughing. 4. Assist patient to change positions frequently. 5. Encourage the use of incentive spirometer as indicated or prescribed. 6. Assist with and encourage early ambulation.	1. Baseline data allow for monitoring of changes and evaluating effectiveness of interventions. 2. Adequate pain relief enables patient to take deep breaths and cough. 3. Splints incision and promotes adequate cough and prevention of atelectasis. 4. Promotes drainage and inflation of all lobes of the lungs. 5. Encourages adequate deep breaths. 6. Mobilizes pulmonary secretions.	• Exhibits respiratory rate of 12 to 18 breaths/min and normal breath sounds without adventitious sounds • Takes deep breaths and coughs adequately when encouraged and assisted • Exhibits full thoracic excursion without shallow respirations • Uses incentive spirometer with encouragement • Splints incision while taking deep breaths and coughing • Reports progressively less pain and discomfort with coughing and deep breaths

NURSING DIAGNOSIS: Acute pain and discomfort associated with surgical incision, positioning, and stretching of muscles during kidney surgery
GOAL: Relief of pain and discomfort

Nursing Interventions	Rationale	Expected Outcomes
1. Assess level of pain based on measureable scale rating. 2. Administer analgesic agents as prescribed. 3. Splint incision with hands or pillow during movement or deep breathing and coughing exercises. 4. Assist and encourage early ambulation. 5. Offer and educate patient how to use appropriate nonpharmacologic interventions. 6. Evaluate the effectiveness of pain relief using a scale rating.	1. Provides baseline for later evaluation of pain relief strategies. 2. Promotes pain relief. 3. Minimizes sensation of pulling or tension on incision and provides sense of support to the patient. 4. Promotes resumption of muscle activity exercise. 5. Many nonpharmacologic interventions, such as music, relaxation exercises, and imagery assist patients to decrease their pain. 6. A scale provides an objective measure of the efficacy of pain relief strategies.	• Reports decreased pain on pain scale to a level that is acceptable to the patient. • Takes analgesia as prescribed • Exercises aching muscles within recommendations • Uses music, relaxation exercises, and imagery to relieve pain • Exhibits no behavioral manifestations of pain and discomfort (e.g., restlessness, perspiration, verbal expressions of pain) • Participates in deep-breathing and coughing exercises • Gradually increases physical activity and exercise

NURSING DIAGNOSIS: Fear and anxiety associated with diagnosis, outcome of surgery, and alteration in urinary function
GOAL: Reduction of fear and anxiety

Nursing Interventions	Rationale	Expected Outcomes

1. Assess patient's anxiety and fear before surgery if possible. 2. Assess patient's knowledge about procedure and expected surgical outcome preoperatively. 3. Evaluate the meaning of alterations resulting from surgical procedure for the patient and family or partner. 4. Encourage patient to verbalize reactions, feelings, and fears. 5. Encourage patient to share feelings with spouse or partner. 6. Offer and arrange for visit from member of support group (e.g., ostomy group, transplant group, if indicated).	1. Provides a baseline for postoperative assessment. 2. Provides a basis for further education. 3. Enables understanding of patient's reactions and responses to expected and unexpected results of surgery. 4. Affirms patient's understanding of and ultimate resolution of feelings and fears. 5. Enables patient and partner to receive mutual support and reduces sense of isolation from each other. 6. Provides support from another person who has encountered the same or a similar surgical procedure and an example of how others have coped with the alteration.	• Verbalizes reactions and feelings to staff • Shares reactions and feelings with family or partner • Grieves appropriately for self and for changes in role and function • Identifies information needed to promote own adaptation and coping • Participates in activities and events in immediate environment • Accepts visit from support group if indicated • Identifies support person or support group

NURSING DIAGNOSIS: Impaired urination associated with urinary drainage; risk for urinary infection associated with altered urinary drainage
GOAL: Maintenance of urinary elimination; infection-free urinary tract

Nursing Interventions	Rationale	Expected Outcomes

1. Assess urinary drainage system immediately. 2. Assess adequacy of urinary output and patency of drainage system. 3. Assess pertinent laboratory values (see Chapter 47, Table 47-5). 4. Use asepsis and hand hygiene when providing care and manipulating drainage system. 5. Maintain closed urinary drainage system. 6. If irrigation of the drainage system is necessary, use sterile gloves and sterile irrigating solution and a closed drainage and irrigation system. 7. If irrigation is necessary and prescribed, perform it gently with sterile saline and the prescribed amount of irrigating fluid. 8. Assist patient in turning and moving in bed and when ambulating to prevent displacement or	1. Provides basis for further assessment and action. 2. Provides baseline. 3. Provides basis for further assessment and action. 4. Prevents or reduces risk of contamination of urinary drainage system. 5. Reduces risk of bacterial contamination and infection. 6. Permits irrigation when necessary while maintaining closed drainage system, minimizing risk of infection. 7. Maintains patency of the catheter or drainage system and prevents sudden increases in pressure in the urinary tract that may cause trauma, pressure on sutures or urinary tract structures, and pain. 8. Prevents trauma from accidental displacement of urinary stent or ureteral catheter necessitating repeated	• Exhibits adequate urinary output and patent drainage system • Exhibits urinary output consistent with fluid intake • Demonstrates normal laboratory values: blood urea nitrogen, serum creatinine levels, urine specific gravity, and osmolality • Exhibits sterile urine on urine culture • Exhibits clear, dilute urine without debris or encrustation in the drainage system • States rationale for avoiding manipulation of catheter, drainage, or irrigation system • Exhibits normal placement of urinary stent or ureteral catheters until removed by physician • Maintains closed urinary drainage system • Exhibits normal body temperature without signs or symptoms of

inadvertent removal of urinary stent or ureteral catheters if in place.

9. Observe urine color, volume, odor, and components.
10. Minimize trauma and manipulation of catheter, drainage system, and urethra.
11. Clean catheter gently with soap during bathing, avoiding any to-and-fro movement of catheter.
12. Anchor drainage tube with hospital-approved device (e.g., Stat-Lock).
13. Maintain adequate fluid intake.
14. Assist with and encourage early ambulation while ensuring placement of urinary drainage system.
15. If patient is to be discharged with urinary drainage system (catheter) in place or a urinary diversion, instruct patient and family member in care.

instrumentation of the urinary tract (e.g., cystoscopy) to replace them.

9. Provides information about adequacy of urine output, condition and patency of drainage system, and debris in urine.
10. Reduces risk of contamination of drainage system and eliminates site of bacterial invasion.
11. Removes debris and encrustations without causing trauma to or contamination of urethra.
12. Prevents movement or slipping of drainage tube, minimizing trauma to and contamination of urethra or catheter.
13. Promotes adequate urine output and prevents urinary stasis.
14. Minimizes cardiovascular and pulmonary complications while preventing loss, dislodging, or

urinary tract infection

- Cleans catheter twice daily with soap and water or antibacterial meatal cleansing cloths
- Consumes adequate fluid intake (6 to 8 glasses of water or more per day, unless contraindicated)
- Urinary drainage system remains in place until physician orders discontinuation.
- Maintains urinary drainage system without infection or obstruction
- Maintains urinary diversion as instructed
- Maintains self-care so that environment is odor free

	disruption of drainage system. 15. Knowledge and understanding of the drainage system or urinary diversion are essential to prevent infection and other complications.	

NURSING DIAGNOSIS: Risk for fluid imbalance associated with surgical fluid loss, altered urinary output, parenteral fluid administration

GOAL: Normal fluid balance will be maintained

Nursing Interventions	Rationale	Expected Outcomes
1. Weigh patient daily. 2. Document accurate intake and output. 3. Place all parenteral therapy on an infusion pump. 4. Monitor amount and characteristics of urine. 5. Monitor vital signs: temperature, pulse, respirations, and blood pressure. 6. Auscultate heart and lungs sounds every shift.	1. Daily weight is the most sensitive indicator of fluid loss or gain. 2. Assists in detection of fluid retention due to poor cardiac or renal output. 3. Ensures that the patient does not receive excess or insufficient IV fluids. 4. Assists in early detection of possible complications of surgery or tube insertion. 5. When fluid volume or cardiac output is altered, vital signs are affected.	• Patient's weight will be within 2 to 3 lb of patient's baseline. • Intake that exceeds output will be detected early. • The exact amount of solution is infused with no adverse effects resulting from over- or underinfusion. • Urine is clear and absent of blood, pus, or any foreign substances. • Temperature, pulse, respiration, and blood pressure are within defined limits.

	6. When fluid volume is increased because of poor cardiac or renal output, fluid accumulates in the lungs. In addition, heart sounds change as heart failure develops; frequent auscultation ensures early detection.	• Normal heart and lung sounds are present.

Monitoring and Managing Potential Complications

Bleeding is a major complication of kidney surgery. If undetected and untreated, it can result in hypovolemia and hemorrhagic shock. The nurse's role is to observe for these complications, to report their signs and symptoms, and to administer prescribed parenteral fluids and blood and blood components. Monitoring of vital signs, skin condition, the urinary drainage system, the surgical incision, and the level of consciousness is necessary to detect evidence of bleeding, decreased circulating blood, and fluid volume and cardiac output. Frequent monitoring of vital signs (initially monitored at least at hourly intervals) and urinary output is necessary for early detection of these complications.

If bleeding goes undetected or is not detected promptly, the patient may lose significant amounts of blood and may experience hypoxemia. In addition to hypovolemic shock due to hemorrhage, this type of blood loss may precipitate a myocardial infarction or transient ischemic attack. Bleeding may be suspected when the patient experiences fatigue and shortness of breath and when urine output is less than 400 mL within 24 hours. As bleeding persists, late signs of hypovolemia occur, such as cool skin, flat neck veins, and change in level of consciousness or responsiveness. Transfusions of blood components are indicated, along with surgical repair of the bleeding vessel.

Pneumonia may be prevented through the use of an incentive spirometer, adequate pain control, and early ambulation. Early signs of pneumonia include fever, increased heart and respiratory rates, and adventitious breath sounds.

Preventing infection involves using asepsis when changing dressings and handling and preparing catheters, other drainage tubes, central venous catheters, and IV catheters for administration of fluids. Insertion sites are monitored closely for signs and symptoms of inflammation: redness, drainage, heat, and pain. Special care must be taken to prevent UTI, which is associated with the use of indwelling urinary catheters. Catheters and other invasive tubes are removed as soon as they are no longer needed.

Antibiotics are commonly given postoperatively to prevent infection. If antibiotic agents are prescribed, serum creatinine and BUN values must be monitored closely because many antibiotic agents are toxic to the kidney or can accumulate to toxic levels if renal function is compromised.

Preventing fluid imbalance is critical when caring for a patient undergoing kidney surgery, because both fluid loss and fluid excess are possible adverse effects of the surgery. Fluid loss may occur during surgery as a result of excessive urinary drainage when the obstruction is removed, or it may occur if diuretic agents are used. Such loss may also occur with GI losses, with diarrhea resulting from antibiotic use, or with nasogastric drainage. When postoperative IV therapy is inadequate to match the output or fluids lost, a fluid deficit results. Fluid excess, or overload, may result from cardiac effects of anesthesia, administration of excessive amounts of fluids, or the patient's inability to excrete fluid because of changes in renal function. Decreased urine output may be an indication of fluid excess.

Astute assessment skills are needed to detect early signs of fluid excess (such as weight gain, pedal edema, urine output below 400 mL/day, and slightly elevated pulmonary artery wedge pressure if available) before they become severe (appearance of adventitious breath sounds, shortness of breath).

Fluid excess may be treated with fluid restriction and administration of furosemide or other diuretic agents. If renal insufficiency is present, these medications may prove ineffective; therefore, dialysis may be necessary to prevent heart failure and pulmonary edema.

Deep vein thrombosis (DVT) may occur postoperatively because of surgical manipulation of the iliac vessels during surgery or prolonged immobility. Anti-embolism stockings are applied, and the patient is monitored closely for signs and symptoms of thrombosis and encouraged to exercise the legs. Heparin or other anticoagulants may be given postoperatively to reduce the risk of thrombosis.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

If the patient has a drainage system in place, measures are taken to ensure that both the patient and family understand the importance of maintaining the system correctly at home and preventing infection. Verbal and written instructions and guidelines are provided to the patient and family at the time of hospital discharge. The patient may be asked to demonstrate or "teach back" management of the drainage system to validate understanding (see Chapter 3 for further discussion of the teach-back technique). Strategies to prevent postoperative complications (urinary tract obstruction and infection, DVT, atelectasis, and pneumonia) are stressed to the patient and family. With both the patient and family, the nurse reviews the signs, symptoms, problems, and questions that should be referred to the physician or other primary provider.

Continuing and Transitional Care

The need for postoperative assessment and care after kidney surgery continues regardless of the setting: the home, subacute care unit, outpatient clinic or office, or rehabilitation facility. Referral for home care is indicated for the patient who is going home with a urinary drainage system in place. During the home visit, the home health nurse reviews the instructions and guidelines given to the patient at hospital discharge. The nurse assesses the patient's ability to carry out the instructions in the home and answers questions that the patient or family has about management of the drainage system and the surgical incision.

In addition, the home health nurse obtains vital signs and assesses the patient for signs and symptoms of urinary tract obstruction and infection. The nurse also ensures that pain is adequately controlled and that the patient is adhering to recommendations. The home health nurse encourages adequate fluid intake and increased levels of activity. Together, the nurse, patient, and family review the signs, symptoms, problems, and questions that should be referred to the primary provider. If the patient has a drainage tube in place, the nurse assesses the site and the patency of the system and monitors the patient for complications, such as DVT, bleeding, or pneumonia.

Because it is easy for the patient, family, and health care team to focus on the patient's immediate disorder to the exclusion of other health issues, the nurse reminds the patient and family about the importance of participating in health promotion activities, including appropriate health screenings.

Kidney Transplantation

Kidney transplantation is the treatment of choice for select and appropriately screened patients with ESKD. It is not considered a cure for ESKD since, in general, the transplant will not continue to function for the entire lifespan of most recipients (Danovitch, 2017). Patients choose kidney transplantation for various reasons, such as the desire to avoid dialysis or to improve their sense of well-being and the wish to lead a more normal life. Kidney transplantation is an elective procedure, not an emergency lifesaving procedure. Therefore, patients should be in the best possible physical condition prior to transplantation.

In the United States and globally, there are many more patients on the waiting list for kidney transplantation than there are organ donors. More than

103,356 Americans are on the waiting list to receive a kidney (Organ Procurement and Transplantation Network [OPTN], 2019). In the United States, the cost of a kidney transplant annually per person is estimated at $34,084 versus about $88,750 annually per person for in center HD (Saran, Robinson, Abbott, et al., 2018). Kidney transplantation involves transplanting a kidney from a living or deceased donor to a recipient who no longer has renal function. A living donor may or may not be related to the recipient. A deceased donor transplant comes from someone who has died and donated their organs. The term “cadaveric donor” is no longer used and the appropriate terminology is “deceased donor.” Transplantation from well-matched living donors (those with compatible ABO and human leukocyte antigens) is more successful than from deceased donors, especially long term (Woodard & Arnold, 2017).

The NKF provides written information describing the organ donation program and a card specifying the organs to be donated in the event of death. The organ donation card is signed by the donor and two witnesses and should be carried by the donor at all times. In many states in the United States, drivers can indicate their desire to be organ donors on their driver’s license application or renewal. However, the donor should discuss this decision with family members because the organ procurement agency will approach the family to explore this option.

Contemporary developments in kidney transplantation are paired exchanges and chains. In paired donor exchanges and chains, recipients swap compatibly matched kidneys with willing donors, who are unrelated or unknown to the recipient. Although medically eligible to donate a kidney, a willing donor may be incompatible with the intended recipient due to blood type or antigens. The donor then agrees to donate the kidney to a compatible and unknown recipient, with the intention that the donor’s originally intended organ recipient will be part of the donation chain and be the recipient of a donated kidney through organized donor and recipient matches. Several national registry programs have organized systems to find a matching pair on the national level (Woodard & Arnold, 2017). See Resources at the end of the chapter.

Prior to either receiving or donating an organ, an extensive medical evaluation is performed; first on the potential recipient and then, if the recipient is deemed suitable for a transplant, the living donor is evaluated. Not everyone is suitable for kidney transplantation. Contraindications include recent malignancy, active or chronic infection (e.g., HIV, hepatitis B and C), severe irreversible extrarenal disease (e.g., inoperable cardiac disease, chronic lung disease, severe peripheral vascular disease), Class II obesity (body mass index greater than 35 kg/m^2), current substance use disorder (SUD), inability to give informed consent, active psychiatric disease, and history of nonadherence to treatment regimens (Bunnapradist et al., 2017; Woodard & Arnold, 2017).

Donors may be rejected for the same reasons or any condition that is determined to have an impact on the remaining kidney. Examples include hypertension and diabetes because both are known causes of kidney disease. It is imperative when donors are evaluated that serious consideration be given to the overall long-term health of the donor. Every precaution must be taken to ensure that the remaining kidney in the donor will remain healthy. When these conditions are met, the donor should remain healthy after donation and have a normal lifespan. Because one kidney can easily handle the body's needs, no long-term adjustments will need to be made. Routine health maintenance visits are stressed for blood pressure monitoring and preventative care.

The recipient's native kidneys are not usually removed, except for enlarged polycystic kidneys with cysts that may rupture or become infected (Bunnapradist et al., 2017). In some centers, for the patient with polycystic kidneys, the surgeon may perform a bilateral nephrectomy simultaneously with the renal transplant, while in others, the native nephrectomy precedes or is scheduled after the transplant procedure.

The transplanted kidney is placed in the patient's iliac fossa anterior to the iliac crest because it allows for easier access to the blood supply needed to perfuse the kidney. The ureter of the newly transplanted kidney is transplanted into the bladder or anastomosed to the ureter of the recipient (see Fig. 48-9). Once the blood supply has been reestablished to the transplanted kidney in the operating room, urine should begin to flow. For deceased donor kidneys, the production of urine at this stage is an important indicator of the overall success of the procedure and ultimate long-term outcome (Longton, 2017).

Preoperative Management

Preoperative management goals include bringing the patient's metabolic state to a level as close to normal as possible through diet, possibly dialysis and medical management, ensuring that the patient is free of infection, and educating the patient for surgery and the postoperative course.

Medical Management

A complete physical examination is performed on the living donor and the recipient to detect and treat any conditions that could cause complications after the living donor nephrectomy and recipient transplantation procedure. Tissue typing, blood typing, and antibody screening are performed to determine compatibility of the tissues and cells of the donor and recipient. Other diagnostic tests must be completed for both potential donor and recipient to identify conditions requiring treatment before the transplant procedure.

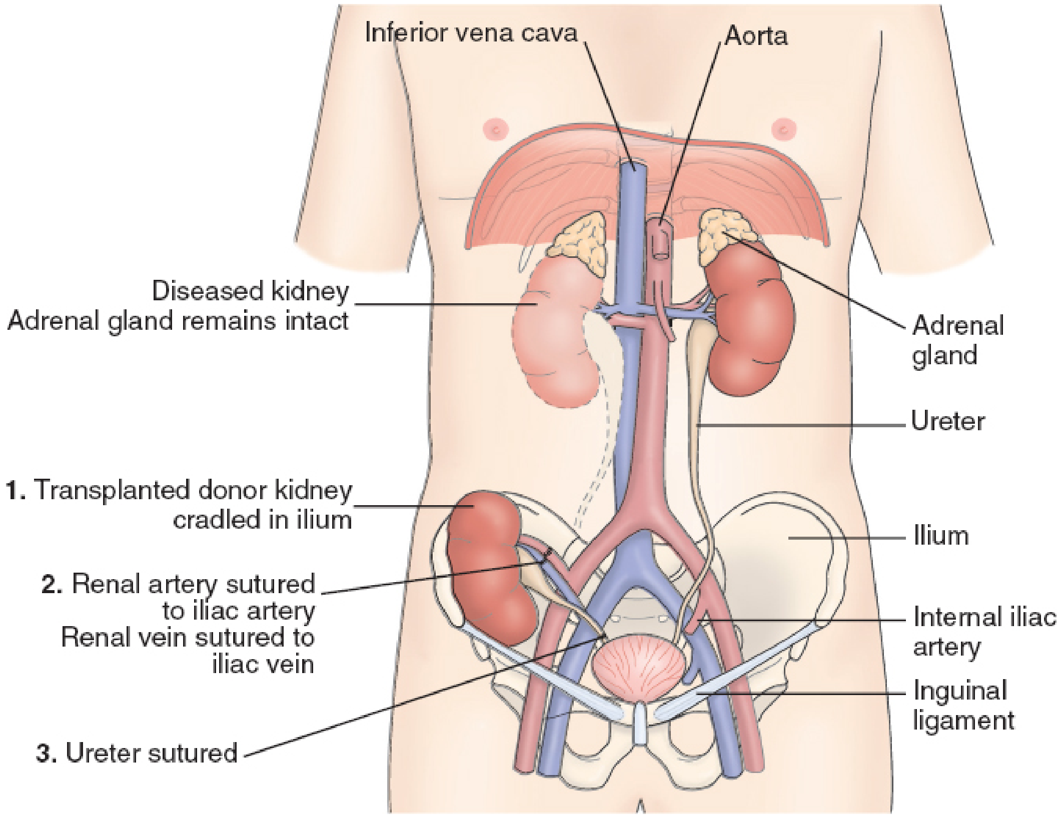


Figure 48-9 • Kidney transplantation. **1.** The transplanted kidney is placed in the iliac fossa. **2.** The renal vein of the donated kidney is sutured to the iliac vein, and the renal artery is sutured to the iliac artery. **3.** The ureter of the donated kidney is sutured to the bladder or to the patient's ureter.

Both patients must be free of infection at the time of kidney transplantation. After surgery, medications to prevent transplant rejection will be prescribed for the transplant recipient. These medications suppress the immune response, leaving the patient at risk for infection. Therefore, both the donor and recipient are evaluated and treated for any infections, including gingival (gum) disease and dental caries.

A psychosocial evaluation is conducted to assess the organ recipient's ability to adjust to the transplant, coping styles, social history, social support available, and financial resources. Psychiatric conditions are often aggravated by the corticosteroids and other medications needed for immunosuppression after transplantation, so a history of psychiatric illness is important to obtain (Shenoy & Danovitch, 2017). A psychosocial evaluation is also conducted to assess the motive of the donor for giving the organ. The donor should not be coerced to donate this organ; it should be an altruistic act (Rastogi, Hersh-Rifkin, Gritsch, et al., 2017).

Nursing Management

The nursing aspects of preoperative care for the patient undergoing kidney transplant and donation are similar to those for patients undergoing other types of kidney or elective abdominal surgery. Preoperative education can be conducted in a variety of settings, including the outpatient preadmission area, the hospital, or the transplantation clinic during the preliminary work up phase. Patient education for the kidney transplant donor and recipient addresses postoperative pulmonary hygiene, pain management options, dietary restrictions, IV lines, tubes (indwelling catheter), and early ambulation. Most patients have been on dialysis for months or years before transplantation, eagerly awaiting a kidney transplant, and are anxious about the surgery, possible rejection, and the need to return to dialysis. Helping the patient to deal with these concerns is part of the nurse's role in preoperative management, as is educating the patient about what to expect after surgery. HD may be performed before the kidney transplantation procedure. When the patient is receiving peritoneal dialysis, the patient will continue to dialyze until the surgery. The dwell will be drained prior to going to the operating room.

The patient who receives a kidney from a living related donor is often concerned about the donor and how the donor will tolerate the surgical procedure. If the patient is receiving a deceased donor transplant, the recipient may express sadness and grief over the loss of the donor's life. The nurse must maintain open communication with the recipient of the organ and allow the patient to express these concerns.

The nurse working in an intensive care setting may provide care to the organ donor who is declared brain dead prior to organ removal. In the absence of brain death, deceased donation may also occur after the heart has stopped beating (donation after cardiac death or non–heart-beating donor). The overall goal is to preserve the function of the organs through maintaining hemodynamic stability, decreasing the risk for infection, and monitoring laboratory values while providing dignified care to the donor and family members (Woodard & Arnold, 2017). Continuing care for the donor can be complex and last for more than several hours. Care is often provided in collaboration with the organ procurement and transplant coordinators.

Postoperative Management

The goal of postoperative care is to maintain homeostasis until the transplanted kidney is functioning well. The patient whose kidney functions immediately has a more favorable prognosis than the patient whose kidney does not (Longton, 2017).

Often, the living organ donor will be on the same unit as the transplant recipient. The donor will require the same level of care provided to the recipient, including follow-up at prescribed intervals after the procedure and long-term. The organ donor often experiences more pain than the recipient, requiring more analgesia for pain control. Fluid, electrolyte, and hemodynamic status are also closely monitored in the living organ donor.

Medical Management

After a kidney transplantation, rejection and failure can occur within 24 hours (hyperacute), within 3 to 14 days (acute), or after many years (chronic). A hyperacute rejection is caused by an immediate antibody-mediated reaction that leads to generalized glomerular capillary thrombosis and necrosis. An acute rejection typically occurs within a few days to weeks of the transplant surgery, and the patient experiences an increase in serum creatinine values. If the rejection continues, the patient may have fever, tenderness at the transplant site, malaise, and oliguria, but these are generally considered late signs (Longton, 2017). An acute rejection requires early recognition and treatment with immunosuppressant therapy, whereas a hyperacute reaction would require immediate removal of the transplanted organ (Longton, 2017). The long-term survival of a transplanted kidney depends on how well it matches the recipient and how well the body's immune response is controlled. The body's immune system views the transplanted kidney as "foreign." Therefore, it continually works to reject it. To overcome or minimize the body's defense mechanisms, immunosuppressive agents are given. Optimally, medications modify the immune system enough to prevent rejection, although not enough to allow infections or malignancies to develop (see Table 48-4).

TABLE 48-4 Immunosuppressant Agents Used Following Organ Transplant

Agent	Action	Nursing Implications
tacrolimus	Calcineurin inhibitor: inhibits helper T lymphocytes	Monitor for nephrotoxicity, hyperkalemia, neurotoxicity (tremors). Assess for hypertension. Monitor tacrolimus levels
cyclosporine	Calcineurin inhibitor: selective and reversible inhibition of first phase of T-cell activation with T lymphocytes	Monitor for nephrotoxicity, hirsutism, gingival hyperplasia. Give medication with food to reduce gastrointestinal upset. Administer medication at the same time each day and ensure consistent food intake. Monitor cyclosporine levels.
sirolimus	mTOR inhibitor: inhibits the response of helper T and B lymphocytes	Instruct patient to swallow tablets whole and to avoid chewing or crushing tablets. Instruct patient to avoid grapefruit juice and grapefruit. Instruct the patient to limit exposure to sunlight. Administer 4 hours after oral cyclosporine.
mycophenolate mofetil mycophenolic acid	Antiproliferative: inhibition of T- and B-lymphocyte responses, thus inhibiting antibody formation and generation of cytotoxic T cells	Causes GI upset, diarrhea. Administer with food. Do not crush or open capsules and avoid contact with powder in capsules; wash hands thoroughly with soap and water if contact occurs. Obtain baseline complete blood count with differential prior to initiating therapy. Instruct the patient to avoid over-the-counter antacids.
belatacept	Costimulation blocker: inhibits T-lymphocyte proliferation and cytokine production	Contraindicated in patients with EBV seronegativity or unknown EBV serostatus, liver transplantation, breast-feeding. Monitor for symptoms of infection, anemia, GI symptoms, and, rarely, progressive multifocal leukoencephalopathy. Administer IV.
everolimus	mTOR inhibitor-proliferation signal inhibitors	Monitor for hypersensitivity reaction.

		Watch for changes in pulmonary status and cough. Avoid administration of live vaccines. Administer at the same time each day with food; do not crush or allow patient to chew tablet.

EBV, Epstein–Barr virus; GI, gastrointestinal; IV, intravenous; mTOR, mammalian target of rapamycin.

Adapted from Alquadan, K., Womer, K., & Casey, M. (2019). Immunosuppressive medications in kidney transplantation. In J. Feehally, J. Floege, M. Tonelli, et al. (Eds.), *Comprehensive clinical nephrology* (6th ed.). Philadelphia, PA: Elsevier.

Combinations of corticosteroids and medications specifically developed to affect the action of lymphocytes are used to minimize the body's reaction to the transplanted organ. Treatment with combinations of new agents has dramatically improved patient and graft survival rates, and now 90% to 95% of transplanted kidneys still function after 1 year (OPTN, 2019). Doses of immunosuppressive agents are often adjusted depending on the patient's immunologic response to the transplant. However, the patient will be required to take some form of immunosuppressive therapy for the entire time that they have the transplanted kidney. Grapefruit juice and grapefruit interact with many immunosuppressant medications and should be avoided (Comerford & Durkin, 2020).

The risks associated with taking these medications include nephrotoxicity, hypertension, hyperlipidemia, hirsutism, tremors, blood dyscrasias, cataracts, gingival hyperplasia, and several types of cancer (Sievers, Lum, & Danovitch, 2017).

COVID-19 Considerations

Because of the need for immunosuppression, patients who have undergone kidney transplantation are at higher risk of contracting SARS-CoV-2 (Ajaimy & Melamed, 2020). One study reported outcomes of 41 patients who had a transplanted kidney, 22 of whom had confirmed COVID-19 and 19 of whom had suspected COVID-19 (Husain, Dube, Morris, et al., 2020). Among the 41 patients, 13 needed to be hospitalized while the rest were managed on an outpatient basis being closely monitored with telehealth. The majority (80%) of patients reported fever but those requiring hospitalization were more likely to report dyspnea compared to those not requiring hospitalization. Patients requiring hospitalization also had higher serum creatinine levels upon admission, suggesting compromise of the function of their transplanted kidneys. More than half of the patients (63%), whether hospitalized or not, had a reduction in the immunosuppressive regimen but there was no reported mortality (Husain et al., 2020). These findings suggest that it may be safe to lower the immunosuppressive regimen of patients who have undergone kidney transplantation to augment the ability of their immune system to fight COVID-19.

Nursing Management

Assessing the Patient for Transplant Rejection

After kidney transplantation, the nurse assesses the patient for signs and symptoms of transplant rejection: oliguria, edema, fever, increasing blood pressure, weight gain, and swelling or tenderness over the transplanted kidney or graft. Patients receiving cyclosporine may not exhibit the usual signs and symptoms of acute rejection. In these patients, the only sign may be an asymptomatic rise in the serum creatinine level (Longton, 2017).

Preventing Infection

The results of blood chemistry tests and leukocyte and platelet counts are monitored closely because immunosuppression depresses the formation of leukocytes and platelets. The patient is closely monitored for infection because of susceptibility to impaired healing and infections related to immunosuppressive therapy and complications of kidney disease. Clinical manifestations of infection include shaking chills, fever, tachycardia (rapid heartbeat), tachypnea (rapid respirations), as well as either leukocytosis (increase in WBCs) or leukopenia (decrease in WBCs).

Infection may be introduced through many sources. Urine cultures are performed frequently because of the high incidence of bacteriuria during early and late stages of transplantation. Any type of wound drainage should be viewed as a potential source of infection because drainage is an excellent culture medium for bacteria. Catheter and drain tips may be cultured when removed by cutting off the tip of the catheter or drain (using aseptic technique) and placing the tip in a sterile container to be sent to the laboratory for culture (see Chart 48-14).

The nurse ensures that the patient is protected from exposure to infection by hospital staff and in the environment (e.g., fresh flowers are not permitted in the transplant unit), visitors, and other patients with active infections. Attention to hand hygiene by all who come in contact with the patient is imperative.

Monitoring Urinary Function

A kidney from a living donor who is related to the patient usually begins to function immediately after surgery and may produce large quantities of dilute urine. A kidney from a deceased donor may undergo ATN and therefore may not function for 2 or 3 weeks, during which time anuria, oliguria, or polyuria may be present. During this stage, the patient may experience significant changes in fluid and electrolyte status. Therefore, careful monitoring is indicated. The output from the urinary catheter is measured every hour. IV fluids are given on the basis of urine volume and serum electrolyte levels, as prescribed by the primary provider. HD may be necessary postoperatively to maintain homeostasis until the transplanted kidney is functioning well. It also may be required if fluid overload and hyperkalemia occur. The vascular access for HD is assessed to ensure patency and to evaluate for evidence of infection.

Chart 48-14

Kidney Transplant Rejection and Infection

Renal graft rejection and failure may occur within 24 hours (hyperacute), within 3 to 14 days (acute), or after many years (chronic). It is not uncommon for a treatable rejection episode to occur during the first year after transplantation.

Detecting Rejection

Ultrasonography may be used to detect hydronephrosis (enlargement of the kidney) due to obstruction of urine flow; percutaneous renal biopsy (most reliable) and nuclear medicine studies are used to evaluate transplant rejection. If the body rejects the transplanted kidney, the patient needs to commence dialysis. The rejected kidney may or may not be removed, depending on when the rejection occurs (acute vs. chronic) and the risk for infection if the kidney is left in place.

Potential Infection

Infection continues to be a major cause of morbidity and mortality in kidney transplant recipients, both due to the surgical procedure, the high doses of induction immunosuppression given in the postoperative period, and the continuing need for maintenance immunosuppression. The majority of infections happen in the first month after transplantation and are generally due to the complications of the surgery or invasive medical devices (IV, central line, and urinary catheters and ureteral stents) and mostly involve the genitourinary tract (since this is the focus of the surgery). The most common infections include genitourinary infections, pneumonia, wound and abdominal fluid collection infections, device-related infections, and, later in the transplant course, viral diseases. After 6 months, patients who have stable kidney function, have not required treatment for rejection or a need for reoperation are considered as having a successful outcome with stable maintenance immunosuppression and, thus, decreased infectious risks. When recipients have poor renal function, have had rejection treatments which have necessitated increased immunosuppression, and have ongoing issues with genitourinary dysfunction, opportunistic infections are more likely to present, such as cytomegalovirus (CMV) and other human herpesviruses (HHV) and polyoma virus. Despite the continuing menace of infection in renal transplant recipients, the 1-year patient survival rates are close to 100% and graft survival exceeds 90%.

Adapted from Schaenman, J., & Kubak, B. (2017). Infections in kidney transplantation. In G. Danovitch (Ed.), *Handbook of kidney transplantation* (6th ed.). Philadelphia, PA: Wolters Kluwer.

Addressing Psychological Concerns

The rejection of a transplanted kidney is of great and ongoing concern to the patient, the family, and the health care team. The fear of kidney rejection and the complications of immunosuppressive therapy (Cushing's syndrome, diabetes, capillary fragility, osteoporosis, glaucoma, cataracts, acne, nephrotoxicity) place tremendous psychological stress on the patient. If the organ donor was a family member there may be added emotional responses that need to be addressed. Anxiety and uncertainty about the future and difficult post transplantation adjustment are often sources of stress for the patient and family.

An important nursing function is the assessment of the patient's stress and coping. Psychosocial issues are common in individuals and families with chronic diseases, and ESKD is a chronic disease (Shenoy & Danovitch, 2017). The nurse uses each visit with the patient to determine if the patient and family are coping effectively and the patient is adhering to the prescribed medication regimen. If indicated or requested, the nurse refers the patient for counseling (Longton, 2017).

Monitoring and Managing Potential Complications

The patient undergoing kidney transplantation is at risk for the postoperative complications that are associated with any surgical procedure. In addition, the patient's physical condition may be compromised because of the effects of long-standing kidney disease and its treatment. Therefore, careful assessment of the complications related to kidney disease and often, diabetes and hypertension, and those associated with a major surgery are important aspects of nursing care. Breathing exercises, early ambulation, and care of the surgical incision are priorities of postoperative care.

GI ulceration and corticosteroid-induced bleeding may occur. Therefore, preventative medications such as H_2-blockers (e.g., famotidine) or proton pump inhibitors (PPIs) (e.g., omeprazole) are prescribed. Fungal colonization of the GI tract (especially the mouth) and urinary bladder may occur secondary to immunosuppressive and antibiotic therapy; thus, prophylactic oral antifungal mouth rinses are prescribed. Closely assessing the patient and notifying the primary provider about the occurrence of these complications are important nursing interventions. In addition, the patient is monitored for any signs and symptoms of adrenal insufficiency if the immunosuppressive regimen has included the use of long-term corticosteroids.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

The nurse works closely with the patient and family to be sure that they understand the need for continuing immunosuppressive therapy as prescribed. In addition, the patient and family are educated on how to assess for and report signs and symptoms of transplant rejection, infection, or significant adverse effects of the immunosuppressive regimen. The patient and family are educated about the need to report decreased urine output; weight gain; malaise; fever; respiratory distress; tenderness over the transplanted kidney; anxiety; depression; changes in eating, drinking, or other habits; and changes in blood pressure. The patient is instructed to inform all health care providers (e.g., dentist) about the kidney transplant and the use of immunosuppressive agents.

Continuing and Transitional Care

The patient needs to know that follow-up care after transplantation is a lifelong necessity. Individual written instructions with verbal explanations are provided concerning diet, medication, fluids, daily weight, daily measurement of urinary output, management of oral intake, prevention of infection and rejection, resumption of activity, and avoidance of contact sports in which the transplanted kidney may be injured. Because of the risk of other potential complications, the patient is followed closely by a health care team that includes the nephrologist, transplant surgeon, transplant coordinator or nurse, social worker, transplant pharmacist, and dietitian. Medications are often obtained at one pharmacy or through the pharmacy at the hospital where the transplant surgery was performed for the purpose of accurate medication reconciliation. Follow-up with providers from the transplant team will initially occur once or twice a week upon discharge from the hospital and taper over time. Laboratory studies will also be obtained and followed on an ongoing basis to monitor the function of the kidney.

Cardiovascular disease is the major cause of morbidity and mortality after transplantation, due in part to the increasing age of patients with transplants. An additional problem is possible malignancy; patients receiving long-term immunosuppressive therapy are at higher risk for cancers than the general population (Huang & Kasiske, 2017). The nurse reminds the patient of the importance of health promotion and health screening and provides information on local transplantation support groups at the transplant hospital or through the procurement organization.

The American Association of Kidney Patients (AAKP) and the NKF (listed in the Resources section of this chapter) are nonprofit organizations that serve the needs of those with kidney disease. These groups can provide many helpful suggestions for patients and family members learning to cope with the journey of dialysis and transplantation.

RENAL TRAUMA

The kidneys are protected by the rib cage and musculature of the back posteriorly and by a cushion of abdominal wall and viscera anteriorly. They are highly mobile and are fixed only at the renal pedicle (stem of renal blood vessels and the ureter). With traumatic injury, the kidneys can be thrust against the lower ribs, resulting in contusion and rupture. Rib fractures or fractures of the transverse process of the upper lumbar vertebrae may be associated with renal contusion or laceration.

Motor vehicle crashes, falls from heights, and assaults cause the majority of blunt renal trauma (Santucci & Chen, 2016). Failure to wear seat belts contributes to the incidence of renal trauma in motor vehicle crashes. Injuries may be blunt (deceleration forces in motor vehicle crashes, falls, athletic injuries, assaults) or penetrating (gunshot wounds, stabbings). Gunshot wounds are responsible for 86% of penetrating trauma, while stab wounds account for about 14% (Santucci & Chen, 2016).

Blunt renal trauma is classified into one of four groups, as follows:

- Contusion: Bruises or hemorrhages under the renal capsule; capsule and collecting system intact
- Minor laceration: Superficial disruption of the cortex; renal medulla and collecting system are not involved
- Major laceration: Parenchymal disruption extending into cortex and medulla, possibly involving the collecting system
- Vascular injury: Tears of renal artery or vein

Physiology/Pathophysiology

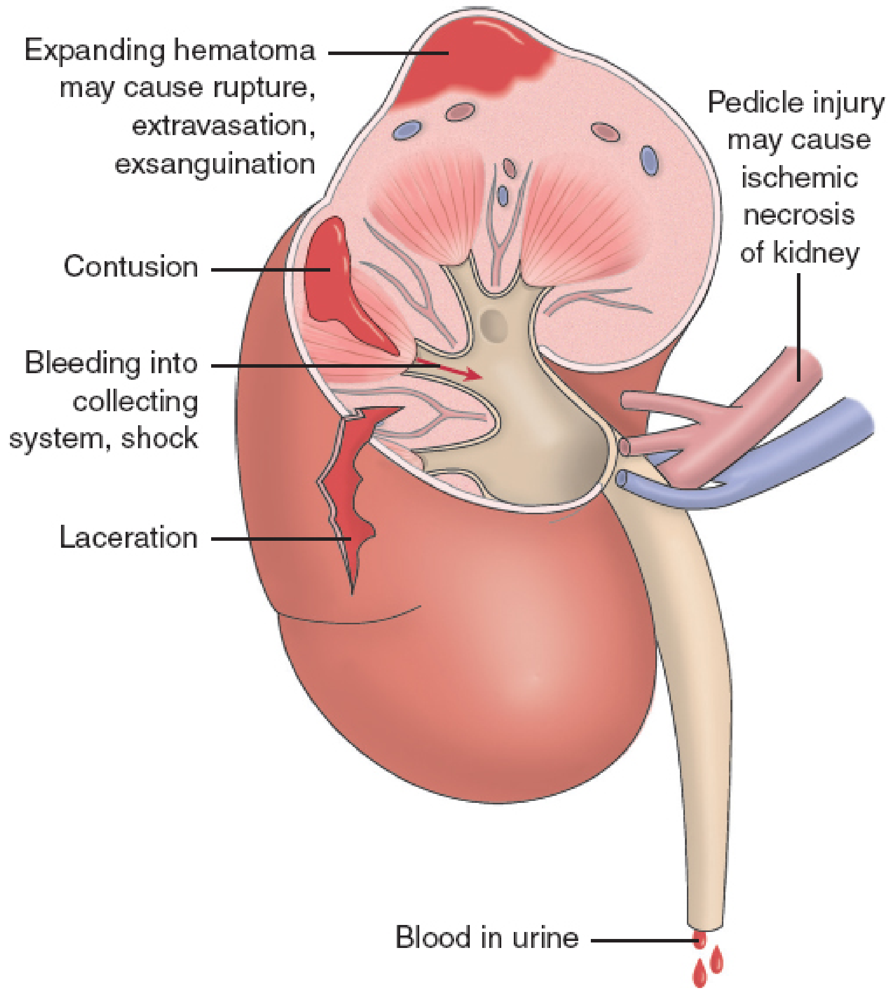


Figure 48-10 • Types and pathophysiologic effects of kidney injuries: contusions, lacerations, rupture, and pedicle injury.

The most common renal injuries are contusions, lacerations, ruptures, and renal pedicle injuries or small internal lacerations of the kidney (see Fig. 48-10). The kidneys receive half of the blood flow from the abdominal aorta; therefore, even a fairly small renal laceration can produce massive bleeding. The majority of patients are in shock when admitted to the hospitals. In some cases, there is an isolated renal artery thrombosis.

The best indicators of urinary system injury are gross and microscopic hematuria (on urinalysis or dipstick), especially in association with a history of injury or trauma (Santucci & Chen, 2016). Other clinical manifestations include pain, renal colic (due to blood clots or fragments obstructing the collecting system), mass or swelling in the flank, ecchymoses, and lacerations or wounds of the lateral abdomen and flank. There is no relationship between the degree of hematuria and the degree of injury. Signs and symptoms of hypovolemia and shock (see Chapter 11) are likely with significant hemorrhage.

Medical Management

The goals of management in patients with renal trauma are to control hemorrhage, pain, and infection as well as to preserve and restore renal function. All urine is saved and sent to the laboratory for analysis to detect RBCs and to evaluate the course of bleeding. Serial hematocrit and hemoglobin levels are monitored closely; decreasing values indicate hemorrhage.

The patient is monitored for oliguria and signs of hemorrhagic shock, because a pedicle injury or shattered kidney can lead to rapid exsanguination (lethal blood loss). An expanding hematoma may cause rupture of the kidney capsule. To detect hematoma, the area around the lower ribs, upper lumbar vertebrae, flank, and abdomen is palpated for tenderness. A palpable flank or abdominal mass with local tenderness, swelling, and ecchymosis suggests renal hemorrhage. The area of the original mass can be outlined with a surgical marking pen so that the examiner can evaluate the area for change.

Renal trauma is often associated with other injuries to the abdominal organs (liver, colon, small intestines); therefore, the patient is assessed for skin abrasions, lacerations, and entry and exit wounds of the upper abdomen and lower thorax, because these may be associated with kidney injury. A contrast-enhanced computed tomography (CT) scan is the standard for genitourinary imaging in renal trauma when the patient is stable and not suspected of acute hemorrhage (Santucci & Chen, 2016).

With a contusion of the kidney, healing may take place with conservative measures. If the patient has microscopic hematuria and a normal CT scan, outpatient management is possible. If gross hematuria or a minor laceration is present, the patient is hospitalized and kept on bed rest until the hematuria clears. Antimicrobial medications may be prescribed to prevent infection from perirenal hematoma or urinoma (a cyst containing urine). Patients with retroperitoneal hematomas may develop low-grade fever as absorption of the clot takes place.

Surgical Management

Depending on the patient's condition and the nature of the injury, major lacerations may be treated through surgical intervention or interventional radiology treatment (angioembolization) or conservatively (bed rest, no surgery). The majority of blunt and penetrating injuries to the kidneys no longer require open surgical intervention (Santucci & Chen, 2016). However, any sudden change in the patient's condition suggests hemorrhage and requires rapid surgical intervention. Vascular injuries require immediate exploratory surgery because of the high incidence of involvement of other organ systems and the serious complications that may result if these injuries are untreated. The patient is often in shock and requires aggressive fluid resuscitation. Nephrectomy, or surgery to remove the damaged kidney, may be required.

Early postoperative complications (within 6 months) include rebleeding, perinephric abscess formation, sepsis, urine extravasation, and fistula formation. Other complications include stone formation, infection, cysts, vascular aneurysms, and loss of renal function. Hypertension can be a complication of any surgery but usually is a late complication of kidney injury.

Nursing Management

The patient with renal trauma must be assessed frequently during the first few days after injury to detect flank and abdominal pain, muscle spasm, and swelling over the flank. During this time, the patient who has undergone surgery is educated about care of the incision and the importance of an adequate fluid intake. In addition, instructions are provided about changes that should be reported to the physician, such as fever, hematuria, flank pain, or any signs and symptoms of decreasing kidney function. Guidelines for gradually increasing activity, lifting, and driving are also explained in accordance with the physician's prescription.

Follow-up nursing care includes monitoring the blood pressure to detect hypertension and advising the patient to restrict activities for about 1 month after trauma to minimize the incidence of delayed or secondary bleeding. The patient should be advised to schedule periodic follow-up assessments of renal function (creatinine clearance, BUN, and serum creatinine analyses). If a nephrectomy was necessary, the patient is advised to wear medical identification.

CRITICAL THINKING EXERCISES

1 pq You are a staff nurse in an outpatient dialysis facility. A 28-year-old woman with ESKD is seen in the clinic for the first time and states that she wants to begin PD. The patient lives alone and is employed full-time. What are your priorities for educating this patient about the options for dialysis and what is involved with each method? How should the priorities change if the patient decides on home HD?

2 ipc A 62-year-old man who normally has HD 3 times a week has been admitted to the medical unit where you work. What nursing and interprofessional assessments are indicated during your initial interactions with him? What other interprofessional services might you try to engage?

3 ebp You are caring for a 45-year-old patient who is postoperative following a kidney transplant. What is the evidence base for treatment options for immunosuppression? Identify the criteria used to evaluate the strength of the evidence.

REFERENCES

*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

Books

Alquadan, K., Womer, K., & Casey, M. (2019). Immunosuppressive medications in kidney transplantation. In J. Feehally, J. Floege, M. Tonelli, et al. (Eds.). *Comprehensive clinical nephrology* (6th ed.). Philadelphia, PA: Elsevier.

Brooks, D. (2017). Chronic kidney disease: Diagnosis, classification, and management. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.

Browne, T., & Johnstone, S. (2017). Psychosocial issues in nephrology nursing. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.

Bunnapradist, S., Abdalla, B., & Reddy, U. (2017). Evaluation of adult kidney transplant candidates. In G. Danovitch (Ed.). *Handbook of kidney transplantation* (6th ed.). Philadelphia, PA: Wolters Kluwer.

Campoy, S. (2017). Hypertension. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.

Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook.* Philadelphia, PA: Wolters Kluwer.

Conde, F., & Workman, T. (2017). Genitourinary cancers. In S. Newton, M. Hickey, & J. Brant (Eds.). *Oncology nursing advisor: A comprehensive guide to clinical practice* (2nd ed.). St. Louis, MO: Elsevier.

Danovitch, G. (Ed.). (2017). *Handbook of kidney transplantation* (6th ed.). Philadelphia, PA: Wolters Kluwer.
Evans, E. (2017). Anemia. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Fischbach, F., & Fischbach, M. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.
Gonyea, J. (2017). Nutrition and chronic kidney disease. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Hain, D. (2017). Older adults with chronic kidney disease. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Harwood, L., & Dominski, C. (2017). Home dialysis therapies. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Hellebrand, A., Allen, D., & Hoffman, M. (2017). Hemodialysis. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Huang, E., & Kasiske, B. (2017). Post-transplant: Long-term management and complications. In G. Danovitch (Ed.). *Handbook of kidney transplantation* (6th ed.). Philadelphia, PA: Wolters Kluwer.
Inglese, M. (2017). Arteriovenous fistula. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Kelman, E., & Watson, D. (2017). Peritoneal dialysis. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Lieser, C. (2017). Depression in chronic kidney disease. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Longton, S. (2017). Kidney, pancreas, and liver transplantation: The procedures and nursing management. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Mahaffey, L. (2017). Diseases of the kidney. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Molzahn, A., & Schick-Makaroff, K. (2017). Supportive care of patients with chronic kidney disease. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.
Odom, B. (2017). Acute kidney injury. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.

Parikh, S., Haddad, N., & Hebert, L. (2019). Retarding progression of kidney disease. In R. Johnson, J. Feehally, J. Floege, et al. (Eds.). *Comprehensive clinical nephrology* (6th ed.). China: Elsevier.
Payton, J., & Kennedy, S. (2017). Peritoneal dialysis access. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Pryor, L., & Brouwer-Maier, D. (2017). Central venous catheter. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Rastogi, A., Hersh-Rifkin, M., Gritsch, H. A., et al. (2017). Living donor kidney transplantation. In G. M. Danovitch (Ed.). *Handbook of kidney transplantation* (6th ed.). Philadelphia, PA: Wolters Kluwer.
Ross, E., Nissenson, A., & Daugirdas, J. (2015). Acute hemodialysis prescription. In J. Daugirdas, P. Blake, & T. Ing, (Eds.). *Handbook of dialysis* (5th ed.). Philadelphia, PA: Wolters Kluwer.
Santucci, R., & Chen, M. (2016). *Upper urinary tract trauma*. In A. Wein, L. Kavoussi, A. Partin, et al. (Eds.). *Campbell-Walsh urology* (11th ed.). Philadelphia, PA: Elsevier.
Schaenman, J., & Kubak, B. (2017). Infections in kidney transplantation. In G. Danovitch (Ed.). *Handbook of kidney transplantation* (6th ed.). Philadelphia, PA: Wolters Kluwer.
Schira, M. (2017). Medication-related nephrotoxicity. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Schonder, K. (2017). Pharmacology of kidney disease. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.
Shenoy, A., & Danovitch, I. (2017). Psychiatric aspects of kidney transplantation. In G. M. Danovitch (Ed.). *Handbook of kidney transplantation* (6th ed.). Philadelphia, PA: Wolters Kluwer.
Sievers, T., Lum, E., & Danovitch, G. (2017). Immunosuppressive medications and protocols for kidney transplantation. In G. M. Danovitch (Ed.). *Handbook of kidney transplantation* (6th ed.). Philadelphia, PA: Wolters Kluwer.
Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.
Woodard, A., & Arnold, E. (2017). Kidney transplantation: Organ donation. In S. M. Bodin (Ed.). *Contemporary nephrology nursing* (3rd ed.). Pitman, NJ: American Nephrology Nurses Association.

Journals and Electronic Documents

Ajaimy, M., & Melamed, M. (2020). COVID-19 in patient with kidney disease. *Clinical Journal of the American Society of Nephrology*, *15*(8), 1087–1089.
American Cancer Society. (2020). Kidney cancer. Retrieved on 1/1/2020 at: www.cancer.org/cancer/kidney-cancer/causes-risks-prevention/what-causes.html

**Bellomo, R., Ronco, C., Kellum, J. A., et al. (2004). Acute renal failure-definition, outcome measures, animal models, fluid therapy and information technology needs: The Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. *Critical Care*, *8*(4), B204.

Bolignano, D., Palmer, S. C., Ruospo, M., et al. (2015). Interventions for preventing the progression of autosomal dominant polycystic kidney disease. *Cochrane Database of Systematic Reviews*, *7*, CD010294.

Carey, R., & Whelton, P. (2018). Prevention, detection, evaluation, and management of high blood pressure in adults: Synopsis of the 2017 American College of Cardiology/American Heart Association Hypertension Guideline. *Annals of Internal Medicine*, *168*(5), 351–358.

Centers for Disease Control and Prevention (CDC). (2019). Chronic kidney disease in the United States, 2019. Retrieved on 1/13/2020 at: www.cdc.gov/kidneydisease/publications-resources/2019-national-facts.html

Cheng, Y., Luo, R., Wang, X., et al. (2020). The incidence, risk factors, and prognosis of acute kidney injury in adult patients with coronavirus 2019. *Clinical Journal of the American Society of Nephrology*, *15*(10), 1394–1402.

Chicca, J. (2020). Adults with chronic kidney disease: Overview and nursing care goals. *American Nurse Journal*, *15*(3), 16–22.

George, D., & Jonasch, E. (2019). Systemic therapy of advanced clear cell renal carcinoma. *UpToDate*. Retrieved on 1/4/2020 at: www.uptodate.com/contents/systemic-therapy-of-advanced-clear-cell-renal-carcinoma

Hines, A., & Goldberg, S. (2018). Radiofrequency ablation and cryoablation for renal cell carcinoma. *UpToDate*. Retrieved on 1/13/2020 at: www.uptodate.com/contents/radiofrequency-ablation-and-cryoablation-for-renal-cell-carcinoma

Hulkower, A. (2020). Learning from COVID. *Hastings Center Report*, *50*(3), 16–17.

Husain, S. A., Dube, G., Morris, H., et al. (2020). Early outcomes of outpatient management of kidney transplant recipients with coronavirus 2019. *Clinical Journal of the American Society of Nephrology*, *15*(8), 1174–1178.

Kalfoss, M., Schick-Makaroff, K., & Molzahn, A. (2019). Living with chronic kidney disease: Illness perceptions, symptoms, coping, and quality of life. *Nephrology Nursing Journal*, *46*(3), 277–290.

Kear, T., Bednarski, D., Smith, L., et al. (2019). Letter from the ANNA Board of Directors to the Centers for Medicare and Medicaid Services Regarding the Advancing American Kidney Health Initiative. *Nephrology Nursing Journal*, *46*(5), 477–481.

Kelepouris, E., & Rovin, B. (2019). Overview of heavy proteinuria and the nephrotic syndrome. *UpToDate*. Retrieved on 1/13/2020 at:www.uptodate.com/contents/overview-of-heavy-proteinuria-and-the-nephrotic-syndrome

*Kim, E., Lee, Y., Chang, S. (2019). How do patients on hemodialysis perceive and overcome hemodialysis? Concept development of the resilience of patients

on hemodialysis. *Nephrology Nursing Journal*, *46*(5), 521–530.
Ku, E., Lee, B. J., Wei, J., et al. (2019). Hypertension in CKD: Core curriculum 2019. *American Journal of Kidney Disease*, *74*(1), 120–131.
*Lin, C. C., Han, C., & Pan, I. J. (2015). A qualitative approach of psychosocial adaptation process in patients undergoing long-term hemodialysis. *Asian Nursing Research*, *9*(1), 35–41.
Mann, J., & Hilgers, K. (2019). Clinical features, diagnosis, and treatment of hypertensive nephrosclerosis. *UpToDate*. Retrieved on 1/12/2019 at: www.uptodate.com/contents/clinical-features-diagnosis-and-treatment-of-hypertensive-nephrosclerosis
Medel-Herrero, A., Mitchell, D., & Moyce, S. (2019). The expanding burden of acute kidney injury in California: Impact of the epidemic of diabetes on kidney injury hospital admissions. *Nephrology Nursing Journal*, *46*(6), 629–640.
Nahar, D. (2017). Prophylactic management of contrast-induced acute kidney injury in high-risk patients. *Nephrology Nursing Journal*, *44*(3), 244–249.
National Cancer Institute. (2019). Kidney cancer. Retrieved on 12/8/2019 at: seer.cancer.gov/statistics/preliminary-estimates/preliminary.html
**National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI). (2000). Clinical practice guidelines for nutrition in chronic renal failure. *American Journal of Kidney Diseases*, *35*(6 Suppl 2), S1–S140.
Organ Procurement and Transplantation Network (OPTN). (2019). Waiting list candidates as of today. Retrieved on 12/11/2019 at: optn.transplant.hrsa.gov/data
Pavkov, M. E., Harding, J. L., & Burrows, N. R. (2018). Trends in hospitalizations for acute kidney injury—United States, 2000–2014. *MMWR*, *67*(10), 289–293.
Richie, J., Atkins, M., & Chen, W. (2019). Definitive surgical management of renal cell carcinoma. *UpToDate*. Retrieved on 4/14/2020 at: www.uptodate.com/contents/definitive-surgical-management-of-renal-cell-carcinoma?search=Definitive%20surgical%20management%20of%20renal%20cell%20carcinoma
Saran, R., Robinson, B., Abbott, K. C., et al. (2018). 2017 USRDS annual data report: Epidemiology of kidney disease in the United States. *American Journal of Kidney Diseases*, *71*(3 Suppl 1), A7.
Shirazian, S., Grant, C. D., Aina, O., et al. (2017). Depression in chronic kidney disease and end-stage renal disease: Similarities and differences in diagnosis, epidemiology, and management. *Kidney International Reports*, *2*(1), 94–107.
Sturdivant, T., & Johnson, P. (2019). Protecting restricted extremities: The implementation of a pink wristband. *Nephrology Nursing Journal 46*(4), 423–452.
Subbiah, A., Chhabra, Y., & Mahajan, S. (2016). Cardiovascular disease in patients with chronic kidney disease: A neglected subgroup. *Heart Asia*, *8*(2), 56–61.
Torres, V., & Bennett, W. (2019). Autosomal dominant polycystic kidney disease (ADPKD) in adults: Epidemiology, clinical presentation, and diagnosis. *UpToDate*. Retrieved on 4/15/2020 at: www.uptodate.com/contents/autosomal-

dominant-polycystic-kidney-disease-adpkd-in-adults-epidemiology-clinical-presentation-and-diagnosis
United States Renal Data System (USRDS). (2019). 2019 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases. Bethesda, MD. Retrieved on 1/14/2020 at: www.usrds.rg/2019/view/Default.aspx
Wu, J., Li, J., Zhu, G., et al. (2020). Clinical features of maintenance hemodialysis patients with novel coronavirus pneumonia in Wuhan, China. *Clinical Journal of the American Society of Nephrology*, *15*(8), 1139–1145.

Resources

Alliance for Paired Donation (APD), paireddonation.org
American Association of Kidney Patients (AAKP), www.aakp.org
American Kidney Fund, www.kidneyfund.org
American Nephrology Nurses' Association (ANNA), www.annanurse.org
American Urological Association (AUA), www.auanet.org
Arteriovenous Fistula First, www.fistulafirst.org
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), www.niddk.nih.gov
National Kidney Registry (NKR), www.kidneyregistry.org
National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC), digestive.niddk.nih.gov
National Kidney Foundation (NKF), www.kidney.org
United Network for Organ Sharing (UNOS), www.unos.org
United States Renal Data System (USRDS), www.usrds.org

49 Management of Patients with Urinary Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Explain the factors contributing to upper and lower urinary tract infections.
2. Use the nursing process as a framework for care of the patient with a lower urinary tract infection.
3. Differentiate between the various adult dysfunctional voiding patterns and develop an education plan for a patient who has urinary incontinence.
4. Identify potential causes of an obstruction of the urinary tract along with the medical, surgical, and nursing management of the patient with this condition.
5. Describe the pathophysiology, clinical manifestations, medical management, and nursing management for patients with genitourinary trauma and urinary tract cancers.
6. Use the nursing process as a framework for care of the patient with renal calculi and for care of the patient undergoing urinary diversion surgery.

NURSING CONCEPTS

Cellular Regulation
Comfort
Elimination
Family
Inflammation
Patient Education

GLOSSARY

bacteriuria: bacteria in the urine

catheter-associated urinary tract infection (CAUTI): a urinary tract infection (UTI) associated with indwelling urinary catheters

cystectomy: surgical removal of the urinary bladder

cystitis: inflammation of the urinary bladder

functional incontinence: involuntary loss of urine due to physical or cognitive impairment

iatrogenic incontinence: involuntary loss of urine due to extrinsic medical factors

ileal conduit: transplantation of the ureters to an isolated section of the terminal ileum, with one end of the ureters brought to the abdominal wall (*synonym:* ileal loop)

interstitial cystitis: inflammation of the bladder wall that eventually causes disintegration of the lining and loss of bladder elasticity

micturition: voiding or urination

mixed incontinence: involuntary urinary leakage associated with urgency and also with exertion, effort, sneezing, or coughing

neurogenic bladder: bladder dysfunction that results from a disorder or dysfunction of the nervous system and leads to urinary incontinence

nocturia: awakening at night to urinate

overflow incontinence: involuntary urine loss associated with overdistention of the bladder

prostatitis: inflammation of the prostate gland

pyelonephritis: inflammation of the renal pelvis

pyuria: white blood cells in the urine

residual urine: urine that remains in the bladder after voiding

stress incontinence: involuntary loss of urine through an intact urethra as a result of exertion, sneezing, coughing, or changing position

suprapubic catheter: a urinary catheter that is inserted through a suprapubic incision into the bladder

ureterovesical or vesicoureteral reflux: backward flow of urine from the bladder into one or both ureters

urethritis: inflammation of the urethra

urethrovesical reflux: an obstruction to free-flowing urine leading to the reflux of urine from the urethra into the bladder

urge incontinence: involuntary loss of urine associated with a strong urge to void that cannot be suppressed

urinary frequency: voiding more often than every 3 hours

urinary incontinence: unplanned, involuntary, or uncontrolled loss of urine from the bladder

urosepsis: spread of infection from the urinary tract to the bloodstream that results in a systemic infection

The urinary system is responsible for providing the route for drainage of urine formed by the kidneys. Care of the patient with disorders of the urinary tract requires an understanding of the anatomy, physiology, diagnostic testing, medical, and nursing care, as well as rehabilitation of patients with the multiple processes that affect the urinary system. Nurses care for patients with urologic disorders in all settings. This chapter focuses on the nursing management of patients with common urinary dysfunctions, including infections, dysfunctional voiding patterns, urolithiasis, genitourinary trauma, cancer of the urinary tract, and urinary diversions.

INFECTIONS OF THE URINARY TRACT

Urinary tract infections (UTIs) are caused by pathogenic microorganisms in the urinary tract (the normal urinary tract is sterile above the urethra). UTIs are generally classified by location as infections of the lower urinary tract, involving the bladder and structures below the bladder, or upper urinary tract, involving the kidneys and ureters.

A UTI is the second most common infection in the body. UTIs account for nearly 25% of all infections and are commonly diagnosed in women visiting emergency departments in the United States. Approximately 8.1 million women are diagnosed with UTIs in the United States annually (Freeman, Martin, & Uithoven, 2017). In addition, UTIs are the cause of more than 100,000 hospital admissions annually (Freeman et al., 2017).

Fifty percent of all hospital-acquired infections are UTIs, and in the majority of cases these are **catheter-associated urinary tract infections (CAUTI)** (Freeman et al., 2017). A CAUTI is a UTI associated with indwelling urinary catheters. The definition used for ongoing monitoring is a UTI that occurs while the patient had an indwelling urinary catheter in place for more than 2 calendar days on the day that the infection was detected.

Lower Urinary Tract Infections

The sterility of the bladder is maintained by several mechanisms, especially important since the urethra is considered a clean, not a sterile space. The physical barrier of the urethra assists in keeping bacteria away from the bladder, while urine flow helps to carry any bacteria away from the bladder. In addition, ureterovesical junction competence, various antibacterial enzymes and antibodies, and antiadherent effects mediated by the mucosal cells of the bladder all play a major part in protecting the sterility of the bladder. Abnormalities or dysfunctions of any of these mechanisms are contributing risk factors for lower UTIs (see Chart 49-1).

Lower UTIs include bacterial **cystitis** (inflammation of the urinary bladder), bacterial **prostatitis** (inflammation of the prostate gland), and bacterial **urethritis** (inflammation of the urethra).

Pathophysiology

For infection to occur, bacteria must gain access to the bladder, attach to and colonize the epithelium of the urinary tract to avoid being washed out with voiding, evade host defense mechanisms, and initiate inflammation. Many UTIs result from fecal organisms ascending from the perineum to the urethra and the bladder and then adhering to the mucosal surfaces.

Chart 49-1 RISK FACTORS

Urinary Tract Infection

- Contributing conditions such as:
  - Female gender
  - Diabetes
  - Pregnancy
  - Neurologic disorders
  - Gout
  - Altered states caused by incomplete emptying of the bladder and urinary stasis
- Decreased natural host defenses or immunosuppression
- Inability or failure to empty the bladder completely
- Inflammation or abrasion of the urethral mucosa
- Instrumentation of the urinary tract (e.g., catheterization, cystoscopic procedures)
- Obstructed urinary flow caused by:
  - Congenital abnormalities
  - Urethral strictures
  - Contracture of the bladder neck
  - Bladder tumors
  - Calculi (stones) in the ureters or kidneys
  - Compression of the ureters

Adapted from Eliopoulos, C. (2018). *Gerontological nursing* (9th ed.). Philadelphia, PA: Wolters Kluwer; Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Bacterial Invasion of the Urinary Tract

By increasing the normal slow shedding of bladder epithelial cells (resulting in bacteria removal), the bladder can clear large numbers of bacteria. Glycosaminoglycan (GAG), a hydrophilic protein, normally exerts a nonadherent protective effect against various bacteria. The GAG molecule attracts water molecules, forming a water barrier that serves as a defensive layer between the bladder and the urine. GAG may be impaired by certain agents (cyclamate, saccharin, aspartame, and tryptophan metabolites). The normal bacterial flora of the vagina and urethral area also interfere with adherence of *Escherichia coli.* Urinary immunoglobulin A (IgA) in the urethra may also provide a barrier to bacteria.

Reflux

An obstruction to free-flowing urine is a condition known as **urethrovesical reflux**, which is the reflux (backward flow) of urine from the urethra into the bladder (see Fig. 49-1). With coughing, sneezing, or straining, the bladder pressure increases, which may force urine from the bladder into the urethra. When the pressure returns to normal, the urine flows back into the bladder, bringing into the bladder bacteria from the anterior portions of the urethra. Urethrovesical reflux is also caused by dysfunction of the bladder neck or urethra. The urethrovesical angle and urethral closure pressure may be altered with menopause, increasing the incidence of infection in postmenopausal women.

Ureterovesical or vesicoureteral reflux refers to the backward flow of urine from the bladder into one or both ureters (see Fig. 49-1). Normally, the ureterovesical junction prevents urine from traveling back into the ureter. The ureters tunnel into the bladder wall so that the bladder musculature compresses a small portion of the ureter during normal voiding. When the ureterovesical valve is impaired by congenital causes or ureteral abnormalities, the bacteria may reach the kidneys and eventually destroy them.

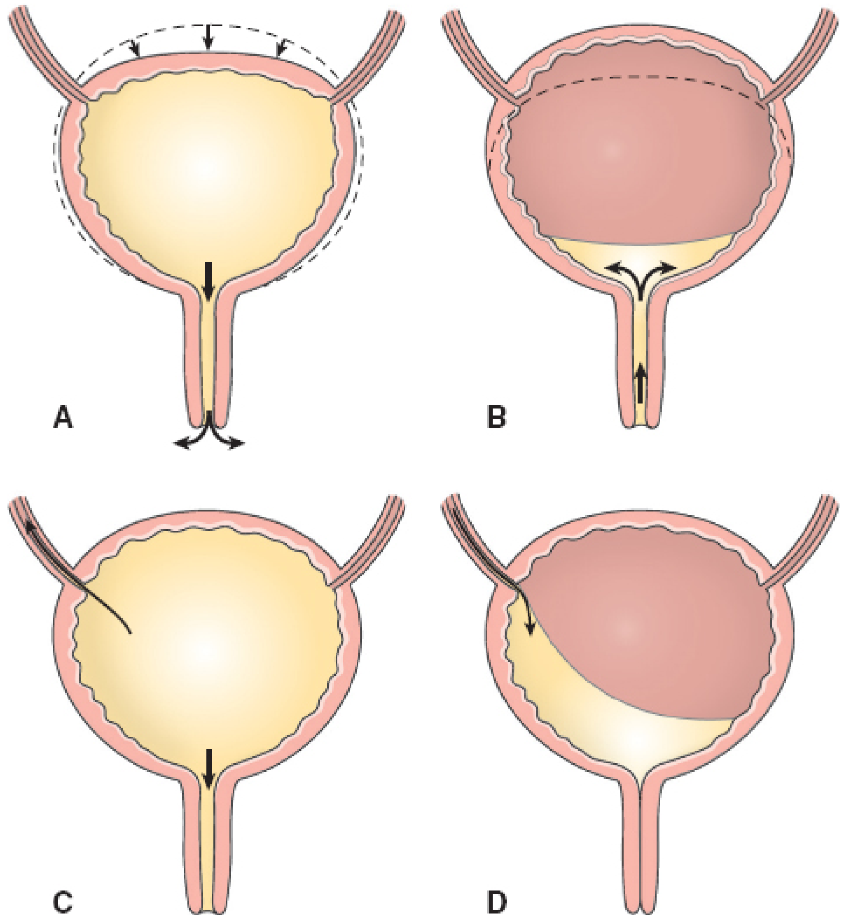


Figure 49-1 • Mechanisms of urethrovesical and ureterovesical reflux may cause urinary tract infection. *Urethrovesical reflux:* With coughing and straining, bladder pressure rises, which may force urine from the bladder into the urethra. **A.** When bladder pressure returns to normal, the urine flows back to the bladder (**B**), which introduces bacteria from the urethra to the bladder. *Ureterovesical reflux:* With failure of the ureterovesical valve, urine moves up the ureters during voiding (**C**) and flows into the bladder when voiding stops (**D**). This prevents complete emptying of the bladder. It also leads to urinary stasis and contamination of the ureters with bacteria-laden urine.

Uropathogenic Bacteria

Bacteriuria is the term used to describe the presence of bacteria in the urine. Because urine samples (especially in women) can be easily contaminated by the bacteria normally present in the urethral area, a clean-catch midstream urine specimen is the measure used to establish bacteriuria. In men, contamination of the collected urine sample occurs less frequently.

Routes of Infection

Bacteria enter the urinary tract in three ways: by the transurethral route (ascending infection), through the bloodstream (hematogenous spread), or by means of a fistula from the intestine (direct extension).

The most common route of infection is transurethral, in which bacteria (often from fecal contamination) colonize the periurethral area and subsequently enter the bladder by means of the urethra (Freeman et al., 2017; Norris, 2019). In women, the short urethra offers little resistance to the movement of uropathogenic bacteria. Penile-vaginal intercourse forces the bacteria from the urethra into the bladder. This accounts for the increased incidence of UTIs in women who engage in penile-vaginal intercourse. Bacteria may also enter the urinary tract by means of the blood from a distant site of infection or through direct extension by way of a fistula from the intestinal tract.

Clinical Manifestations

Signs and symptoms of UTI depend on whether the infection involves the lower (bladder) or upper (kidney) urinary tract and whether the infection is acute or chronic. Signs and symptoms of an uncomplicated lower UTI include burning on urination, **urinary frequency** (voiding more than every 3 hours), urgency, **nocturia** (awakening at night to urinate), incontinence, and suprapubic or pelvic pain. Hematuria and back pain may also be present (Martin, Wingo, & Holland, 2019). In older adults, these symptoms are less common (see Gerontologic Considerations section).

In patients with complicated UTIs, manifestations can range from asymptomatic bacteriuria to gram-negative sepsis with shock. Complicated UTIs often are caused by a broader spectrum of organisms, have a lower response rate to treatment, and tend to recur. Many patients with CAUTIs are asymptomatic; however, any patient with a catheter who suddenly develops signs and symptoms of septic shock should be evaluated for **urosepsis** (the spread of infection from the urinary tract to the bloodstream that results in a systemic infection).

Gerontologic Considerations

The incidence of bacteriuria in older adults differs from that in younger adults. Bacteriuria increases with age and disability, and women are affected more frequently than men. UTI is the most common infection of older adults and increases in prevalence with age. UTIs occur more frequently in women than in men at younger ages but the gap between the sexes narrows in later life, which is due to reduced penile-vaginal intercourse in women and a higher incidence of bladder outlet obstruction secondary to benign prostatic hyperplasia in men (Eliopoulos, 2018).

In older adults, structural abnormalities secondary to decreased bladder tone, **neurogenic bladder** (dysfunctional bladder) secondary to stroke, or autonomic neuropathy of diabetes may prevent complete emptying of the bladder and increase the risk of UTI (Eliopoulos, 2018). When indwelling catheters are used, the risk of CAUTI increases dramatically. Older women often have incomplete emptying of the bladder and urinary stasis. In the absence of estrogen, postmenopausal women are susceptible to colonization and increased adherence of bacteria to the vagina and urethra. Oral or topical estrogen has been used to restore the glycogen content of vaginal epithelial cells and an acidic pH for some postmenopausal women with recurrent cystitis.

The antibacterial activity of prostatic secretions that protect men from bacterial colonization of the urethra and bladder decreases with aging. The use of catheterization or cystoscopy in evaluation or treatment for prostatic hyperplasia or carcinoma, strictures of the urethra, and neuropathic bladder may contribute to the higher incidence of UTIs in men. The incidence of bacteriuria also increases in men with confusion, dementia, or bowel or bladder incontinence. The most common cause of recurrent UTIs in older males is chronic bacterial prostatitis. Resection of the prostate gland may help reduce its incidence (see Chapter 53).

Chart 49-2

Factors That Contribute to Urinary Tract Infection in Older Adults

- Cognitive impairment
- Frequent use of antimicrobial agents
- High incidence of multiple chronic medical conditions
- Immune compromised
- Immobility and incomplete emptying of bladder
- Low fluid intake and excessive fluid loss
- Obstructed flow of urine (e.g., urethral strictures, neoplasms, clogged indwelling catheter)
- Poor hygiene practices

Adapted from Eliopoulos, C. (2018). *Gerontological nursing* (9th ed.). Philadelphia, PA: Wolters Kluwer.

Chart 49-2 lists other factors that may contribute to UTI in older patients. Diligent hand hygiene, careful perineal care, and frequent toileting may decrease the incidence of UTIs.

The organisms responsible for UTIs in older adults residing in institutions may differ from those found in patients residing in the community; this is thought to result in part from the frequent use of antibiotic agents by patients in long-term care facilities. *Escherichia coli* is the most common organism seen in older patients in the community or hospital. However, patients with indwelling catheters are more likely to be infected with organisms such as *Proteus, Klebsiella, Pseudomonas,* or *Staphylococcus.* Patients who have been previously treated with antibiotics may be infected with *Enterococcus* species. Frequent reinfections are common in older adults.

Early symptoms of UTI in postmenopausal women and older adults include malaise, nocturia, urinary incontinence, or a complaint of foul-smelling urine. Additional early symptoms include burning, urgency, and fever (Eliopoulos, 2018; Freeman et al., 2017). Some patients develop incontinence and delirium with the onset of a UTI.

Antibiotics are prescribed when bacteriuria is present (Eliopoulos, 2018). Treatment regimens are generally the same as those for younger adults, although age-related changes in the intestinal absorption of medications and decreased kidney function and hepatic flow may necessitate alterations in the antimicrobial regimen. Kidney function must be monitored, and medication dosages should be altered accordingly. The nurse carefully monitors fluid intake and output. Increasing fluid intake is advisable, provided that the patient's cardiac status does not contraindicate this action (Eliopoulos, 2018).

Assessment and Diagnostic Findings

Results of various tests, such as bacterial colony counts, cellular studies, and urine cultures, help confirm the diagnosis of UTI. In an uncomplicated UTI, the strain of bacteria determines the antibiotic of choice (Norris, 2019).

Urine Cultures

Urine cultures are useful for documenting a UTI and identifying the specific organism present. UTI is diagnosed by bacteria in the urine culture. A colony count greater than 100,000 CFU/mL of urine on a clean-catch midstream or catheterized specimen indicates infection (Fischbach & Fischbach, 2018). However, symptoms of UTI and subsequent sepsis have occurred with lower bacterial colony counts. The presence of any bacteria in specimens obtained by suprapubic needle aspiration of the urinary bladder, straight catheterization (insertion of a tube into the urinary bladder), or during surgery or cystoscopy is considered clinically significant (Fischbach & Fischbach, 2018).

The following groups of patients should have urine cultures obtained when bacteriuria is present (Fischbach & Fischbach, 2018; Norris, 2019):

- All children
- All men (because of the likelihood of structural or functional abnormalities)

- Patients who have been recently hospitalized or who live in long-term care facilities
- Patients who have undergone recent instrumentation (including catheterization) of the urinary tract
- Patients with diabetes
- Patients with prolonged or persistent symptoms
- Patients with three or more UTIs in the previous year
- Women who are postmenopausal
- Women who are pregnant
- Women who are sexually active
- Women who have new sexual partners
- Women with a history of compromised immune function or renal problems

Cellular Studies

Microscopic hematuria is present in about half of patients with an acute UTI (see Chapter 47). **Pyuria** (white blood cells [WBCs] in the urine) occurs in all patients with UTI; however, it is not specific for bacterial infection. Pyuria can also be seen with renal calculi, interstitial nephritis, and renal tuberculosis.

Other Studies

A multiple-test dipstick often includes testing for WBCs, known as the leukocyte esterase test, and nitrite testing (Norris, 2019). Tests for sexually transmitted infections may be performed because acute urethritis caused by sexually transmitted organisms (i.e., *Chlamydia trachomatis, Neisseria gonorrhoeae,* herpes simplex) or acute vaginitis infections (caused by *Trichomonas* or *Candida* species) may be responsible for symptoms similar to those of UTIs.

X-ray images, computed tomography (CT) scan, ultrasonography, and kidney scans are useful diagnostic tools. A CT scan may detect pyelonephritis or abscesses. Ultrasonography and kidney scans are extremely sensitive for detecting obstruction, abscesses, tumors, and cysts (Norris, 2019).

Medical Management

Management of UTIs typically involves pharmacologic therapy and patient education. Various prescribed medication regimens are used to treat UTI. The American Urological Association (AUA) guidelines for treatment of UTIs, particularly for recurrent uncomplicated UTIs in women, guide medical management (AUA, 2019a, 2019b).

Acute Pharmacologic Therapy

The ideal medication for treatment of UTI in women is an antibacterial agent that eradicates bacteria from the urinary tract with minimal effects on fecal and vaginal flora, thereby minimizing the incidence of vaginal yeast infections. The antibacterial agent should be affordable and should have few adverse effects and low resistance. Because the organism in initial, uncomplicated UTIs in women is most likely *E. coli* or other fecal flora, the agent should be effective against these organisms. Various treatment regimens have been successful in treating uncomplicated lower UTIs in women: single-dose administration, short-course (3-day) regimens, or 7-day regimens (Freeman et al., 2017). The trend is toward a shortened course of antibiotic therapy for uncomplicated UTIs, because most cases are cured after 3 days of treatment. Medications commonly used to treat UTIs are listed in Table 49-1. Regardless of the regimen prescribed, the patient is instructed to take all doses prescribed, even if relief of symptoms occurs promptly. Longer medication courses are indicated for men, pregnant women, and women with pyelonephritis and other types of complicated UTIs. Men with UTIs should be evaluated for possible prostatitis (Eliopoulos, 2018). Hospitalization and intravenous (IV) antibiotics are occasionally necessary (Freeman et al., 2017).

TABLE 49-1 Select Medications Used to Treat Urinary Tract Infections and Pyelonephritis

Drug Classes	Generic Name	Major Indications
Anti-infective, urinary tract Bactericidal	Nitrofurantoin Cephalexin	UTI Genitourinary infection
Cephalosporin	Cefadroxil	UTI
Fluoroquinolone	Ciprofloxacin Ofloxacin Norfloxacin Gatifloxacin	UTI Pyelonephritis
Fluoroquinolone	levofloxacin	Uncomplicated UTI
Penicillin	ampicillin amoxicillin	UTI—not commonly used alone due to *Escherichia coli* resistance Pyelonephritis UTI—not commonly used alone due to *E. coli* resistance
Trimethoprim–sulfamethoxazole combination	Co-trimoxazole	UTI Pyelonephritis
Urinary analgesic agent	Phenazopyridine	For relief of burning, pain, and other symptoms associated with UTI

UTI, urinary tract infection.

Adapted from Comerford, K. C., & Durkin, M. A. (2020). *Nursing 2020 drug handbook* (40th ed.). Philadelphia, PA: Wolters Kluwer.

Long-Term Pharmacologic Therapy

Although pharmacologic treatment of UTIs for 3 days is usually adequate in women, infection recurs in about 20% of women treated for uncomplicated UTIs. Infections that recur within 2 weeks of therapy do so because organisms of the original offending strain remain. Relapses suggest that the source of bacteriuria may be the upper urinary tract or that initial treatment was inadequate or given for too short a time. Recurrent infections in men are usually caused by persistence of the same organism; further evaluation and treatment are indicated (Eliopoulos, 2018).

If infection recurs after completing antimicrobial therapy, another short course (3 to 4 days) of full-dose antimicrobial therapy followed by a regular bedtime dose of an antimicrobial agent may be prescribed.

A meta-analysis of nine studies reported the daily intake of cranberry, especially in the form of capsules, significantly reduced the rate of recurrent UTI compared to placebo with minor adverse effects such as rash and gastrointestinal symptoms (Tambunan & Rahardjo, 2019). The same meta-analysis reported that antibiotics were more effective for the treatment of recurrent UTI compared to cranberry capsules but had more severe adverse effects including gastrointestinal symptoms and Stevens–Johnson syndrome (Tambunan & Rahardjo, 2019).

NURSING PROCESS

The Patient with a Lower Urinary Tract Infection

Nursing care of the patient with a lower UTI focuses on treating the underlying infection and preventing a recurrence.

Assessment

A history of pertinent signs and symptoms is obtained from the patient with a suspected UTI. The presence of pain, frequency, urgency, hesitancy, and changes in urine are assessed, documented, and reported. The patient's usual pattern of voiding is assessed to detect factors that may predispose them to UTI. Infrequent emptying of the bladder, the association of symptoms of UTI with penile-vaginal intercourse, contraceptive practices, and personal hygiene are assessed. The patient's knowledge about prescribed antimicrobial medications and preventive health care measures is also assessed. In addition, the urine is assessed for volume, color, concentration, cloudiness, and odor—all of which are altered by bacteria in the urinary tract. Patients need to be asked specifically about the use of complementary and alternative medicine (CAM) therapies. Women with **interstitial cystitis** (inflammation of the bladder wall) use both complementary and conventional therapies. CAM therapies reported include behavioral therapy, physical therapy, stress reduction, and dietary manipulation (Oh-oka, 2017). Clinical efficacy was reported in a year-long clinical trial of intensive dietary manipulation (Oh-oka, 2017).

Diagnosis

Nursing Diagnoses

Based on the assessment data, nursing diagnoses may include the following:

- Acute pain associated with infection within the urinary tract
- Lack of knowledge about factors predisposing the patient to infection and recurrence, detection and prevention of recurrence, and pharmacologic therapy

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Sepsis (urosepsis)
- The long term result of either extensive infective or inflammatory processes have the potential to result in either acute kidney injury or chronic kidney disease.

Planning and Goals

Major goals for the patient may include relief of pain and discomfort, increased knowledge of preventive measures and treatment modalities, and absence of complications.

Nursing Interventions

Relieving Pain

The pain associated with a UTI is quickly relieved once effective antimicrobial therapy is initiated. Antispasmodic agents may also be useful in relieving bladder irritability and pain. Analgesic agents and the application of heat to the perineum help relieve pain and spasm. The patient is encouraged to drink liberal amounts of fluids (water and cranberry juice are the best choices) to promote renal blood flow and to flush the bacteria from the urinary tract. Urinary tract irritants (e.g., coffee, tea, citrus, spices, colas, alcohol) should be avoided. Frequent voiding (every 2 to 3 hours) is encouraged to empty the bladder completely, because doing so can lower urine bacterial counts, reduce urinary stasis, and prevent reinfection (Wu, Grealish, Moyle, et al., 2020).

Monitoring and Managing Potential Complications

Early recognition of UTI and prompt treatment are essential to prevent recurrent infection and the possibility of complications, such as kidney disease, sepsis (urosepsis), strictures, and obstructions. The goal of treatment is to prevent infection from progressing and causing permanent kidney damage and injury. Thus, the patient must be educated to recognize early signs and symptoms, to test for bacteriuria, and to initiate treatment as prescribed. Appropriate antimicrobial therapy, liberal fluid intake, frequent voiding, and hygienic measures are commonly prescribed for managing UTIs. The patient is instructed to notify the primary provider if fatigue, nausea, vomiting, fever, or pruritus occurs. Periodic monitoring of renal function and evaluation for strictures, obstructions, or stones may be indicated for patients with recurrent UTIs.

Chart 49-3 PATIENT EDUCATION

Preventing Recurrent Urinary Tract Infections

The nurse instructs the patient on the following basic information:

Hygiene

- Shower rather than bathe in the tub because bacteria in the bathwater may enter the urethra.
- Clean the perineum and urethral meatus from front to back after each bowel movement. This will help reduce concentrations of pathogens at the urethral opening and, in women, the vaginal opening.

Fluid Intake

- Drink liberal amounts of fluids daily to flush out bacteria. It may be helpful to include at least one glass of cranberry juice per day.
- Avoid coffee, tea, colas, alcohol, and other fluids that are urinary tract irritants.

Voiding Habits

Void every 2 to 3 hours during the day, and completely empty the bladder. This prevents overdistention of the bladder and compromised blood supply to the bladder wall. Both predispose the patient to urinary tract infection. Precautions expressly for women include voiding immediately after penile-vaginal intercourse.

Interventions

- Take medication *exactly* as prescribed. Special timing of administration may be required.
- Keep in mind that if bacteria continue to appear in the urine, long-term antimicrobial therapy may be required to prevent colonization of the periurethral area and recurrence of infection.
- For recurrent infection, consider daily consumption of cranberry juice or capsules.
- If prescribed, test urine for presence of bacteria following manufacturer's and health care provider's instructions.
- Notify the primary provider if fever occurs or if signs and symptoms persist.
- Consult the primary provider regularly for follow-up.

Adapted from Tambunan, M. P., & Rahardjo, H. E. (2019). Cranberries for women with recurrent urinary tract infection: A meta-analysis. *Medical Journal of Indonesia*, *28*(3), 268–275.

Patients with UTIs are at increased risk for gram-negative sepsis. For each day a urinary catheter is in place, the risk of developing CAUTI increases by 3% to 7% per day of catheterization (Gould, Umscheid, Agarwal, et al., 2019). The Centers for Medicare and Medicaid Services has classified a CAUTI as a “never event” which means no reimbursement to pay for the cost of treatment will be covered by CMS or other insurers if the CAUTI is incurred within an acute care or rehabilitation hospital (Gould et al., 2019). Urosepsis mortality rates following catheterization are reported to be 25% to 60% (Newman, 2017).

Careful assessment of vital signs and level of consciousness may alert the nurse to kidney involvement or impending sepsis. Positive blood cultures and elevated WBC counts must be reported immediately. At the same time, appropriate antibiotic therapy and increased fluid intake are prescribed (IV antibiotic therapy and fluids may be required). Aggressive early treatment is the key to reducing the mortality rate associated with CAUTI especially in older patients, those with anemia, and those with elevated blood glucose levels (McCoy, Paredes, Allen, et al., 2017; Taylor, 2018).

Promoting Home, Community-based, and Transitional Care

Educating Patients About Self-Care. In helping patients learn about and prevent or manage a recurrent UTI, the nurse implements education that meets the patient’s needs. Health-related behaviors that help prevent recurrent UTIs include practicing careful personal hygiene, increasing fluid intake to promote voiding and dilution of urine, urinating regularly and more frequently, and adhering to the therapeutic regimen (Martin et al., 2019). For a detailed discussion of patient education, see Chart 49-3.

Evaluation

Expected patient outcomes may include:

1. Experiences relief of pain
    a. Reports absence of pain, urgency, frequency, nocturia, or hesitancy on voiding
    b. Takes analgesic, antispasmodic, and antibiotic agents as prescribed
2. Explains UTIs and their treatment
    a. Demonstrates knowledge of preventive measures and prescribed treatments
    b. Drinks 8 to 10 glasses of fluids daily
    c. Voids every 2 to 3 hours
    d. Produces urine that is clear and odorless
3. Experiences no complications
    a. Reports no symptoms of infection (fever, frequency)

b. Has normal kidney function, negative urine and blood cultures
c. Exhibits normal vital signs and temperature; no signs or symptoms of sepsis (urosepsis)
d. Maintains adequate urine output more than 400 mL/day

Upper Urinary Tract Infections

Upper UTIs are much less common than those in the lower urinary tract. Acute pyelonephritis and chronic pyelonephritis are thought to be the most likely type, with interstitial nephritis (inflammation of the kidney) and kidney abscesses also a potential cause. Upper UTIs are a common cause of urosepsis (Freeman et al., 2017).

Pyelonephritis is a bacterial infection of the renal pelvis, tubules, and interstitial tissue of one or both kidneys. Causes involve either the upward spread of bacteria from the bladder or spread from systemic sources reaching the kidney via the bloodstream. Bacteria from a bladder infection can ascend into the kidney, resulting in pyelonephritis. An incompetent ureterovesical valve or obstruction occurring in the urinary tract increases the susceptibility of the kidneys to infection (see Fig. 49-1), because static urine provides a good medium for bacterial growth. Bladder or prostate tumors, strictures, benign prostatic hyperplasia, and urinary stones are some potential causes of obstruction that can lead to infections. Systemic infections (such as tuberculosis) can spread to the kidneys and result in abscesses. Pyelonephritis may be acute or chronic.

Acute Pyelonephritis

Acute pyelonephritis is the cause of more than 25,000 hospital admissions annually and usually leads to enlargement of the kidneys with interstitial infiltrations of inflammatory cells (Freeman et al., 2017; Norris, 2019). Abscesses may be noted on or within the renal capsule and at the corticomedullary junction. Eventually, atrophy and destruction of tubules and the glomeruli may result.

Clinical Manifestations

The patient with acute pyelonephritis has chills, fever, leukocytosis, bacteriuria, and pyuria. Low back pain, flank pain, nausea and vomiting, headache, malaise, and painful urination are common findings. Physical examination reveals pain and tenderness in the area of the costovertebral angle (see Chapter 47, Fig. 47-6). In addition, symptoms of lower urinary tract involvement, such as urgency and frequency, are common.

Assessment and Diagnostic Findings

An ultrasound study or a CT scan may be performed to locate an obstruction in the urinary tract. Relief of obstruction is essential to prevent complications and eventual kidney damage. An IV pyelogram may be indicated if functional and structural renal abnormalities are suspected (Fischbach & Fischbach, 2018). Radionuclide imaging with gallium citrate and indium-111 (^{111}In)–labeled WBCs may be useful to identify sites of infection that may not be visualized on CT scan or ultrasound. Urine culture and sensitivity tests are performed to determine the causative organism so that appropriate antimicrobial agents can be prescribed (Fischbach & Fischbach, 2018).

Medical Management

Patients with acute uncomplicated pyelonephritis are most often treated on an outpatient basis if they are not exhibiting acute symptoms of sepsis, dehydration, nausea, or vomiting. Patients treated on an outpatient basis must be willing and able to take their medications as prescribed. For outpatients, a 2-week course of antibiotic agents is recommended because renal parenchymal disease is more difficult to eradicate than mucosal bladder infections. Commonly prescribed agents include many of the same medications prescribed for the treatment of UTIs (see Table 49-1).

Following acute pyelonephritis treatment, the patient may develop a chronic or recurring symptomless infection persisting for months or years. After the initial antibiotic regimen, the patient may need antibiotic therapy for up to 6 weeks if a relapse occurs. A follow-up urine culture is obtained 2 weeks after completion of antibiotic therapy to document clearing of the infection.

Hydration with oral or parenteral fluids is essential in all patients with UTIs when there is adequate kidney function. Hydration helps facilitate “flushing” of the urinary tract and reduces pain and discomfort.

Chronic Pyelonephritis

Repeated bouts of acute pyelonephritis may lead to chronic pyelonephritis. When pyelonephritis becomes chronic, the kidneys become scarred, contracted, and nonfunctioning. Chronic pyelonephritis is a cause of chronic kidney disease that can result in the need for renal replacement therapy (RRT) such as transplantation or dialysis (see Chapter 48 for discussion of RRT).

Clinical Manifestations

The patient with chronic pyelonephritis usually has no symptoms of infection unless an acute exacerbation occurs. Noticeable signs and symptoms may include fatigue, headache, poor appetite, polyuria, excessive thirst, and weight loss. Persistent and recurring infection may produce progressive scarring of the kidney, resulting in chronic kidney disease (see Chapter 48).

Assessment and Diagnostic Findings

The extent of the disease is assessed by an IV urogram and measurements of creatinine clearance, blood urea nitrogen, and creatinine levels (Fischbach & Fischbach, 2018).

Complications

Complications of chronic pyelonephritis include end-stage kidney disease (from progressive loss of nephrons secondary to chronic inflammation and scarring), hypertension, and formation of renal calculi (from chronic infection with urea-splitting organisms).

Medical Management

Bacteria, if detected in the urine, are eradicated if possible. Long-term use of prophylactic antimicrobial therapy may help limit recurrence of infections and kidney scarring. Impaired kidney function alters the excretion of antimicrobial agents and necessitates careful monitoring of kidney function, especially if the medications are potentially toxic to the kidneys.

Nursing Management

The patient may require hospitalization or may be treated as an outpatient. When the patient requires hospitalization, fluid intake and output are carefully measured and recorded. Unless contraindicated, 3 to 4 L of fluids per day is encouraged to dilute the urine, decrease burning on urination, and prevent dehydration. The nurse assesses the patient's temperature every 4 hours and administers antipyretic and antibiotic agents as prescribed.

TABLE 49-2 Conditions Causing Adult Voiding Disorders

Disorder	Voiding Dysfunction	Treatment
Neurogenic Disorders		
Cerebellar ataxia	Incontinence or dyssynergia	Timed voiding; anticholinergic agents
Stroke	Retention or incontinence	Anticholinergic agents; bladder retraining
Dementia	Incontinence	Prompted voiding; anticholinergic agents
Diabetes	Incontinence and/or incomplete bladder emptying	Timed voiding; EMG/biofeedback; pelvic floor nerve stimulation; anticholinergic/antispasmodic agents; well-controlled blood glucose levels
Multiple sclerosis	Incontinence or incomplete bladder emptying	Timed voiding; EMG/biofeedback to learn pelvic muscle exercises and urge inhibition; pelvic floor nerve stimulation; antispasmodic agents
Parkinson's disease	Incontinence	Anticholinergic/antispasmodic agents
Spinal Cord Dysfunction		
Acute injury	Urinary retention	Indwelling catheter
Degenerative disease	Incontinence and/or incomplete bladder emptying	EMG/biofeedback; pelvic floor nerve stimulation; anticholinergic agents
Nonneurogenic Disorder		
"Bashful bladder"	Inability to initiate voiding in public bathrooms	Relaxation therapy; EMG/biofeedback
Overactive bladder	Urgency, frequency, and/or urge incontinence	EMG/biofeedback; pelvic floor nerve stimulation; bladder drill (see Chart 49-6); anticholinergic agents
Post general surgery	Acute urine retention	Catheterization
Postprostatectomy	Incontinence	*Mild:* Biofeedback; bladder drill (see Chart 49-6); pelvic floor nerve stimulation *Moderate/severe:* Surgery—artificial sphincter
Stress incontinence	Incontinence with cough, laugh, sneeze, position change	*Mild:* Biofeedback; bladder drill (see Chart 49-6); periurethral bulking with collagen *Moderate/severe:* Surgery

EMG, electromyogram.

Adapted from Hickey, J. V., & Strayer, A. L. (2020). *The clinical practice of neurological and neurosurgical nursing* (8th ed.). Philadelphia, PA: Wolters Kluwer.

Patient education focuses on prevention of further infection by consuming adequate fluids, emptying the bladder regularly, and performing recommended perineal hygiene. The importance of taking antimicrobial medications exactly as prescribed is stressed, as is the need for keeping follow-up appointments.

ADULT VOIDING DYSFUNCTION

The **micturition** (voiding or urination) process involves several highly coordinated neurologic responses that mediate bladder function. A functional urinary system allows for appropriate bladder filling and complete bladder emptying (see Chapter 47). If voiding dysfunction goes undetected and untreated, the upper urinary system may be compromised. Both neurogenic and nonneurogenic disorders can cause adult voiding dysfunction (see Table 49-2). Chronic incomplete bladder emptying from poor detrusor pressure results in recurrent bladder infection. Incomplete bladder emptying due to bladder outlet obstruction (such as benign prostatic hyperplasia), causing high-pressure detrusor contractions, can result in hydronephrosis from the high detrusor pressure that radiates up the ureters to the renal pelvis.

Urinary Incontinence

More than 25 million adults in the United States are estimated to have **urinary incontinence** (unplanned, involuntary, or uncontrolled loss of urine from the bladder); however, it is difficult to determine exact numbers as there are many types of urinary incontinence. The prevalence is thought to be 9% to 12% of all adults in the United States, but women are affected twice as often as men (Norris, 2019). Urinary incontinence is more common in older adults, with rates of between 50% and 90% reported in older adults residing in institutions (Eliopoulos, 2018).

Chart 49-4 RISK FACTORS

Urinary Incontinence

- Age-related changes in the urinary tract
- Caregiver or toilet unavailable
- Cognitive disturbances—dementia, Parkinson's disease
- Class III obesity (also called extreme or severe obesity)
- Diabetes
- Genitourinary surgery
- High-impact exercise
- Immobility
- Incompetent urethra due to trauma or sphincter relaxation
- Medications—diuretic, sedative, hypnotic, and opioid agents
- Menopause
- Pelvic muscle weakness
- Pregnancy—vaginal delivery, episiotomy
- Stroke

Adapted from Wooldridge, L. S. (2017). Urinary incontinence. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Anthony J. Jannetti, Inc.

Despite widespread media coverage, urinary incontinence remains underdiagnosed, underreported, and undertreated. Patients may be too embarrassed to seek help, causing them to ignore or conceal symptoms. Many patients use absorbent pads or other devices without having their condition properly diagnosed and appropriately treated. Health care providers must be alert to subtle cues of urinary incontinence and stay informed about current management strategies.

The costs of care for patients with urinary incontinence include the expenses of absorbent products, medications, and surgical or nonsurgical treatment modalities, as well as psychosocial costs (i.e., embarrassment, loss of self-esteem, and social isolation) (Norris, 2019).

Although urinary incontinence is commonly regarded as a condition that occurs in older multiparous women, it can occur in young nulliparous women, especially during vigorous high-impact activity. Age, gender, and number of vaginal deliveries are established risk factors that explain, in part, the increased incidence in women (see Chart 49-4). Men can have urinary incontinence, especially those with certain comorbid conditions. Researchers have reported that 40% of men with Parkinson's disease reported urinary incontinence (McDonald, Winge, & Burn, 2017). Urinary incontinence may be a symptom of other disorders, such as UTI or fecal impaction.

Types of Urinary Incontinence

There are many types of urinary incontinence, including the following:

Stress incontinence is the involuntary loss of urine through an intact urethra as a result of exertion, sneezing, coughing, or changing position (Wooldridge, 2017). It predominantly affects women who have had vaginal deliveries and is thought to be the result of decreasing ligament and pelvic floor support of the urethra and decreasing or absent estrogen levels within the urethral walls and bladder base. In men, stress incontinence is often experienced after a radical prostatectomy for prostate cancer because of the loss of urethral compression that the prostate had supplied before the surgery, and possibly bladder wall irritability.

Urge incontinence is the involuntary loss of urine associated with a strong urge to void that cannot be suppressed (Wooldridge, 2017). The patient is aware of the need to void but is unable to reach a toilet in time. An uninhibited detrusor contraction is the precipitating factor. This can occur in a patient with neurologic dysfunction that impairs inhibition of bladder contraction or in a patient without overt neurologic dysfunction.

Functional incontinence is the involuntary loss of urine due to physical or cognitive impairment. This occurs when the lower urinary tract function is intact but other factors, such as severe cognitive impairment (e.g., Alzheimer's dementia), make it difficult for the patient to identify the need to void or physical impairments make it difficult or impossible for the patient to reach the toilet in time for voiding (Miller, 2019; Wooldridge, 2017).

Iatrogenic incontinence is the involuntary loss of urine due to extrinsic medical factors, predominantly medications. One such example is the use of alpha-adrenergic agents to decrease blood pressure. In some people with an intact urinary system, these agents adversely affect the alpha receptors responsible for bladder neck closing pressure; the bladder neck relaxes to the point of incontinence with a minimal increase in intra-abdominal pressure, thus mimicking stress incontinence. As soon as the medication is discontinued, the apparent incontinence resolves.

Mixed incontinence, which encompasses several types of urinary incontinence, is involuntary leakage associated with urgency and also with exertion, effort, sneezing, or coughing (Miller, 2019; Wooldridge, 2017).

Overflow incontinence occurs when there is continual leakage of urine from an overdistended bladder (Norris, 2019). This can occur because of detrusor muscle underactivity or an outlet obstruction caused by benign prostatic hyperplasia, pelvic organ prolapse, or tumors, among other things.

Only with appropriate recognition of the problem, assessment, and referral for diagnostic evaluation and treatment can the outcome of incontinence be determined. All people with incontinence should be considered for evaluation and treatment.

Gerontologic Considerations

Although urinary incontinence is not a normal consequence of aging, age-related changes in the urinary tract do predispose the older person to incontinence. However, if nurses and other health care providers accept incontinence as an inevitable part of illness or aging or consider it irreversible and untreatable, it cannot be treated successfully. Collaborative, interdisciplinary efforts are essential in assessing and effectively treating urinary incontinence. Urinary incontinence can decrease an older person's ability to maintain an independent lifestyle, which increases dependence on caregivers and may lead to institutionalization. Between 35% and 41% of older women have urinary incontinence (Wooldridge, 2017).

Many older adults experience transient episodes of incontinence that tend to be abrupt in onset. When this occurs, the nurse should question the patient, as well as the family if possible, about the onset of symptoms and any signs or symptoms of a change in other organ systems. Acute UTI, infection elsewhere in the body, constipation, decreased fluid intake, and a change in a chronic disease pattern, such as elevated blood glucose levels in patients with diabetes or decreased estrogen levels in menopausal women, can provoke the onset of urinary incontinence. If the cause is identified and modified or eliminated early at the onset of incontinence, the incontinence itself may be eliminated. Although the bladder of the older person is more vulnerable to altered detrusor activity, age alone is not a risk factor for urinary incontinence (Miller, 2019; Wooldridge, 2017).

Decreased bladder muscle tone is a normal age-related change found in older adults. This leads to decreased bladder capacity, increased **residual urine** (urine remaining in the bladder after voiding), and an increase in urgency.

Many medications affect urinary continence in addition to causing other unwanted or unexpected effects (Miller, 2019; Wooldridge, 2017). All medications need to be assessed for potential interactions.

Assessment and Diagnostic Findings

Once incontinence is recognized, a thorough history is necessary. This includes a detailed description of the problem and a history of medication use. The patient's voiding history, a diary of fluid intake and output, and bedside tests (e.g., residual urine, stress maneuvers) may be used to help determine the type of urinary incontinence involved. Urodynamic tests may be performed (see Chapter 47). Urinalysis and urine culture are performed to identify infection.

Urinary incontinence may be transient or reversible if the underlying cause is successfully treated and the voiding pattern reverts to normal. Chart 49-5 provides causes of transient incontinence.

Medical Management

Management depends on the type of urinary incontinence and its causes. Management of urinary incontinence may be behavioral, pharmacologic, or surgical.

Behavioral Therapy

Behavioral therapies, also known as nonpharmacologic, or conservative treatments, are the first choice to decrease or eliminate urinary incontinence (see Chart 49-6). These are recommended as first-line treatment for nonneurologic causes of incontinence in adults (AUA, 2019b). In using these techniques, health care professionals help patients avoid potential adverse effects of pharmacologic or surgical interventions. Pelvic floor muscle exercises (sometimes referred to as Kegel exercises) represent the cornerstone of behavioral intervention for addressing symptoms of stress, urge, and mixed incontinence (Miller, 2019; Wooldridge, 2017). Other behavioral treatments include the use of a voiding diary, biofeedback, verbal instruction (prompted voiding), and physical therapy (AUA, 2019b; Wooldridge, 2017).

Chart 49-5

Causes of Transient Incontinence

- Atrophic vaginitis, urethritis, prostatitis
- Delirium or confusion
- Excessive urine production (increased intake, diabetes, diabetic ketoacidosis)
- Limited or restricted activity
- Pharmacologic agents (anticholinergic agents, sedatives, alcohol, analgesic agents, diuretics, muscle relaxants, adrenergic agents)
- Psychological factors (depression, regression)
- Stool impaction or constipation
- Urinary tract infections (UTI)

Pharmacologic Therapy

Pharmacologic therapy works best when used as an adjunct to behavioral interventions. The particular antibiotic used will be dependent on the type of incontinence diagnosed (AUA, 2019a). Anticholinergic agents inhibit bladder contraction and are considered first-line medications for urge incontinence (AUA, 2019a; Wooldridge, 2017). Mirabegron, a beta-3 adrenergic agonist, may be used for urge incontinence and overactive bladder but should be used with caution in patients with hypertension as it can cause increased blood pressure (Wooldridge, 2017). A tricyclic antidepressant medication (e.g., amitriptyline) can also decrease bladder contractions as well as increase bladder neck resistance (Wooldridge, 2017). Pseudoephedrine sulfate, which acts on alpha-adrenergic receptors, causing urinary retention, may be used to treat stress incontinence; it needs to be used with caution in men with prostatic hyperplasia and in patients with hypertension.

Surgical Management

Surgical correction may be indicated in patients who have not achieved continence using behavioral and pharmacologic therapy. Surgical options vary according to the underlying anatomy and the physiologic problem. Most procedures involve lifting and stabilizing the bladder or urethra to restore the normal urethrovesical angle or to lengthen the urethra.

Women with stress incontinence may undergo an anterior vaginal repair, retropubic suspension, or needle suspension to reposition the urethra. Procedures to compress the urethra and increase resistance to urine flow include sling procedures and placement of periurethral bulking agents such as artificial collagen.

Periurethral bulking is a minimally invasive procedure in which small amounts of artificial collagen are placed within the walls of the urethra to enhance the closing pressure of the urethra (Norris, 2019). This procedure takes only 10 to 20 minutes and may be performed under local anesthesia or moderate sedation. A cystoscope is inserted into the urethra. An instrument is inserted through the cystoscope to deliver a small amount of collagen into the urethral wall at locations selected by the urologist. The patient is usually discharged home after voiding. There are no restrictions following the procedure, although multiple sessions may be necessary for a cure (Norris, 2019). Collagen placement anywhere in the body is considered semipermanent because its durability averages between 12 and 24 months, until the body absorbs the material. Periurethral bulking with collagen is a relatively safe alternative to surgery. It is also an option for people who are seeking help with stress incontinence who prefer to avoid surgery and who do not have access to behavioral therapies.

Chart 49-6 HEALTH PROMOTION

Interventions for Urinary Incontinence

Behavioral strategies are largely carried out, coordinated, and monitored by the nurse. These interventions may or may not be augmented by the use of medications.

Fluid Management

An adequate daily fluid intake of approximately 1500 to 1600 mL, taken as small increments between breakfast and the evening meal, helps to reduce urinary urgency related to concentrated urine production, decreases the risk of urinary tract infection, and maintains bowel functioning. (Constipation, resulting from inadequate daily fluid intake, can increase urinary urgency and urine retention.) The best fluid is water, although some suggest it may be helpful to include at least one glass of cranberry juice per day. Fluids containing caffeine, carbonation, alcohol, or artificial sweetener should be avoided because they irritate the bladder wall, thus resulting in urinary urgency. Some patients who have heart failure or end-stage kidney disease need to discuss their daily fluid limit with their primary provider.

Standardized Voiding Frequency

After establishing a patient's natural voiding and urinary incontinence tendencies, voiding on a schedule can be very effective in those with and without cognitive impairment, although patients with cognitive impairment may require assistance with this technique from nursing personnel or family members. The object is to purposely empty the bladder before the bladder reaches the critical volume that would cause an urge or stress incontinence episode. This approach involves the following:

- **Timed voiding** involves establishing a set voiding frequency (such as every 2 hours if incontinent episodes tend to occur 2 or more hours after voiding). The individual chooses to "void by the clock" at the given interval while awake rather than wait until a voiding urge occurs.
- **Prompted voiding** is timed voiding that is carried out by staff or family members when the individual has cognitive difficulties that make it difficult to remember to void at set intervals. The caregiver checks the patient to assess if they have remained dry and, if so, assists the patient to use the bathroom while providing positive reinforcement for remaining dry.
- **Habit retraining** is timed voiding at an interval that is more frequent than the individual would usually choose. This technique helps to restore the sensation of the need to void in individuals who are experiencing diminished sensation of bladder filling due to various medical conditions such as a stroke.
- **Bladder retraining**, also known as "bladder drill," incorporates a timed voiding schedule and urinary urge inhibition exercises to inhibit

voiding, or leaking urine, in an attempt to remain dry for a set time. When the first timing interval is easily reached on a consistent basis without urinary urgency or incontinence, a new voiding interval, usually 10 to 15 minutes beyond the last, is established. Again, the individual practices urge inhibition exercises to delay voiding or avoid incontinence until the next preset interval arrives. When an acceptable voiding interval is reached, the patient continues that timed voiding sequence throughout the day.

Pelvic Muscle Exercise

Also known as Kegel exercises, pelvic muscle exercise (PME) aims to strengthen the voluntary muscles that assist in bladder and bowel continence in both men and women. Written or verbal instruction alone is usually inadequate to educate an individual about how to identify and strengthen the pelvic floor for sufficient bladder and bowel control. Biofeedback-assisted PME uses either electromyography or manometry to help the individual identify the pelvic muscles as they attempt to learn which muscle group is involved when performing PME. The biofeedback method also allows assessment of the strength of this muscle area.

PME involves gently tightening the same muscles used to stop flatus or the stream of urine for 5- to 10-second increments, followed by 10-second resting phases. To be effective, these exercises need to be performed two or three times a day for at least 6 weeks. Depending on the strength of the pelvic musculature when initially evaluated, anywhere from 10 to 30 repetitions of PME are prescribed at each session. Older patients may need to exercise for an even longer time to strengthen the pelvic floor muscles. Pelvic muscle exercises are helpful for women with stress, urge, or mixed incontinence and for men who have undergone prostate surgery.

Vaginal Cone Retention Exercises

Vaginal cone retention exercises are an adjunct to the Kegel exercises. Vaginal cones of varying weight are inserted intravaginally twice a day. The patient tries to retain the cone for 15 minutes by contracting the pelvic muscles.

Transvaginal or Transrectal Electrical Stimulation

Commonly used to treat urinary incontinence, electrical stimulation is known to elicit a passive contraction of the pelvic floor musculature, thus re-educating these muscles to provide enhanced levels of continence. This modality is often used with biofeedback-assisted pelvic muscle exercise training and voiding schedules. At high frequencies, it is effective for stress incontinence. At low frequencies, electrical stimulation can also relieve symptoms of urinary urgency, frequency, and urge incontinence. Intermediate ranges are used for mixed incontinence.

Neuromodulation

Neuromodulation via transvaginal or transrectal nerve stimulation of the pelvic floor inhibits detrusor overactivity and hypersensory bladder signals and strengthens weak sphincter muscles.

Adapted from Hickey, J. V., & Strayer, A. L. (2020). *The clinical practice of neurological and neurosurgical nursing* (8th ed.). Philadelphia, PA: Wolters Kluwer.

An artificial urinary sphincter can be used to close the urethra and promote continence. Two types of artificial sphincters are a periurethral cuff and a cuff inflation pump.

Men with overflow and stress incontinence may undergo a transurethral resection to relieve symptoms of prostatic enlargement. An artificial sphincter can be used after prostatic surgery for sphincter incompetence (see Fig. 49-2). After surgery, periurethral bulking agents can be injected into the periurethral area to increase compression of the urethra.

Nursing Management

The nurse may encounter the patient with incontinence either in the hospital or as an outpatient. Nursing management of the patient with urinary incontinence in any setting is based on the premise that incontinence is not inevitable with illness or aging and that it is often reversible and treatable. Patients who are incontinent and hospitalized need routine skin assessment to distinguish between incontinence-associated dermatitis (IAD) and pressure injury (Francis, 2019; Qiang, Xian, Bin, et al., 2020). When either IAD or pressure injury are identified, appropriate management techniques must be implemented to avoid complications (Francis, 2019; Qiang et al., 2020). See the Nursing Research Profile in Chart 49-7.

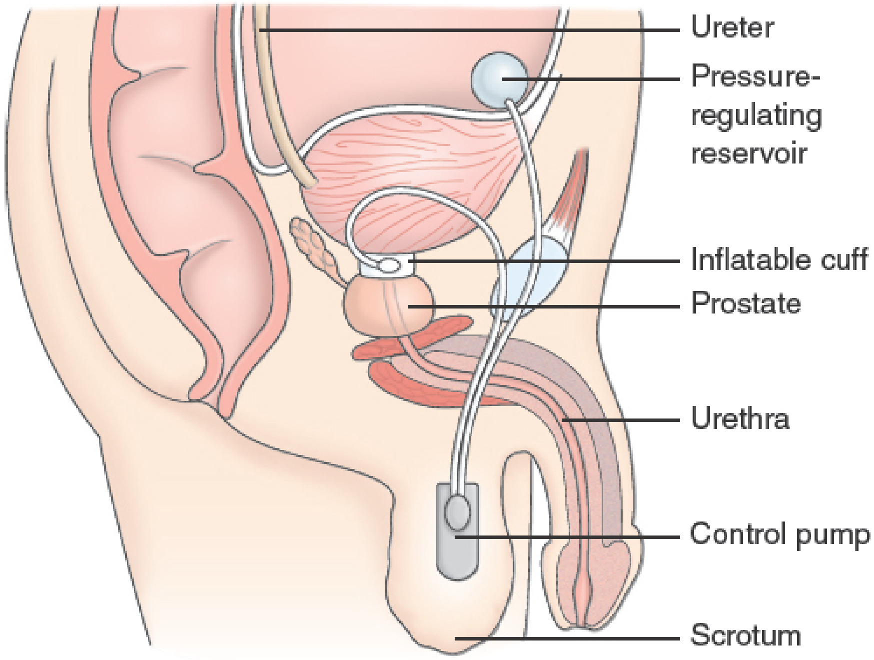


Figure 49-2 • Male artificial urinary sphincter. An inflatable cuff is inserted surgically around the urethra or neck of the bladder. To empty the bladder, the cuff is deflated by squeezing the control pump located in the scrotum.

The nursing interventions in the outpatient setting are determined in part by the type of treatment that is undertaken. For behavioral therapy to be effective, the nurse must provide support and encouragement, because it is easy for the patient to become discouraged if therapy does not quickly improve the level of continence. Patient education is important and should be provided verbally and in writing (see Chart 49-8). The patient should be educated to develop and use a log or diary to record timing of pelvic floor muscle exercises, frequency of voiding, any changes in bladder function, and any episodes of incontinence (Miller, 2019).

Chart 49-7 NURSING RESEARCH PROFILE

Understanding Incontinence-Associated Dermatitis

Qiang, L., Xian, L. W., Bin, P. Y., et al. (2020). Investigating ICU nurses' understanding of incontinence-associated dermatitis: An analysis of influencing factors. *World Council of Enterostomal Therapists Journal*, *40*(1), 32–38.

Purpose

Patients with urinary and bowel incontinence are at high risk for incontinence-associated dermatitis (IAD) in the hospital setting. The purpose of this study was to investigate the knowledge, attitude, and preventive behavior of ICU nurses related to IAD.

Design

This was a prospective study that used a questionnaire designed by the researchers. A convenience sample of 508 nurses who had been working in an ICU in China with at least 1 year of experience were asked to fill out an online version of the questionnaire which resulted in 500 useable surveys.

Findings

The mean score on the knowledge of IAD was 7 out of a possible 11, indicating the need to educate nurses on their knowledge of IAD. The mean score on the attitude toward prevention of IAD was 23 out of a possible 28. The lowest scores on this portion of the questionnaire were in the section about conducting quality control and monitoring of IAD that indicated the need to have a quality improvement program that recorded and followed rates of IAD. The mean score on prevention behaviors was 43 out of a possible 59, indicating the need for more education about daily behaviors such as assessment. Experience was the main influence on knowledge, attitude, and preventive behaviors, as nurses with the most years of experience scored highest.

Nursing Implications

This study provided information about the knowledge, attitude, and preventive behaviors associated with IAD. Nurses have a positive attitude but lack the knowledge and protocols needed to help prevent IAD. This study provides evidence for the need for educational programs and the implementation of standardized quality control and monitoring protocols.

Chart 49-8 PATIENT EDUCATION

Strategies for Promoting Urinary Continence

The nurse instructs the patient to:

- Avoid bladder irritants, such as caffeine, alcohol, and artificial sweeteners such as aspartame (NutraSweet).
- Avoid taking diuretic agents after 4 PM.
- Increase awareness of the amount and timing of all fluid intake.
- Perform all pelvic floor muscle exercises as prescribed, every day.
- Stop smoking (smokers usually cough frequently, which increases incontinence).
- Take steps to avoid constipation: Drink adequate fluids, eat a well-balanced diet high in fiber, exercise regularly, and take stool softeners if recommended.
- Void regularly, five to eight times a day (about every 2 to 3 hours):
    - First thing in the morning
    - Before each meal
    - Before retiring to bed
    - Once during the night if necessary

If pharmacologic treatment is used, the patient and family are educated about its purpose. Patients with mixed incontinence must be informed that anticholinergic and antispasmodic agents can help decrease urinary urgency and frequency and urge incontinence but do not decrease the urinary incontinence related to stress incontinence. If surgical correction is undertaken, the procedure and its desired outcomes are described to the patient and family. Follow-up contact with the patient enables the nurse to answer the patient's questions and to provide reinforcement and encouragement.

Urinary Retention

Urinary retention is the inability to empty the bladder completely during attempts to void. Chronic urine retention often leads to overflow incontinence (described previously). In a healthy adult younger than 60 years, complete bladder emptying should occur with each voiding, with no residual. In adults older than 60 years, 50 to 100 mL of residual urine may remain after each voiding because of the decreased contractility of the detrusor muscle.

Urinary retention can occur postoperatively in any patient, particularly if the surgery affected the perineal or anal regions and resulted in reflex spasm of the sphincters. General anesthesia reduces bladder muscle innervation and suppresses the urge to void, impeding bladder emptying.

Pathophysiology

Urinary retention may result from diabetes, prostatic enlargement, urethral pathology (infection, tumor, calculus), trauma (pelvic injuries), pregnancy, or neurologic disorders (e.g., stroke, spinal cord injury, multiple sclerosis, Parkinson's disease). Some medications cause urinary retention either by inhibiting bladder contractility or by increasing bladder outlet resistance (AUA, 2019b; Wooldridge, 2017).

Assessment and Diagnostic Findings

The assessment of a patient for urinary retention is multifaceted because the signs and symptoms are challenging to detect. The following questions serve as a guide in assessment:

- What was the time of the last voiding, and how much urine was voided?
- Is the patient voiding small amounts of urine frequently?
- Is the patient dribbling urine?
- Does the patient complain of pain or discomfort in the lower abdomen? (Discomfort may be relatively mild if the bladder distends slowly.)
- Is the pelvic area rounded and swollen (could indicate urine retention and a distended bladder)?
- Does percussion of the suprapubic region elicit dullness (possibly indicating urine retention and a distended bladder)?
- Are other indicators of urinary retention present, such as restlessness and agitation?
- Does a postvoid bladder ultrasound test reveal residual urine?

The patient may verbalize an awareness of bladder fullness and a sensation of incomplete bladder emptying. Signs and symptoms of UTI (hematuria, urgency, frequency, and nocturia) may be present. A series of urodynamic studies (described in Chapter 47) may be performed to identify the type of bladder dysfunction and to aid in determining appropriate treatment. A voiding diary can be used to provide a written record of the amount of urine voided and the frequency of voiding. Postvoid residual urine may be assessed by using either straight catheterization or an ultrasound bladder scanner (see Chapter 47, Fig. 47-8) and is considered diagnostic of urinary retention. Normally, residual urine amounts to no more than 50 mL in the middle-aged adult and less than 50 to 100 mL in the older adult (Weber & Kelley, 2018).

Complications

The retention of urine can lead to chronic infections that, if unresolved, predispose the patient to renal calculi (urolithiasis or nephrolithiasis), pyelonephritis, sepsis, or hydronephrosis. In addition, urine leakage can lead to perineal skin breakdown, especially if regular hygiene measures are neglected.

Nursing Management

Strategies are instituted to prevent overdistention of the bladder and to treat infection or correct obstruction. However, many complications can be prevented with careful assessment and appropriate nursing interventions. The nurse explains to the patient why normal voiding is not occurring and monitors urine output closely. The nurse also provides reassurance about the temporary nature of retention and successful management strategies.

Promoting Urinary Elimination

Nursing measures to encourage normal voiding patterns include providing privacy, ensuring an environment and body position conducive to voiding, and assisting the patient with the use of the bathroom or bedside commode, rather than a bedpan, to provide a more natural setting for voiding. If his condition allows, the male patient may stand beside the bed to use the urinal; most men find this position more comfortable and natural.

Additional measures include applying warmth to relax the sphincters (e.g., sitz baths, warm compresses to the perineum, showers), giving the patient hot caffeine-free beverage and offering encouragement and reassurance. Simple trigger techniques, such as turning on the water faucet while the patient is trying to void, may also be used. Other examples of trigger techniques are stroking the abdomen or inner thighs, tapping above the pubic area, and dipping the patient's hands in warm water. After surgery or childbirth, prescribed analgesic agents should be given because pain in the perineal area can make voiding difficult. A combination of techniques may be necessary to initiate voiding.

When the patient cannot void, bladder scanning is used to assess for distention, then straight catheterization (as prescribed) is used to prevent overdistention of the bladder (see later discussion of neurogenic bladder and catheterization). In the case of prostatic obstruction, attempts at catheterization (by the urologist) may not be successful, requiring insertion of a **suprapubic catheter** (catheter inserted through a small abdominal incision into the bladder) (see Fig. 49-4, below). After urinary drainage is restored, bladder retraining is initiated for the patient who cannot void spontaneously.

Promoting Home, Community-Based, and Transitional Care

In addition to the strategies listed for promoting urinary continence found in Chart 49-8, modifications to the home environment can provide simple and effective ways to assist in treating urinary incontinence and retention. For example, the patient may need to remove obstacles, such as throw rugs or other objects, to provide easy, safe access to the bathroom. Other modifications that the nurse may recommend include installing support bars in the bathroom; placing a bedside commode, bedpan, or urinal within easy reach; leaving lights on in the bedroom and bathroom; and wearing clothing that is easy to remove quickly.

Neurogenic Bladder

Neurogenic bladder is a dysfunction that results from a disorder or dysfunction of the nervous system and leads to urinary incontinence. It may be caused by spinal cord injury, spinal tumor, herniated vertebral disc, multiple sclerosis, congenital disorders (spina bifida or myelomeningocele), infection, or complications of diabetes (Alley, 2017) (see Chapters 63 and 64).

Pathophysiology

The two types of neurogenic bladder are spastic (or reflex) bladder and flaccid bladder. Spastic bladder is the more common type and is caused by any spinal cord lesion above the voiding reflex arc (upper motor neuron lesion) (Hickey & Strayer, 2020). The result is a loss of conscious sensation and cerebral motor control. A spastic bladder empties on reflex, with minimal or no controlling influence to regulate its activity.

Flaccid bladder is caused by a lower motor neuron lesion, commonly resulting from trauma. This form of neurogenic bladder is also increasingly being recognized in patients with diabetes. The bladder continues to fill and becomes greatly distended, and overflow incontinence occurs. The bladder muscle does not contract forcefully at any time. Because sensory loss may accompany a flaccid bladder, the patient feels no discomfort.

Assessment and Diagnostic Findings

Evaluation for neurogenic bladder involves measurement of fluid intake, urine output, and residual urine volume; urinalysis; and assessment of sensory awareness of bladder fullness and degree of motor control. Comprehensive urodynamic studies are also performed.

Complications

The most common complication of neurogenic bladder is infection resulting from urinary stasis and catheterization. Other complications include renal calculi, impaired skin integrity, and urinary incontinence or retention.

Medical Management

The problems resulting from neurogenic bladder disorders vary considerably from patient to patient and are a major challenge to the health care team. Several long-term objectives appropriate for all types of neurogenic bladders include preventing overdistention of the bladder, emptying the bladder regularly and completely, maintaining urine sterility with no stone formation, and maintaining adequate bladder capacity with no reflux.

Specific interventions include continuous, intermittent, or self-catheterization (discussed later in this chapter); the use of an external condom-type catheter; a diet low in calcium (to prevent calculi); and encouragement of mobility and ambulation. A liberal fluid intake is encouraged to reduce the urinary bacterial count, reduce stasis, decrease the concentration of calcium in the urine, and minimize the precipitation of urinary crystals and subsequent stone formation.

A bladder retraining program may be effective in treating a spastic bladder or urine retention. The use of a timed, or habit, voiding schedule may be established. To further enhance emptying of a flaccid bladder, the patient may be taught to “double void.” After each voiding, the patient is instructed to remain on the toilet, relax for 1 to 2 minutes, and then attempt to void again in an effort to further empty the bladder.

Pharmacologic Therapy

Parasympathomimetic medications, such as bethanechol, may help to increase the contraction of the detrusor muscle.

Surgical Management

Surgery may be carried out to correct bladder neck contractures or vesicoureteral reflux, or to perform a urinary diversion procedure.

Urinary Catheters

In patients with a urologic disorder or with marginal kidney function, care must be taken to ensure that urinary drainage is adequate and that kidney function is preserved. When urine cannot be eliminated naturally and must be drained artificially, catheters may be inserted directly into the bladder, the ureter, or the renal pelvis.

Catheterization is performed to achieve the following (Gould et al., 2019; Taylor, 2018):

- Assist with postoperative drainage in urologic and other surgeries
- Provide a means to monitor accurate urine output in patients who are critically ill
- Promote urinary drainage in patients with neurogenic bladder dysfunction, urine retention, or at end-of-life care
- Prevent urinary leakage in patients with stage III to IV pressure injuries (see Chapter 56)
- Relieve urinary tract obstruction

An indwelling urinary catheter should be placed only if necessary because catheterization commonly leads to CAUTI. Figure 49-3 summarizes the pathophysiology of CAUTI.

Indwelling Catheters

If an indwelling catheter is necessary, the following specific nursing interventions are initiated to prevent CAUTI (McCoy et al., 2017; Taylor, 2018):

- Use strict aseptic technique during insertion of the smallest catheter possible
- Secure the catheter to prevent movement
- Frequently inspect urine color, odor, and consistency
- Perform daily perineal care with soap and water
- Maintain a closed system
- Follow the manufacturer's instructions when using the catheter port to obtain urine specimens
- Discontinue use as soon as feasible

Physiology/Pathophysiology

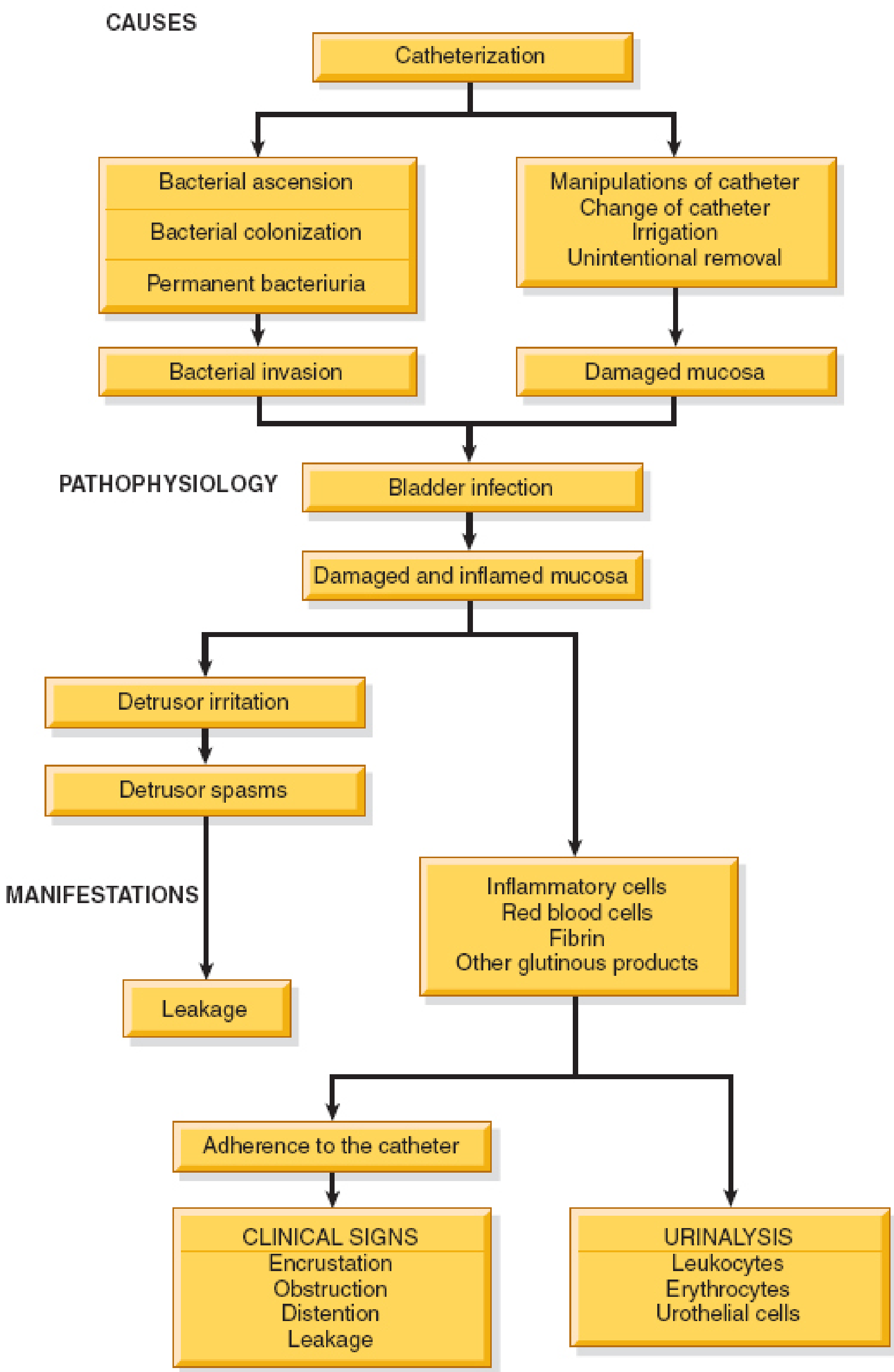


Figure 49-3 • Pathophysiology of CAUTI.

Suprapubic Catheters

Suprapubic catheterization allows bladder drainage by inserting a catheter or tube into the bladder through a suprapubic (above the pubis) incision or puncture (see Fig. 49-4). The catheter or suprapubic drainage tube is then threaded into the bladder and secured with sutures or tape, and the area around the catheter is covered with a sterile dressing. The catheter is connected to a sterile closed drainage system, and the tubing is secured to prevent tension on the catheter. This may be a temporary measure to divert the flow of urine from the urethra when the urethral route is impassable (because of injuries, strictures, prostatic obstruction), after gynecologic or other abdominal surgery when bladder dysfunction is likely to occur, and occasionally after pelvic fractures. A permanent indwelling suprapubic catheter may be needed in the patient who is incontinent following a spinal cord injury (Hickey & Strayer, 2020).

Suprapubic bladder drainage may be maintained continuously for several weeks. When the patient's ability to void is to be tested, the catheter is clamped for 4 hours, during which time the patient attempts to void. After the patient voids, the catheter is unclamped, and the residual urine is measured. If the amount of residual urine is less than 100 mL on two separate occasions (morning and evening), the catheter is usually removed. However, if the patient complains of pain or discomfort, the suprapubic catheter is usually left in place until the patient can void successfully.

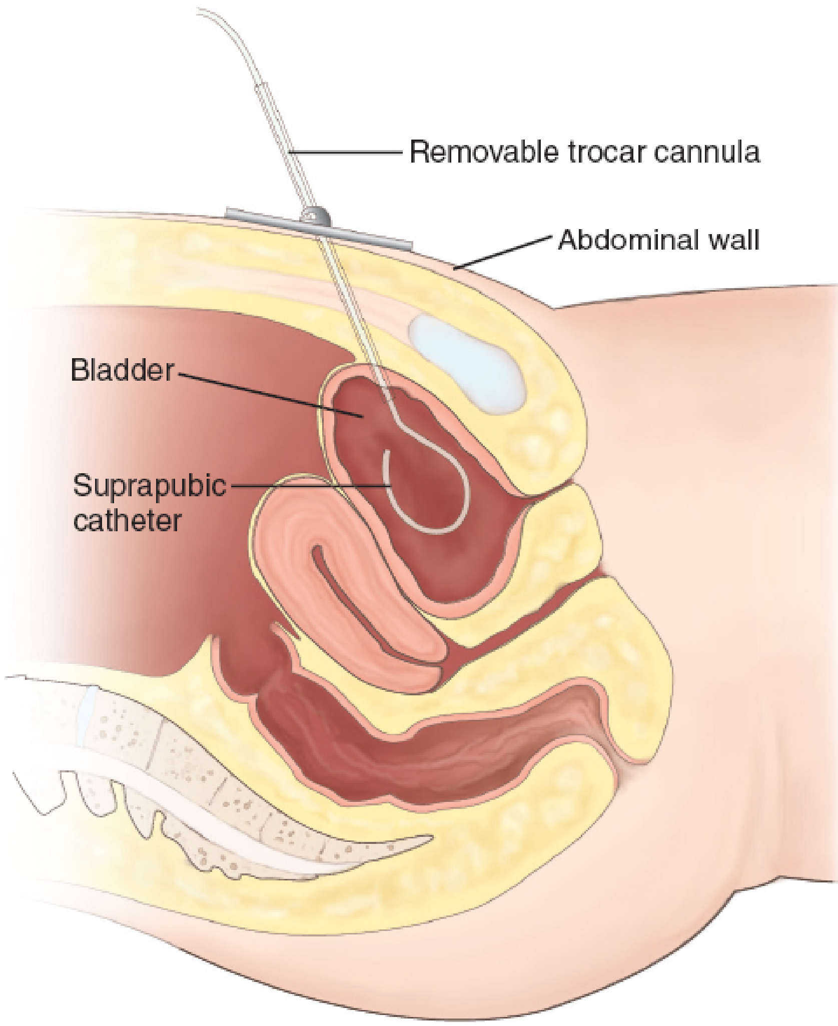


Figure 49-4 • Suprapubic bladder drainage. A trocar cannula is used to puncture the abdominal and bladder walls. The catheter is threaded through the trocar cannula, which is then removed, leaving the catheter in place. The catheter is secured by tape or sutures to prevent unintentional removal.

Suprapubic drainage offers certain advantages. Patients can usually void sooner after surgery than those with urethral catheters, and they may be more comfortable. The catheter allows greater mobility, permits measurement of residual urine without urethral instrumentation, and presents less risk of bladder infection. The suprapubic catheter is removed when it is no longer required, and a sterile dressing is placed over the site.

The patient requires liberal amounts of fluid to prevent encrustation around the catheter. Other potential problems include the formation of bladder stones, acute and chronic infections, and problems collecting urine. A wound-ostomy-continence (WOC) nurse may be consulted to assist the patient and family in selecting the most suitable urine collection system and to educate them about its use and care.

Nursing Management

Assessing the Patient and the System

Patients at high risk for CAUTI need to be identified and monitored carefully. These include women; older adults; and patients who are debilitated, malnourished, chronically ill, immunosuppressed, or have diabetes (Newman, 2017). They are observed for signs and symptoms of CAUTI: cloudy malodorous urine, hematuria, fever, chills, anorexia, and malaise. Any drainage and excoriation in the area around the urethral orifice is noted. Urine cultures provide the most accurate means of assessing a patient for infection.

Preventing Infection

Certain principles of care are essential to prevent infection in patients with a closed urinary drainage system (see Chart 49-9). The catheter is an object foreign to the body and produces a reaction in the urethral mucosa with some urethral discharge. Cleansing should be done on a daily basis and after bowel movements/contamination. A clean washcloth or wipe is used, cleansing from the catheter along its length from the meatus away from the patient. Disinfectants or antibacterial lubricants have not been found to decrease infections. Water in the wash basin used for daily cleansing is avoided as it may harbor microbes. Using disposable wipes that contain purified water, aloe, and vitamin E has been shown to decrease the incidence of CAUTIs (Newman, 2017). Vigorous cleansing of the meatus while the catheter is in place is discouraged because the cleansing action can move the catheter back and forth, increasing the risk of infection. The catheter is anchored as securely as possible to prevent it from moving in the urethra (Gould et al., 2019). Special care should be taken to ensure that any patient who is confused does not remove the catheter with the retention balloon still inflated, because this could cause bleeding and considerable injury to the urethra.

Chart 49-9

Preventing Infection in the Patient with an Indwelling Urinary Catheter

- Avoid contamination of the drainage spout. A receptacle in which to empty the bag is provided for each patient.
- Avoid routine catheter changes. The catheter is changed only to correct problems such as leakage, blockage, or encrustations.
- Avoid unnecessary handling or manipulation of the catheter by the patient or staff.
- Carry out hand hygiene before and after handling the catheter, tubing, or drainage bag.
- Ensure a free flow of urine to prevent infection. Improper drainage occurs when the tubing is kinked or twisted, allowing pools of urine to collect in the tubing loops.
- Evaluate the benefit of placing an indwelling urinary catheter versus the risk of the patient developing a catheter-associated urinary tract infection (CAUTI).
- If the collection bag *must* be raised above the level of the patient's bladder, clamp the drainage tube. This prevents backflow of contaminated urine into the patient's bladder from the bag.
- Monitor the patient's voiding when the catheter is removed. The patient must void within 8 hours; if unable to void, the patient may require catheterization with a straight catheter.
- Never disconnect the tubing to obtain urine samples, to irrigate the catheter, or to ambulate or transport the patient.
- Never irrigate the catheter routinely. If the patient is prone to obstruction from clots or large amounts of sediment, use a three-way system with continuous irrigation.
- Never leave the catheter in place longer than is necessary to decrease the risk of CAUTI.
- Obtain a urine specimen for culture at the first sign of infection.
- To prevent contamination of the closed system, *never* disconnect the tubing. The drainage bag must *never* touch the floor. The bag and collecting tubing are changed if contamination occurs, if urine flow becomes obstructed, or if tubing junctions start to leak at the connections.
- To reduce the risk of bacterial proliferation, empty the collection bag at least every 8 hours through the drainage spout—more frequently if there is a large volume of urine.
- Use scrupulous aseptic technique during insertion of the catheter. Use a preassembled, sterile, closed urinary drainage system of the smallest catheter size possible to minimize trauma.
- Wash the perineal area with soap and water at least twice a day; avoid a to-and-fro motion of the catheter. Dry the area well, but avoid applying powder because it may irritate the perineum.

Adapted from McCoy, C., Paredes, M., Allen, S., et al. (2017). Catheter-associated urinary tract infections. *Clinical Journal of Oncology Nursing*, *21*(4), 460–465; Gould, C. V., Umscheid, C. A., Agarwal, R. K., et al. (2019). Guideline for prevention of catheter-associated urinary tract infections 2009. Retrieved on 5/13/2020 at: www.cdc.gov/infectioncontrol/guidelines/cauti/

A liberal fluid intake, within the limits of the patient's cardiac and renal reserve, and an increased urine output must be ensured to flush the catheter and to dilute urinary substances that might form encrustations (Newman, 2017).

Urine cultures are obtained as prescribed or indicated when monitoring the patient for infection; many catheters have an aspiration (puncture) port from which a specimen can be obtained.

Bacteriuria is considered inevitable in patients with indwelling catheters; therefore, controversy remains about the usefulness of taking cultures and treating asymptomatic bacteriuria, because overtreatment may lead to resistant strains of bacteria. Continual observation for fever, chills, and other signs and symptoms of systemic infection is necessary. Infections are treated aggressively.

Retraining the Bladder

When an indwelling urinary catheter is in place, the detrusor muscle does not actively contract the bladder wall to stimulate emptying because urine is continuously draining from the bladder. As a result, the detrusor may not immediately respond to bladder filling when the catheter is removed, resulting in either urine retention or urinary incontinence. This condition, known as postcatheterization detrusor instability, can be managed with bladder retraining (see Chart 49-10).

Immediately after the indwelling catheter is removed, the patient is placed on a timed voiding schedule, usually every 2 to 3 hours. At the given time interval, the patient is instructed to void. The bladder is then scanned using a portable ultrasonic bladder scanner, and if the bladder has not emptied completely, straight catheterization may be performed (Newman, 2017). After a few days, as the nerve endings in the bladder wall become resensitized to the bladder filling and emptying, bladder function usually returns to normal. If the patient has had an indwelling catheter in place for an extended period (e.g., greater than 1 month), bladder retraining will take longer; in some cases, function may never return to normal, and long-term intermittent catheterization may become necessary.

Assisting with Intermittent Self-Catheterization

Intermittent self-catheterization provides periodic drainage of urine from the bladder. By promoting drainage and eliminating excessive residual urine, intermittent catheterization protects the kidneys, reduces the incidence of UTIs, and improves continence. It is the treatment of choice in some patients with spinal cord injury and other neurologic disorders, such as multiple sclerosis, when the ability to empty the bladder is impaired. Self-catheterization promotes independence, results in few complications, and enhances self-esteem and quality of life.

Chart 49-10

Bladder Retraining After Indwelling Catheterization

- Instruct the patient to drink a measured amount of fluid from 8 AM to 10 PM to avoid bladder overdistention. Offer no fluids (except sips) after 10 PM.
- At specific times, ask the patient to void by applying pressure over the bladder, tapping the abdomen, or running water to trigger the bladder.
- Immediately after the voiding attempt, perform a bladder scan to determine the amount of residual urine (see Chapter 47, Fig. 47-8).
- Measure the volumes of urine voided.
- Palpate the bladder at repeated intervals to assess for distention.
- Instruct the patient who has no voiding sensation to be alert to any signs that indicate a full bladder, such as perspiration, cold hands or feet, or feelings of anxiety.
- Perform straight catheterization, as prescribed, usually for residual urine of >300 mL.
- Lengthen the intervals between catheterizations as the volume of residual urine decreases. Catheterization is usually discontinued when the volume of residual urine is <100 mL.

Adapted from Newman, D. (2017). Catheters, devices, products, and catheter-associated urinary tract infections. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

When educating the patient about how to perform self-catheterization, the nurse often teaches the patient to use a “clean technique” (nonsterile) at home (Hickey & Strayer, 2020). Antibacterial liquid soap is recommended for cleaning urinary catheters at home. The catheter is thoroughly rinsed with warm tap water and must be dried before reuse. It should be kept in its own container, such as a plastic food storage bag.

In educating the patient, the nurse emphasizes the importance of frequent catheterization and emptying the bladder at the prescribed time. The average daytime clean intermittent catheterization schedule is every 4 to 6 hours and just before bedtime. If the patient is awakened at night with an urge to void, catheterization may be performed after an attempt is made to void normally.

The female patient assumes a Fowler position and uses a mirror to help locate the urinary meatus. She lubricates the catheter and inserts it 7.5 cm (3 inches) into the urethra, in a downward and backward direction. The male patient assumes a Fowler or sitting position, lubricates the catheter, and retracts the foreskin of the penis with one hand while grasping the penis and holding it at a right angle to the body. (This maneuver straightens the urethra and makes it easier to insert the catheter.) He inserts the catheter 15 to 25 cm (6 to 10 inches) until urine begins to flow. After removal, the catheter is cleaned, rinsed, dried, and placed in a plastic bag or case. Patients who follow an intermittent catheterization routine should consult a primary provider at regular intervals to assess urinary function and to detect complications. If the patient cannot perform intermittent self-catheterization, a family member or caregiver may be taught to carry out the procedure at regular intervals during the day.

An alternative to self-catheterization is creation of the Mitrofanoff umbilical appendicovesicostomy, which provides easy access to the bladder but requires an extensive surgical procedure (King, 2017). In this procedure, the bladder neck is closed and the appendix is used to create access to the bladder from the skin surface through a submucosal tunnel created with the appendix. One end of the appendix is brought to the skin surface and used as a stoma, and the other end is tunneled into the bladder. The appendix serves as an artificial urinary sphincter when an alternative is necessary to empty the bladder. A surgically prepared continent urine reservoir with a sphincter mechanism is required in cases of bladder cancer and severe interstitial cystitis. Various types of urinary diversions may be used when a radical **cystectomy** (surgical removal of the bladder) is necessary (see discussion later in chapter).

UROLITHIASIS AND NEPHROLITHIASIS

Urolithiasis and nephrolithiasis refer to stones (calculi) in the urinary tract and kidney, respectively. Urinary stones predominantly occur in the third to fifth decades of life and affect men twice as often as women (Norris, 2019). The prevalence of renal calculi is 10.6% for males and 7.1% for females; however, recent studies show that rates are increasing among women with estimates that the ratio of affected males-to-females is 1.3 to 1 (Flagg & Joiner, 2017). Stones may develop in one or both kidneys (Norris, 2019).

Pathophysiology

Stones are formed in the urinary tract when urinary concentrations of substances such as calcium oxalate, calcium phosphate, and uric acid increase. Referred to as supersaturation, this depends on the amount of the substance, ionic strength, and pH of the urine. Stones may be found anywhere from the kidney to the bladder and may vary in size from minute granular deposits, called *sand* or *gravel,* to bladder stones as large as an orange. The different sites of calculi formation in the urinary tract are shown in Figure 49-5.

Certain factors favor the formation of stones, including infection, urinary stasis, and periods of immobility, all of which slow kidney drainage and alter calcium metabolism (Norris, 2019). In addition, increased calcium concentrations in the blood and urine promote precipitation of calcium and formation of stones (the most common are calcium based) (Norris, 2019). Causes of hypercalcemia (high serum calcium) and hypercalciuria (high urine calcium) may include the following (Norris, 2019):

- Hyperparathyroidism
- Renal tubular acidosis
- Cancers (e.g., leukemia, multiple myeloma)
- Dehydration
- Granulomatous diseases (e.g., sarcoidosis, tuberculosis), which may cause increased vitamin D production by the granulomatous tissue
- Excessive intake of vitamin D
- Excessive intake of milk and alkali
- Myeloproliferative diseases such as polycythemia vera, which produce an unusual proliferation of blood cells from the bone marrow
- Intestinal bypass surgery

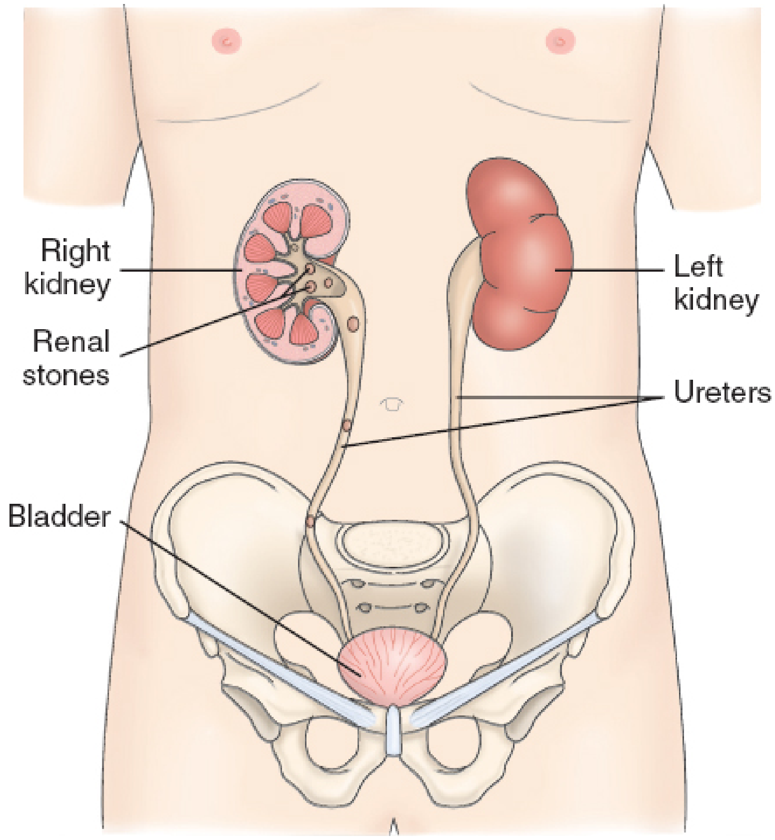


Figure 49-5 • Examples of potential sites of calculi formation in the urinary tract (urolithiasis) and kidney (nephrolithiasis).

For patients with stones containing uric acid, struvite, or cystine, a thorough physical examination and metabolic workup are indicated because of associated disturbances contributing to the stone formation. Uric acid stones account for 72% of stones in men (Flagg & Joiner, 2017). These may be seen in patients with gout or myeloproliferative disorders. Seventy-two percent of stones diagnosed in women are struvite stones (Flagg & Joiner, 2017) which form in persistently alkaline, ammonia-rich urine caused by the presence of bacteria such as *Proteus, Pseudomonas, Klebsiella, Staphylococcus,* or *Mycoplasma*. Predisposing factors for struvite stones include neurogenic bladder, foreign bodies, and recurrent UTIs (Norris, 2019).

Several conditions, as well as certain metabolic risk factors, predispose patients to stone formation. These include anatomic derangements such as polycystic kidney disease, horseshoe kidneys, chronic strictures, and medullary sponge disease. Urinary stone formation can occur in patients with inflammatory bowel disease and in those with an ileostomy or bowel resection because these patients absorb more oxalate. Medications known to cause stones in some patients include antacids, acetazolamide, vitamin D, laxatives, and high doses of aspirin (Comerford & Durkin, 2020). However, in many patients, no cause may be found.

Clinical Manifestations

Signs and symptoms of stones in the urinary system depend on the presence of obstruction, infection, and edema. When stones block the flow of urine, obstruction develops, producing an increase in hydrostatic pressure and distending the renal pelvis and proximal ureter (Norris, 2019). Infection (pyelonephritis and UTI with chills, fever, and frequency) can be a contributing factor with struvite stones. Some stones cause few, if any, symptoms while slowly destroying the functional units (nephrons) of the kidney; others cause excruciating pain and discomfort (Flagg & Joiner, 2017). Stones in the renal pelvis may be associated with an intense, deep ache in the costovertebral region. Hematuria is often present; pyuria may also be noted. Pain originating in the renal area radiates anteriorly and downward toward the bladder in the female and toward the testes in the male. If the pain suddenly becomes acute, with tenderness over the costovertebral area, and nausea and vomiting occur, the patient is having an episode of renal colic. Diarrhea and abdominal discomfort are due to renointestinal reflexes and the anatomic proximity of the kidneys to the stomach, pancreas, and large intestine.

Stones lodged in the ureter (ureteral obstruction) cause acute, excruciating, colicky, wavelike pain that radiates down the thigh and to the genitalia. Often, the patient has a desire to void, but little urine is passed, and it usually contains blood because of the abrasive action of the stone. This group of symptoms is called *ureteral colic.* Colic is mediated by prostaglandin E, a substance that increases ureteral contractility and renal blood flow and that leads to increased intraureteral pressure and pain. In general, the patient is able to pass stones 0.5 cm in diameter (Norris, 2019). Stones larger than 1 cm in diameter usually must be removed or fragmented (broken up by lithotripsy) so that they can be removed or passed spontaneously.

Stones lodged in the bladder usually produce symptoms of irritation and may be associated with UTI and hematuria. If the stone obstructs the bladder neck, urinary retention occurs. If infection is associated with a stone, the condition is far more serious, with the potential for urosepsis developing.

Assessment and Diagnostic Findings

The diagnosis is confirmed by a noncontrast CT scan (Flagg & Joiner, 2017). Blood chemistries and a 24-hour urine test for measurement of calcium, uric acid, creatinine, sodium, pH, and total volume may be part of the diagnostic workup. Dietary and medication histories and family history of renal calculi are obtained to identify factors predisposing the patient to the formation of stones.

When stones are recovered (whether freely passed by the patient or removed through special procedures), chemical analysis is carried out to determine their composition. Stone analysis can provide a clear indication of the underlying disorder. For example, calcium oxalate or calcium phosphate stones usually indicate disorders of oxalate or calcium metabolism, whereas urate stones suggest a disturbance in uric acid metabolism (Flagg & Joiner, 2017).

Medical Management

The goals of management are to eradicate the stone, determine the stone type, prevent nephron destruction, control infection, and relieve any obstruction that may be present. The immediate objective of treatment of renal or ureteral colic is to relieve the pain until its cause can be eliminated. Opioid analgesic agents are given to prevent shock and syncope that may result from the excruciating pain. Nonsteroidal anti-inflammatory drugs (NSAIDs) are effective in treating renal calculus pain because they provide specific pain relief. They also inhibit the synthesis of prostaglandin E, reducing swelling and facilitating passage of the stone. Generally, once the stone has passed, the pain is relieved. Unless the patient is vomiting or has heart failure or any other condition requiring fluid restriction, fluids are encouraged. This increases the hydrostatic pressure behind the stone, assisting it in its downward passage. A high, around-the-clock fluid intake reduces the concentration of urinary crystalloids, dilutes the urine, and ensures a high urine output.

Chart 49-11 PATIENT EDUCATION

Preventing Renal Calculi

The nurse instructs the patient to:

- Avoid protein intake to decrease urinary excretion of calcium and uric acid.
- Limit sodium intake to 3 to 4 g/day. Table salt and high-sodium foods should be reduced, because sodium competes with calcium for reabsorption in the kidneys.
- Be aware that low-calcium diets are not generally recommended, except for true absorptive hypercalciuria. Evidence shows that limiting calcium, especially in women, can lead to osteoporosis and does not prevent calculi.
- Avoid intake of oxalate-containing foods (e.g., spinach, Swiss chard, chocolate, peanuts, pecans).
- Drink fluids (ideally water) every 1 to 2 hours during the day and one glass of cranberry juice per day.
- Drink two glasses of water at bedtime and an additional glass at each nighttime awakening to prevent urine from becoming too concentrated during the night.
- Avoid activities leading to sudden increases in environmental temperatures that may cause excessive sweating and dehydration.
- Contact the primary provider at the first sign of a urinary tract infection.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Nutritional Therapy

Nutritional therapy plays an important role in preventing renal calculi (Flagg & Joiner, 2017) (see Chart 49-11). Fluid intake is the mainstay of most medical therapy for renal calculi. Unless fluids are contraindicated, patients with renal calculi should drink eight to ten 8-oz glasses of water daily or have IV fluids prescribed to keep the urine dilute. A urine output exceeding 2 L/day is advisable.

Calcium Stones

Historically, patients with calcium-based renal calculi were advised to restrict calcium in their diet. However, evidence has questioned this practice, except for patients with type 2 absorptive hypercalciuria (half of all patients with calcium stones), as stones in these patients are clearly the result of excess dietary calcium. Liberal fluid intake is encouraged. Medications such as ammonium chloride may be used, and if increased parathormone production (resulting in increased serum calcium levels in blood and urine) is a factor in the formation of stones, therapy with thiazide diuretics may be beneficial in reducing the calcium loss in the urine and lowering the elevated parathormone levels (Cahill & Haras, 2017).

Uric Acid Stones

For uric acid stones, the patient is placed on a low-purine diet to reduce the excretion of uric acid in the urine. Foods high in purine (shellfish, anchovies, asparagus, mushrooms, and organ meats) are avoided, and other proteins may be limited. Allopurinol may be prescribed to reduce serum uric acid levels and urinary uric acid excretion, and to dissolve or reduce the size of existing stones (Cahill & Haras, 2017).

Cystine Stones

A low-protein diet may be prescribed, the urine is alkalinized with potassium alkali salts, and fluid intake is increased (Norris, 2019).

Oxalate Stones

A dilute urine is maintained through increasing fluid intake, and the intake of oxalate is limited. Many foods contain oxalate including spinach, Swiss chard, chocolate, peanuts, and pecans (Norris, 2019).

Interventional Procedures

If the stone does not pass spontaneously or if complications occur, common interventions include endoscopic or other procedures. For example, ureteroscopy, extracorporeal shock wave lithotripsy (ESWL), or endourologic (percutaneous) stone removal may be necessary (Norris, 2019).

Ureteroscopy (see Fig. 49-6A) involves first visualizing the stone and then destroying it. Access to the stone is accomplished by inserting a ureteroscope into the ureter and then inserting a laser, electrohydraulic lithotripter, or ultrasound device through the ureteroscope to fragment and remove the stones. A stent may be inserted and left in place for 48 hours or more after the procedure to keep the ureter patent. Length of hospital stay is generally brief, and some patients can be treated as outpatients.

ESWL, commonly referred to as lithotripsy, is a noninvasive procedure used to break up stones in the calyx of the kidney (see Fig. 49-6B). After the stones are fragmented to the size of grains of sand, the remnants of the stones are spontaneously voided. In ESWL, a high-energy amplitude of pressure, or shock wave, is generated by the abrupt release of energy and transmitted through water and soft tissues. When the shock wave encounters a substance of different intensity (a renal calculus), a compression wave causes the surface of the stone to fragment. Repeated shock waves focused on the stone eventually reduce it to many small pieces that are excreted in the urine.

Discomfort from the multiple shocks may occur, although the shock waves usually do not cause damage to other tissue. The patient is observed for obstruction and infection resulting from blockage of the urinary tract by stone fragments. All urine is strained after the procedure; voided gravel or sand is sent to the laboratory for chemical analysis. Several treatments may be necessary to ensure disintegration of stones.

Endourologic methods of stone removal (see Fig. 49-6C) may be used to extract kidney calculi that cannot be removed by other procedures. A percutaneous nephrostomy or a percutaneous nephrolithotomy (which are similar procedures) may be performed. A nephroscope is introduced through a percutaneous route into the renal parenchyma. Depending on its size, the stone may be extracted with forceps or by a stone retrieval basket. If the stone is too large to initially be removed, an ultrasound probe inserted through a nephrostomy tube is used to pulverize the stone. Small stone fragments and stone dust are then removed.

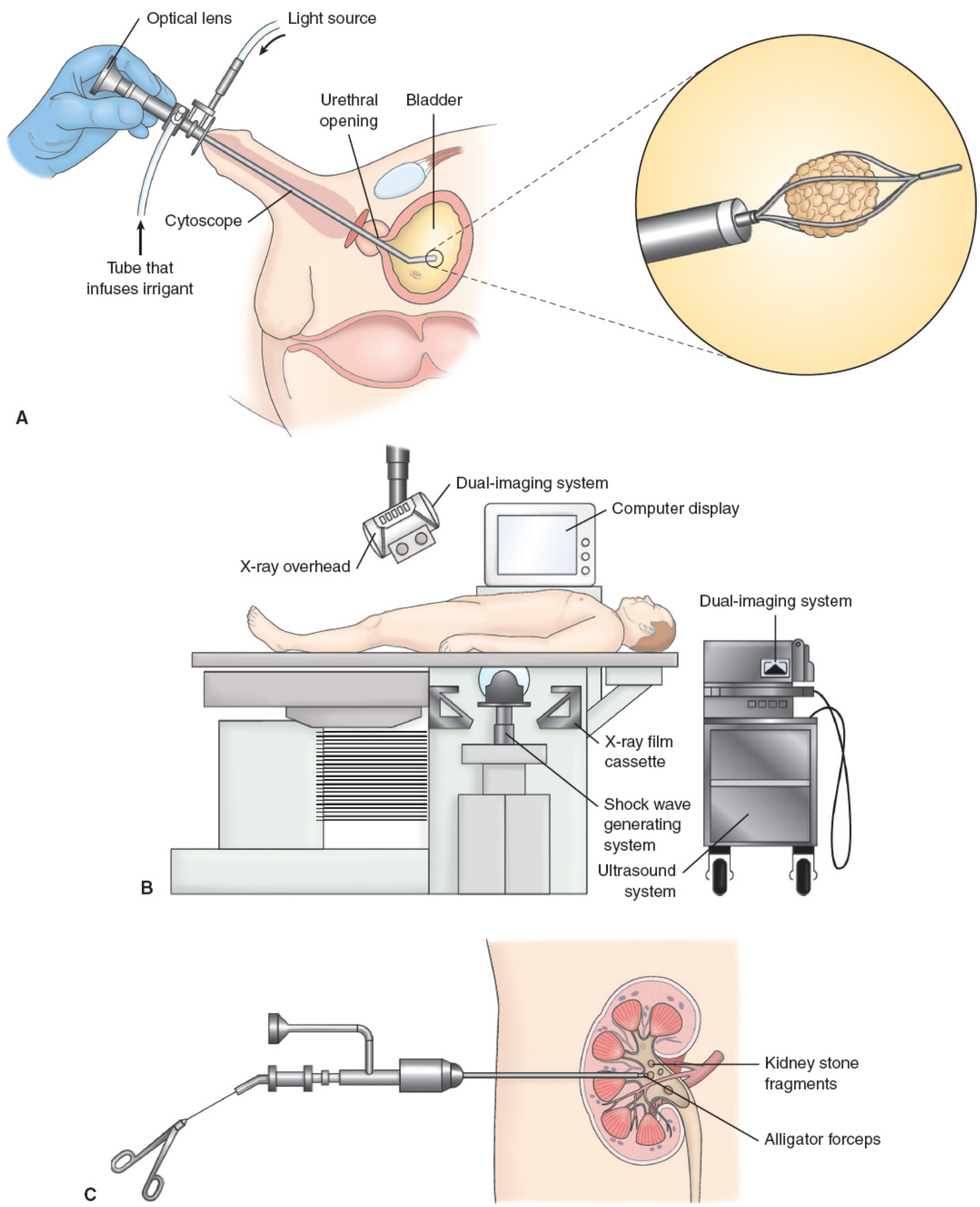


Figure 49-6 • Methods of treating renal calculi. **A.** During ureteroscopy, which is used for removing small stones located in the ureter close to the bladder, a ureteroscope is inserted into the ureter to visualize the stone. The stone is then fragmented or captured and removed. **B.** Extracorporeal shock water lithotripsy is used for most symptomatic, nonpassable upper urinary stones. Electromagnetically generated shock waves are focused over the area of the renal calculus. The high-energy dry shock waves pass through the skin and fragment the stone. **C.** Percutaneous nephrolithotomy is used to treat larger stones. A percutaneous tract is formed, and a nephroscope is inserted through it. Then, the stone is extracted or pulverized.

Electrohydraulic lithotripsy is a similar method in which an electrical discharge is used to create a hydraulic shock wave to break up the stone. A probe is passed through the cystoscope, and the tip of the lithotripter is placed near the stone. The strength of the discharge and pulse frequency can be varied. This procedure is performed under topical anesthesia. After the stone is extracted, the percutaneous nephrostomy tube may be left in place for a time to ensure that the ureter is not obstructed by edema, blood clots, or fragmented calculi (Norris, 2019). The most common complications are hemorrhage, infection, and urinary extravasation. After the tube is removed, the nephrostomy tract usually closes spontaneously.

Chemolysis, stone dissolution using infusions of chemical solutions (e.g., alkylating agents, acidifying agents) for the purpose of dissolving the stone, is an alternative treatment sometimes used in patients who are at risk for complications with other types of therapy, who refuse to undergo other methods, or who have stones (struvite) that dissolve easily. A percutaneous nephrostomy is performed, and the warm chemical solution is allowed to flow continuously onto the stone. The solution exits the renal collecting system by means of the ureter or the nephrostomy tube. The pressure inside the renal pelvis is monitored during the procedure.

Several of these treatment modalities may be used in combination to ensure removal of the stones.

Surgical Management

Surgical intervention may be indicated if the stone does not respond to other forms of treatment. It may also be performed to correct anatomic abnormalities within the kidney to improve urinary drainage. If the stone is in the kidney, the surgery performed may be a nephrolithotomy (incision into the kidney with removal of the stone) or a nephrectomy, if the kidney is nonfunctional secondary to infection or hydronephrosis. Stones in the kidney pelvis are removed by a pyelolithotomy, those in the ureter by ureterolithotomy, and those in the bladder by cystotomy. If the stone is in the bladder, an instrument may be inserted through the urethra into the bladder, and the stone crushed. Such a procedure is called a cystolitholapaxy. Nursing management following kidney surgery is discussed in Chapter 48.

NURSING PROCESS

The Patient with Renal Calculi

Assessment

The patient with suspected renal calculi is assessed for pain and discomfort as well as associated symptoms, such as nausea, vomiting, diarrhea, and abdominal distention. The severity and location of pain are determined, along with any radiation of the pain. Nursing assessment also includes observing for signs and symptoms of UTI (chills, fever, frequency, and hesitancy) and obstruction (frequent urination of small amounts, oliguria, or anuria). The urine is inspected for blood and is strained for stones or gravel.

The history focuses on factors that predispose the patient to urinary tract stones or that may have precipitated the current episode of renal or ureteral colic. The patient's knowledge about renal calculi and measures to prevent their occurrence or recurrence is also assessed.

Diagnosis

Nursing Diagnoses

Based on the assessment data, nursing diagnoses may include the following:

- Acute pain associated with inflammation, obstruction, and abrasion of the urinary tract
- Lack of knowledge regarding prevention of recurrence of renal calculi

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Infection and urosepsis (from UTI and pyelonephritis)
- Obstruction of the urinary tract by a stone or edema with subsequent acute kidney injury

Planning and Goals

The major goals for the patient may include relief of pain and discomfort, prevention of recurrence of renal calculi, and absence of complications.

Nursing Interventions

Relieving Pain

Severe acute pain is often the presenting symptom of a patient with kidney and urinary calculi and requires immediate attention. Opioid analgesic agents may be prescribed and given to provide rapid relief along with an IV NSAID. The patient is encouraged and assisted to assume a position of comfort. If activity brings pain relief, the patient is assisted to ambulate. The pain level is monitored closely, and an increase in severity is reported promptly to the primary provider so that relief can be provided and additional treatment initiated.

Monitoring and Managing Potential Complications

Increased fluid intake is encouraged to prevent dehydration and increase hydrostatic pressure within the urinary tract to promote passage of the stone. If the patient cannot take adequate fluids orally, IV fluids are prescribed. The total urine output and patterns of voiding are monitored. Ambulation is encouraged as a means of moving the stone through the urinary tract.

All urine is strained as it be necessary to determine the type of calculi the patient has formed (Flagg & Joiner, 2017). Any blood clots passed in the urine should be crushed and the sides of the urinal and bedpan inspected for clinging calculi. Renal calculi increase the risk of infection, sepsis, and obstruction of the urinary tract. Therefore, the patient is instructed to report decreased urine volume, bloody or cloudy urine, fever, and pain to the primary provider.

Patients with calculi require frequent nursing observation to detect the spontaneous passage. The patient is instructed to immediately report any sudden increases in pain intensity because of the possibility of a stone fragment obstructing a ureter. Vital signs, including temperature, are monitored closely to detect early signs of infection. UTIs may be associated with renal calculi due to an obstruction from the stone or from the stone itself. All infections should be treated with the appropriate antibiotic agent before efforts are made to dissolve the stone.

Promoting Home, Community-based, and Transitional Care

Educating Patients About Self-Care. Because the risk of recurring renal calculi is high, the nurse provides education about the causes of renal calculi and recommendations to prevent their recurrence (see Chart 49-11).

The patient is encouraged to follow a regimen to avoid further stone formation, including maintaining a high fluid intake because stones form more readily in concentrated urine. A patient who has shown a tendency to form stones should drink enough fluid to excrete greater than 2000 mL (preferably 3000 to 4000 mL) of urine every 24 hours (Flagg & Joiner, 2017).

Urine cultures may be performed every 1 to 2 months in the first year and periodically thereafter. Recurrent UTI is treated promptly. Because prolonged immobilization slows renal drainage and alters calcium metabolism, increased mobility is encouraged whenever possible. In addition, excessive ingestion of vitamins (especially vitamin D) and minerals is discouraged.

If lithotripsy, percutaneous stone removal, ureteroscopy, or other surgical procedures for stone removal have been performed, the nurse educates the patient about the signs and symptoms of complications (e.g., urinary retention, infection) that need to be reported to the primary provider. The importance of follow-up is to assess kidney function and to ensure the eradication or removal of all renal calculi is emphasized to the patient and family.

If ESWL has been performed, the nurse must provide instructions for home care and necessary follow-up. The patient is encouraged to increase fluid intake to assist in the passage of stone fragments, which may occur for 6 weeks to several months after the procedure. The patient and family are educated about signs and symptoms of complications. It is also important to inform the patient to expect hematuria (it is anticipated in all patients), but it should disappear within 4 to 5 days. If the patient has a stent in the ureter, hematuria may be expected until the stent is removed. The patient is instructed to check their temperature daily and notify the primary provider if the temperature is greater than 38°C (about 101°F) or the pain is unrelieved by the prescribed medication. The patient is also informed that a bruise may be observed on the treated side of the back.

Continuing and Transitional Care. Close monitoring of the patient in follow-up care is essential to ensure that treatment has been effective and that no complications develop. The nurse has the opportunity to assess the patient's understanding of ESWL and possible complications. In addition, the nurse has the opportunity to assess the patient's understanding of factors that increase the risk of recurrence of renal calculi and strategies to reduce those risks.

The nurse must assess the patient's ability to monitor urinary pH and interpret the results during follow-up visits. Because of the high risk of recurrence, the patient with renal calculi needs to understand the signs and symptoms of stone formation, obstruction, and infection and the importance of reporting these signs promptly. If medications are prescribed for the prevention of stone formation, the nurse explains their actions, importance, and side effects to the patient.

Evaluation

Expected patient outcomes may include:

1. Reports relief of pain
2. States increased knowledge of health-seeking behaviors to prevent recurrence
    a. Consumes increased fluid intake (at least eight 8-oz glasses of fluid per day)
    b. Participates in appropriate activity

c. Consumes diet prescribed to reduce dietary factors predisposing to stone formation
d. Recognizes symptoms (fever, chills, flank pain, hematuria) to be reported to primary provider
e. Monitors urinary pH as directed
f. Takes prescribed medication as directed to reduce stone formation

3. Experiences no complications
   a. Reports no signs or symptoms of infection or urosepsis
   b. Voids 200 to 400 mL per voiding of clear urine without evidence of bleeding
   c. Experiences absence of urgency, frequency, and hesitancy
   d. Maintains normal body temperature

GENITOURINARY TRAUMA

Various types of injuries to the flank, back, or upper abdomen may result in trauma to the ureters, bladder, or urethra. Blunt trauma is responsible for approximately 85% of all genitourinary trauma and another 15% is from penetrating trauma (Blair, 2017). Kidney trauma is discussed in Chapter 48.

Specific Injuries

Ureteral Trauma

The main causes of ureteral trauma are motor vehicle crashes, sports injuries, falls, and assaults. Penetrating trauma, such as gunshot wounds, is the most frequent etiology, accounting for 90% of ureteral injuries (Blair, 2017). Injuries range from contusions to complete transection. Unintentional injury to the ureter may occur during gynecologic or urologic surgery. There are no specific signs or symptoms of ureteral injury; many traumatic injuries are discovered during exploratory surgery. Surgical repair with placement of stents (to divert urine away from an anastomosis) is usually necessary. If the ureteral trauma is not detected and urine leakage continues, fistulas can develop (Norris, 2019).

Bladder Trauma

Injury to the bladder may occur with pelvic fractures, multiple trauma, or from a blow to the lower abdomen when the bladder is full. Blunt trauma may result in contusion evident as an ecchymosis—a large bruise resulting from escape of blood into the tissues and involving a segment of the bladder wall—or in rupture of the bladder extraperitoneally, intraperitoneally, or both. Because of the bladder's protected location within the bony pelvis, bladder trauma is relatively uncommon (Blair, 2017). Complications from these injuries include hemorrhage, shock, sepsis, and extravasation of blood into the tissues, which must be treated promptly.

Urethral Trauma

Urethral injuries usually occur with blunt trauma to the lower abdomen or pelvic region. Many patients with urethral injuries also have associated pelvic fractures. The classic triad of symptoms include blood at the urinary meatus, inability to void, and a distended bladder. Complete rupture is seen more often in children because their urethras are less elastic and tear more easily than the adult urethra. Men have five times the risk of urethral injury than women because of the exposed nature of the male urethra (Blair, 2017).

Medical Management

The goals of management in patients with genitourinary trauma are to control hemorrhage, pain, and infection and to maintain urinary drainage. Genitourinary trauma is frequently associated with kidney trauma (see Chapter 48). Hematocrit and hemoglobin levels are monitored closely; decreasing values can indicate hemorrhage within the genitourinary system. The patient is also monitored for oliguria, signs of hemorrhagic shock, and signs and symptoms of acute peritonitis.

Surgical Management

In urethral trauma, a patient whose condition is unstable and who needs monitoring of urine output may need a suprapubic catheter inserted. The patient is catheterized after urethrography has been performed to minimize the risk of urethral disruption and extensive, long-term complications, such as stricture, incontinence, and impotence. Surgical repair may be performed using either open or laparoscopic approaches (Blair, 2017). After surgery, an indwelling urinary catheter may remain in place for 1 to 2 months to allow the system to heal.

Nursing Management

The patient with genitourinary trauma should be assessed frequently during the first few days after injury to detect flank and abdominal pain, muscle spasm, and swelling over the flank.

During this time, patients are educated about care of the incision and the importance of adequate fluid intake. In addition, instructions about changes that should be reported to the primary provider, such as fever, hematuria, flank pain, or any signs and symptoms of decreasing kidney function, are provided (Blair, 2017). The patient with a ruptured bladder may have gross bleeding for several days after repair. Guidelines for increasing activity gradually, lifting, and driving are also provided.

Follow-up nursing care includes monitoring the blood pressure to detect hypertension and advising the patient to restrict activities for about 1 month after trauma to minimize the incidence of delayed or secondary bleeding.

URINARY TRACT CANCERS

Urinary tract cancers include those of the urinary bladder; kidney and renal pelvis; ureters; and other urinary structures, such as the prostate. Kidney cancer is discussed in Chapter 48, and prostate cancer is discussed in Chapter 53.

Cancer of the Bladder

Twenty-five percent of cancers of the urinary bladder occur in adults older than 65 years (Caruso, Tyler, & Wolkowicz, 2017). It is the sixth most common cancer with a much higher incidence in men than women for reasons that are still not well understood (National Cancer Institute [NCI], 2020). Bladder cancer is a leading cause of death, accounting for more than 15,000 deaths in the United States annually (NCI, 2020). Cancers arising from the prostate, colon, and rectum in males and from the lower gynecologic tract in females may metastasize to the bladder.

Tobacco use, especially cigarettes, continues to be a leading risk factor for all urinary tract cancers (NCI, 2020) (see Chart 49-12).

Clinical Manifestations

Bladder tumors usually arise at the base of the bladder and involve the ureteral orifices and bladder neck. Visible, painless hematuria is the most common symptom of bladder cancer. Infection of the urinary tract is a common complication, producing frequency and urgency. However, any alteration in voiding or change in the urine may indicate cancer of the bladder. Pelvic or back pain may occur with metastasis.

Assessment and Diagnostic Findings

The diagnostic evaluation includes cystography, excretory urography, CT and MRI scans, ultrasonography, and bimanual examination with the patient anesthetized. Noninvasive detection using molecular markers is currently under investigation (Caruso et al., 2017). Biopsies of the tumor and adjacent mucosa are the definitive diagnostic procedures (NCI, 2020; Norris, 2019). Transitional cell carcinomas and carcinomas in situ shed recognizable cancer cells. Cytologic examination of fresh urine and saline bladder washings provides information about the prognosis and staging, especially for patients at high risk for recurrence of primary bladder tumors. See Chapter 12 for more information on cancer grading and staging.

Chart 49-12 RISK FACTORS

Bladder Cancer

- Certain genetic mutations including:
  - *HRAS* mutation (Costello syndrome, Facio-cutaneous-skeletal syndrome).
  - *Rb1* mutation.
  - *PTEN/MMAC1* mutation (Cowden syndrome).
  - *NAT2* slow acetylator phenotype.
  - *GSTM1* null phenotype.
- Exposure to arsenic
- Occupational exposure to chemicals in processed paint, dye, metal, and petroleum products
- Positive family history of bladder cancer
- Pelvic radiation therapy or treatment for other cancers
- Tobacco use, cigarette smoking in particular

Adapted from National Cancer Institute (NCI). (2020). Bladder cancer treatment (PDQ®)—Health professional version. Retrieved on 01/11/2020 at: www.cancer.gov/types/bladder/hp/bladder-treatment-pdq#section/all

Medical Management

Treatment of bladder cancer depends on the grade of the tumor (the degree of cellular differentiation) and the stage of tumor growth (the degree of local invasion and the presence or absence of metastasis) (NCI, 2020). The patient's age and physical, mental, and emotional status are considered when determining treatment modalities.

Surgical Management

Transurethral resection or fulguration (cauterization) may be performed for simple papillomas (benign epithelial tumors) (Caruso et al., 2017). These procedures eradicate the tumors through surgical incision or electrical current with the use of instruments inserted through the urethra. After this bladder-sparing surgery, intravesical administration of bacille Calmette–Guérin (BCG) is the treatment of choice. BCG Live is an attenuated live strain of *Mycobacterium bovis,* the causative agent in tuberculosis; treatment is recommended for a minimum of 1 year (NCI, 2020). The exact action of BCG is unknown, but it is thought to produce a local inflammatory and a systemic immunologic response.

Management of superficial bladder cancers presents a challenge because there are usually widespread abnormalities in the bladder mucosa. The entire lining of the urinary tract, or urothelium, is at risk because carcinomatous changes can occur in the mucosa of the bladder, kidney pelvis, ureter, and urethra.

A simple cystectomy or a radical cystectomy is performed for invasive or multifocal bladder cancer. Radical cystectomy in men involves removal of the bladder, prostate, and seminal vesicles and immediate adjacent perivesical tissues. In women, radical cystectomy involves removal of the bladder, lower ureter, uterus, fallopian tubes, ovaries, anterior vagina, and urethra. It may include removal of pelvic lymph nodes. Removal of the bladder requires a urinary diversion procedure, which is described later in this chapter.

Although radical cystectomy remains the standard of care for invasive bladder cancer in the United States, clinical trials continue to explore other options in an effort to spare patients the need for radical cystectomy (NCI, 2020). Other options for managing transitional cell bladder cancer mandate lifelong surveillance with periodic cystoscopy. Although most patients respond completely and their bladders remain free from invasive relapse, one fourth develop a relapse of noninvasive disease. This may be managed with transurethral resection of the bladder tumor and intravesical therapies but carries an additional risk that a late cystectomy may be required.

Pharmacologic Therapy

Chemotherapy with a combination of methotrexate, 5-fluorouracil, vinblastine, doxorubicin, and cisplatin has been effective in producing partial remission of transitional cell carcinoma of the bladder in some patients. IV chemotherapy may be accompanied by radiation therapy (NCI, 2020). Topical chemotherapy (intravesical chemotherapy or instillation of antineoplastic agents into the bladder, resulting in contact of the agent with the bladder wall) is considered when there is a high risk of recurrence, when cancer in situ is present, or when tumor resection has been incomplete. Topical chemotherapy delivers a high concentration of medication (thiotepa, doxorubicin, mitomycin, and BCG Live) to the tumor to promote tumor destruction. Bladder cancer may also be treated by direct infusion of the cytotoxic agent through the bladder's arterial blood supply to achieve a higher concentration of the chemotherapeutic agent with fewer systemic toxic effects (Blair, 2017; NCI, 2020).

BCG Live is now considered the most predominant and conservative intravesical agent for recurrent bladder cancer, especially superficial transitional cell carcinoma, because it is an immunotherapeutic agent that enhances the body's immune response to cancer. BCG Live has a 43% advantage in preventing tumor recurrence, a significantly better rate than the 16% to 21% advantage of intravesical chemotherapy. In addition, BCG Live is particularly effective in the treatment of carcinoma in situ, eradicating it in more than 80% of cases. In contrast to intravesical chemotherapy, BCG Live has also been shown to decrease the risk of tumor progression. Although BCG Live treatment is the current standard of care, this treatment is most effective when some form of maintenance therapy is utilized (Caruso, et al., 2017; NCI, 2020).

The optimal course of BCG Live appears to be a 6-week course of weekly instillations, followed by a 3-week course at 3 months for tumors that do not respond. In high-risk cancers, maintenance BCG Live given in a 3-week course at 6, 12, 18, and 24 months may limit recurrence and prevent progression. However, the adverse effects associated with this prolonged therapy may limit its widespread applicability.

The patient is allowed to eat and drink before the instillation procedure. Once the bladder is full, the patient must retain the intravesical solution for 2 hours before voiding. At the end of the procedure, the patient is encouraged to void and to drink liberal amounts of fluid to flush the medication from the bladder.

Radiation Therapy

Radiation of the tumor may be performed preoperatively to reduce microextension of the neoplasm and viability of tumor cells, thus decreasing the chances that the cancer may recur in the immediate area or spread through the circulatory or lymphatic systems. Radiation therapy is also used in combination with surgery or to control the disease in patients with inoperable tumors.

For more advanced bladder cancer or for patients with intractable hematuria (especially after radiation therapy), a large, water-filled balloon placed in the bladder produces tumor necrosis by reducing the blood supply of the bladder wall (hydrostatic therapy). The instillation of formalin, phenol, or silver nitrate relieves hematuria and strangury (slow and painful discharge of urine) in some patients.

URINARY DIVERSIONS

Urinary diversion procedures are performed to divert urine from the bladder to a new exit site, usually through a surgically created opening (stoma) in the skin. These procedures are primarily performed when a bladder tumor necessitates cystectomy (NCI, 2020) and are most commonly associated with a high-grade or muscle-invasive bladder cancer (Caruso et al., 2017). Urinary diversion has also been used in managing pelvic malignancy, birth defects, strictures, trauma to the ureters and urethra, neurogenic bladder, chronic infection causing severe ureteral and kidney damage, and intractable interstitial cystitis. It may also be used as a last resort in managing incontinence.

Controversy exists about the best method of establishing permanent diversion of the urinary tract. New techniques are frequently introduced in an effort to improve patient outcomes and quality of life (Shi, Yu, Bellmont, et al., 2018). The age of the patient, condition of the bladder, body build, presence of obesity, degree of ureteral dilation, status of kidney function, and the patient's learning ability, and willingness to participate in postoperative care are all taken into consideration when determining the appropriate surgical procedure.

The types of urinary diversions are an ileal conduit, an orthotopic neobladder reconstruction, or various other continent urinary diversions (Chang & Lawrentschuk, 2015; Yang, Bai, Wang, et al., 2019). The choice of a urinary diversion surgical procedure depends on the patient's and surgeon's preferences, the extent of comorbidity, and the quality of life goal in the postoperative period (Chang & Lawrentschuk, 2015). Variations in urinary diversion surgical procedures are devised frequently in an effort to identify and perfect procedures that will improve patient outcomes and reduce the incidence of postoperative problems (Yang et al., 2019).

Ileal Conduit

The **ileal conduit** (ileal loop) is the oldest and most common of the urinary diversion procedures in use because of the low number of complications and the simplicity of the procedure (Chang & Lawrentschuk, 2015; Shi et al., 2018) (Fig 49-7). Additional advantages include that it is well known to health care professionals, there is no need for bladder retraining, and no nocturnal incontinence (Chang & Lawrentschuk, 2015).

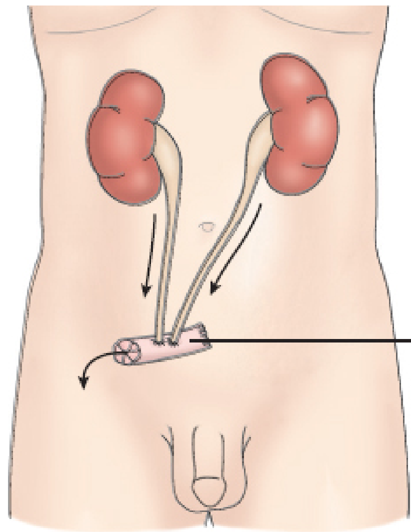


Figure 49-7 • Conventional ileal conduit. The surgeon transplants the ureters to an isolated section of the terminal ileum (ileal conduit), bringing one end to the abdominal wall. The ureter may also be transplanted into the transverse sigmoid colon (colon conduit) or proximal jejunum (jejuna conduit).

When an ileal conduit surgical procedure is performed, the urine is diverted by implanting the ureter into a 12-cm loop of ileum that is led out through the abdominal wall. This loop of ileum is a simple conduit (passageway) for urine from the ureters to the surface. A loop of the sigmoid colon may also be used. An ileostomy bag is used to collect the urine. The resected (cut) ends of the remaining intestine are anastomosed (connected) to provide an intact bowel (Wound Ostomy Continence Nurses [WOCN] Society, 2018).

Stents, usually made of thin, pliable tubing, are placed in the ureters to prevent occlusion secondary to postsurgical edema (Yang et al., 2019). The bilateral ureteral stents allow urine to drain from the kidney to the stoma and provide a method for accurate measurement of urine output. They may be left in place 10 to 21 days postoperatively. Jackson–Pratt drains or other types of drains are inserted to prevent the accumulation of fluid in the space created by removal of the bladder.

The outcome for a patient with an ileal conduit depends to a large degree on the location or position of the stoma, whether the drainage device (bag) establishes a watertight seal to the skin, and the patient’s ability to manage the appliance.

After surgery, a skin barrier and a transparent, disposable urinary drainage bag are applied around the conduit and connected to drainage. A custom-cut appliance is used until the edema subsides and the stoma shrinks to normal size. The clear bag allows the stoma to be inspected and the patency of the stent and the urine output to be monitored. The ileal bag drains urine (not feces) continuously. The appliance (bag) usually remains in place as long as it is watertight; it is changed when necessary to prevent leakage of urine.

Complications

Complications that may follow placement of an ileal conduit include wound infection or wound dehiscence, urinary leakage, ureteral obstruction, hyperchloremic acidosis, small bowel obstruction, ileus, and gangrene of the stoma. Delayed complications include ureteral obstruction, contraction or stenosis (narrowing) of the stoma, kidney deterioration due to chronic reflux, peristomal hernia, retraction, pyelonephritis, renal calculi, and cancer recurrence (WOCN Society, 2018).

Nursing Management

During the preoperative period, the nurse helps facilitate the marking of the stoma on the abdominal wall as this is associated with decreased complications postoperatively, fewer problems with the fitting of the appliance, and increased quality of life and independence postoperatively (WOCN Society, 2018). Preoperative education is initiated about basic self-care skills for managing the ileal conduit (WOCN Society, 2018). Because the patient requires specialized care, a consultation is initiated with a WOC nurse.

In the immediate postoperative period, urine volumes are monitored hourly. Throughout the patient's hospitalization, the nurse monitors closely for complications, reports signs and symptoms of them promptly, and intervenes quickly to prevent their progression.

A urine output below 0.5 mL/kg/h may indicate dehydration or an obstruction in the ileal conduit, with possible backflow or leakage from the ureteroileal anastomosis. A catheter may be inserted through the urinary conduit to monitor the patient for possible stasis or residual urine from a constricted stoma. Urine may drain through the bilateral ureteral stents as well as around the stents. If the ureteral stents are not draining, the nurse may be instructed to carefully irrigate with 5 to 10 mL sterile normal saline solution, being careful not to exert tension that could dislodge the stent. Hematuria may be noted in the first 48 hours after surgery but usually resolves spontaneously.

Providing Stoma and Skin Care

The stoma is inspected frequently for color and viability. A healthy stoma is pink or red. A change from this normal color to purple, brown, or black suggests that the vascular supply may be compromised. If cyanosis and a compromised blood supply persist, surgical intervention may be necessary. The stoma is not sensitive to touch, but the skin around the stoma becomes sensitive if urine or the appliance causes irritation. The skin is inspected for signs of irritation and bleeding of the stoma mucosa, encrustation and skin irritation around the stoma (from alkaline urine coming in contact with exposed skin), rashes, redness, pruritus, or other signs of impairment and wound infections (WOCN Society, 2018).

Caring for the Ostomy

Moisture in bed linens or clothing or the odor of urine around the patient should alert the nurse to the possibility of leakage from the appliance, potential infection, or a problem in hygienic management. A properly fitted appliance is essential to prevent exposure of the skin around the stoma to urine (WOCN Society, 2018). If the urine smells foul, the stoma is catheterized, if prescribed, to obtain a urine specimen for culture and sensitivity testing.

Encouraging Fluids and Relieving Anxiety

Because mucous membrane is used in forming the conduit, the patient may excrete a large amount of mucus mixed with urine. This causes anxiety in many patients. To help relieve this anxiety, the nurse reassures the patient that this is a normal occurrence after an ileal conduit procedure. The nurse encourages adequate fluid intake to flush the ileal conduit and decrease the accumulation of mucus.

Selecting the Ostomy Appliance

The nurse is instrumental (often with consultation with a WOC nurse) in selecting an appropriate ostomy appliance. The urinary appliance may consist of one or two pieces and may be disposable (usually used once and discarded) or reusable. The choice of appliance is determined by the location of the stoma and by the patient’s normal activity, manual dexterity, visual function, body build, economic resources, and preference.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Patient education begins in the hospital but continues in the home setting because patients are usually discharged within days of surgery. The nurse educates the patient how to assess and manage the urinary diversion as well as how to deal with changes in body image. A WOC nurse is invaluable in consulting with the nurse on various aspects of care and patient education (WOCN Society, 2018).

Changing the Appliance

The patient and family are educated about how to apply and change the appliance so that they are comfortable carrying out the procedure and can do so proficiently. Ideally, the appliance system is changed before the system leaks and at a time that is convenient for the patient. Many patients find that early morning is most convenient because the urine output is reduced. A variety of appliances are available (WOCN Society, 2018).

Regardless of the type of appliance used, a skin barrier is essential to protect the skin from irritation and excoriation (WOCN Society, 2018). To maintain skin integrity, a skin barrier or leaking pouch is never patched with tape to prevent accumulation of urine under the skin barrier or faceplate. The patient is instructed to avoid moisturizing soaps and body washes when cleaning the area because they interfere with the adhesion of the pouch. The degree to which the stoma protrudes is not the same in all patients; thus, there are various accessories and custom-made appliances to solve individual problems. Patient guidelines for applying reusable and disposable systems are presented in Chart 49-13.

Controlling Odor

The patient is instructed to avoid foods that give the urine a strong odor (e.g., asparagus, cheese, eggs). Most appliances contain odor barriers, but, if needed, a few drops of liquid deodorizer or diluted white vinegar may be introduced through the drain spout into the bottom of the pouch with a syringe or eyedropper to reduce odors. The patient is reminded that odor will develop if the pouch is worn longer than recommended and not cared for properly (WOCN Society, 2018).

Managing the Ostomy Appliance

The patient is instructed to empty the pouch by means of a drain valve when it is one third full because the weight of more urine will cause the pouch to separate from the skin. Some patients prefer wearing a leg bag attached with an adapter to the drainage apparatus. To promote uninterrupted sleep, a collecting bottle and tubing (one unit) are snapped onto an adapter that connects to the ileal appliance. A small amount of urine is left in the bag when the adapter is attached to prevent the bag from collapsing against itself. The tubing may be threaded down the pajama or pants leg to prevent kinking. The collecting bottle and tubing are rinsed daily with cool water and once a week with a 3:1 solution of water and white vinegar.

Cleaning and Deodorizing the Appliance

Usually, the reusable appliance is rinsed in warm water and soaked in a 3:1 solution of water and white vinegar or a commercial deodorizing solution for 30 minutes. It is rinsed with tepid water and air-dried away from direct sunlight as hot water and exposure to direct sunlight dry the pouch and increase the incidence of cracking. After drying, the appliance may be powdered with cornstarch and stored. Two appliances are necessary—one to be worn while the other is air-drying.

Chart 49-13 PATIENT EDUCATION

Using Urinary Diversion Collection Appliances

Applying a Reusable Pouch System

The nurse instructs the patient to:

1. **Gather** all necessary supplies. Perform hand hygiene.
2. Prepare new appliance according to the manufacturer's directions:
   - Apply double-faced adhesive disc that has been properly sized to fit the reusable pouch faceplate.
   - Remove paper backing and set pouch aside, or apply thin layer of contact cement to one side of the reusable pouch faceplate.
   - Set pouch aside.
3. Remove soiled pouch gently. Lay aside to clean later.
4. Clean peristomal skin (skin around stoma) with small amount of soap and water. Rinse thoroughly and dry. If a film of soap remains on the skin and the site does not dry, the appliance will not adhere adequately.
5. Use a wick (rolled gauze pad or tampon) over the stoma to absorb urine and keep the skin dry throughout the appliance change.
6. Inspect peristomal skin for irritation.
7. Note that a skin protector wipe or barrier ring may be applied before centering the faceplate opening directly over the stoma.
8. Position appliance over stoma, and press gently into place.
9. If desired, use a pouch cover or apply cornstarch under the pouch to prevent perspiration and skin irritation.
10. Clean soiled pouch, and prepare for reuse.

Applying a Disposable Pouch System

The nurse instructs the patient to:

1. Gather all necessary supplies. Perform hand hygiene.
2. Measure stoma, and prepare an opening in the skin barrier about 1/8-inch larger than the stoma and the same shape as the stoma.
3. Remove paper backing from skin barrier, and set aside.
4. Gently remove old appliance, and set aside.
5. Clean peristomal skin with warm water, and dry thoroughly.
6. Inspect peristomal skin (skin around stoma) for irritation.
7. Use a wick (rolled gauze pad or tampon) over the stoma to absorb urine, and keep the skin dry during the appliance change.
8. Center opening of skin barrier over stoma, and apply with firm, gentle pressure to attain a watertight seal.
9. If using a two-piece system, snap pouch onto the flanged wafer that adheres to skin.
10. Close drainage tap or spout at bottom of pouch.
11. Note that a pouch cover can be used or cornstarch applied under pouch to prevent perspiration and skin irritation.

12. Apply hypoallergenic tape around the skin barrier in a picture-frame manner.
13. Dispose of soiled appliance.

Adapted from Wound Ostomy Continence Nurses (WOCN) Society. (2018). WOCN Society Clinical Guideline: Management of the adult patient with a fecal or urinary ostomy—An executive summary. *Journal of Wound Ostomy Continence Nursing*, *45*(1), 50–58.

Continuing and Transitional Care

Follow-up care is essential to determine how the patient has adapted to the altered body image and lifestyle changes. Referral for home health is indicated to determine how well the patient and family are coping with the urinary drainage diversion. The nurse assesses the patient's physical status and emotional response. In addition, the nurse assesses the ability of the patient and family to manage the urinary diversion and appliance, reinforces previous education, and provides additional information (e.g., community resources, sources of ostomy supplies, insurance coverage for supplies).

As the postoperative edema subsides, the nurse assists in determining the appropriate changes needed in the ostomy appliance. The size of the stoma is measured every 3 to 6 weeks for the first few months postoperatively. The correct appliance size is determined by measuring the widest part of the stoma with a ruler. The permanent appliance should be no more than 1.6 mm (1/8 inch) larger than the diameter of the stoma and the same shape as the stoma to prevent contact of the skin with drainage.

The nurse educates the patient and family about resources (see the Resources section at the end of this chapter). Local chapters of the American Cancer Society (ACS) can provide medical equipment and supplies and other resources for the patient who has undergone ostomy surgery for cancer.

The home health nurse assesses the patient for potential long-term complications such as ureteral obstruction, strictures, hernias, or deterioration of kidney function (Yang et al., 2019). The nurse also reinforces previous education about potential complications and self-care management (WOCN Society, 2018).

Orthotopic Neobladder

An orthotopic neobladder reconstruction is performed in approximately 38% of patients who have undergone cystectomy for invasive bladder cancer (Shi et al., 2018). During this surgery, a new bladder is constructed from segments of the intestine (Chang & Lawrentschuk, 2015) (see Fig. 49-8). There are several advantages of this type of urinary diversion compared to the more common ileal conduit including that the newly reconstructed bladder is attached to the urethra, achieving functional and anatomical restoration (Shi et al., 2018). The new voiding system is similar to the natural preoperative state, and researchers have reported a higher quality of life in patients who undergo this procedure compared to patients with an ileal conduit (Chang & Lawrentschuk, 2015; Shi et al., 2018; Yang et al., 2019).

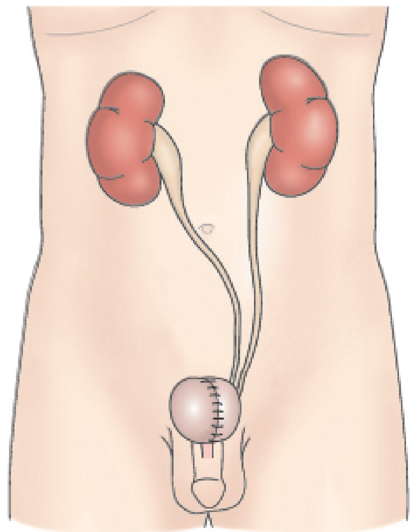


Figure 49-8 • Orthotopic neobladder. The surgeon constructs a new bladder from segments of intestine.

There are several disadvantages to orthotopic neobladder reconstruction as well. Not all patients are suitable for the surgery (see later discussion). Other disadvantages include the need for bladder retraining and the potential for incontinence postoperatively (Chang & Lawrentschuk, 2015). The intestine used to create the neobladder does not have the stimulation to contract that the natural bladder had, leading to the need for bladder retraining. Even with bladder retraining, only 80% of patients achieve full continence (Shi et al., 2018).

Surgical Management

In the preoperative period, the patient undergoes careful evaluation as not all patients are suitable for this surgery. Major contraindications include renal and liver impairment, intestinal disease, and cancer in specific parts of the bladder (Chang & Lawrentschuk, 2015). See Chart 49-14 for a list of patient characteristics that contraindicate performing an orthotopic neobladder reconstruction. However, this surgery is a viable alternative to an ileal conduit in the patient who is free of these contraindications, does not want a stoma, and is willing to adhere to the neobladder training (Chang & Lawrentschuk, 2015).

When the surgery is performed, the surgeon constructs a sphere-shaped neobladder, also referred to as a pouch, from intestinal segments to replace the bladder that has been removed. The most common intestinal segments used are the ileum, colon, and sigmoid portions of the intestine (Chang & Lawrentschuk, 2015).

Complications

This is a more complex surgery than the creation of an ileal conduit; therefore, there is a higher risk of several complications including fluid and electrolyte imbalances, postoperative ileus, and incontinence. The patient is at risk for metabolic acidosis as the wall of the neobladder is now made of intestinal mucosa that is more permeable to urinary electrolytes compared to the original bladder wall (Chang & Lawrentschuk, 2015). The shift in electrolytes also leads to the urine being more concentrated, which can lead to dehydration (Chang & Lawrentschuk, 2015). Patients are at higher risk of postoperative ileus at the fifth postoperative day and later compared to those undergoing an ileal conduit procedure (Chang & Lawrentschuk, 2015).

Chart 49-14

Contraindications to Orthotopic Neobladder Reconstruction Surgery

- Acute kidney injury with a serum creatinine of >150 umol/L
- Lack of motivation or intellectual ability to follow a strict postoperative voiding regimen
- Impaired liver function
- Inability to accept incontinence postoperatively (mainly nocturnal) in the short term and possibly long term
- Intestinal disease due to radiation or inflammatory bowel disease
- Histologically confirmed cancer at the prostatic apex (males) or bladder neck (females)
- Physical limitations preventing the performance of self-catheterization
- Presence of metastatic cancer

Adapted from Chang, D. T. S., & Lawrentschuk, N. (2015). Orthotopic neobladder reconstruction. *Urology Annals*, *7*(1), 1–7.

Nursing Management

In the preoperative period, the nurse assists in the assessment of the suitability of the patient to undergo an orthotopic neobladder reconstruction. In conjunction with the surgeon the nurse assesses for potential patient contraindications to the surgery (see Chart 49-14). It is important to begin education about what the patient can expect in the postoperative period, especially the time and effort that will be needed for bladder retraining. The patient needs to clearly understand the risk for incontinence both in the short term postoperatively and possibly on a long-term basis.

Postoperative nursing care of the patient with an orthotopic neobladder reconstruction is similar to nursing care of the patient with an ileal conduit. In addition to the usual postoperative care (see Chapter 16), the patient will have an indwelling and subrapubic catheter (Chang & Lawrentschuk, 2015). Procedures may vary between surgical centers that perform this procedure, but commonly an irrigation of 100 mL normal saline every 6 to 8 hours is prescribed to prevent catheter blockage due to an increase in the amount of mucous discharged from the intestine compared to a regular bladder wall (Chang & Lawrentschuk, 2015).

Monitoring Fluid and Electrolytes

Fluid and electrolyte balance is maintained in the immediate postoperative period by closely monitoring the serum electrolyte levels and administering appropriate IV fluids. The patient is monitored for signs and symptoms of metabolic acidosis and dehydration. Electrolyte replacement may be required to return values to within normal limits.

Encouraging Adequate Nutrition

The patient has additional carbohydrate and protein needs in order to heal from the complex surgery (Chang & Lawrentschuk, 2015). Dietary instructions include increasing the fiber content in the diet to decrease the risk of postoperative ileus, particularly on the fifth postoperative day and following discharge. Increased dietary fiber and other measures are needed to prevent constipation as the intestine is now shorter.

Promoting Home, Community-Based, and Transitional Care

Patient education begins in the hospital but continues in the home setting because patients are usually discharged within days of surgery. The neobladder needs 2 to 3 weeks to heal and therefore the patient is discharged home with an indwelling and subrapubic catheter (Chang & Lawrentschuk, 2015). The nurse instructs the patient how to assess and manage the indwelling catheters and irrigate as needed. Once it is determined that the neobladder is watertight, neobladder retraining begins.

Chart 49-15 PATIENT EDUCATION

Neobladder Training

The nurse instructs the patient to:

- Void in a sitting position using the Valsalva maneuver to empty the neobladder
- Perform all pelvic floor muscle exercises as prescribed, every day.
- Take steps to avoid constipation: Drink adequate fluids, eat a well-balanced diet high in fiber, exercise regularly, and take stool softeners if recommended.
- Void regularly, five to eight times a day (about every 2 to 3 hours):
    - First thing in the morning
    - Before each meal
    - Before retiring to bed
    - Once during the night if necessary

Adapted from Chang, D. T. S., & Lawrentschuk, N. (2015). Orthotopic neobladder reconstruction. *Urology Annals*, *7*(1), 1–7.

Educating Patients About Self-Care

Patient education is important and should be provided verbally and in writing (see Chart 49-15). The patient should be educated to develop and use a log or diary to record timing of pelvic floor muscle exercises, frequency of voiding and intermittent catheterization, any changes in bowel function, and any episodes of incontinence.

Continuing and Transitional Care

Follow-up care is essential to determine how the patient has adapted to the changes needed to manage the neobladder. Referral for home health is indicated to continue the neobladder training and determine how well the patient and family are coping with the urinary drainage diversion. The nurse assesses the patient’s physical status and emotional response. In addition, the nurse assesses the ability of the patient and family to manage the urinary diversion, reinforces previous education, and provides additional information (e.g., community resources, insurance coverage for supplies).

Other Continent Urinary Diversion Procedures

Another type of continent urinary diversion is the Indiana pouch, created for the patient whose bladder is removed (Chang & Lawrentschuk, 2015). The Indiana pouch uses a segment of the ileum and cecum to form the reservoir for urine (see Fig. 49-9). The ureters are tunneled through the muscular bands of the intestinal pouch and anastomosed. The reservoir is made continent by narrowing the efferent portion of the ileum and sewing the terminal ileum to the subcutaneous tissue, forming a continent stoma flush with the skin. The pouch is sewn to the anterior abdominal wall around a cecostomy tube. Urine collects in the pouch until a catheter is inserted and the urine is drained.

The pouch must be drained at regular intervals by a catheter to prevent absorption of metabolic waste products from the urine, reflux of urine to the ureters, and UTI. Postoperative nursing care of the patient with a continent ileal urinary pouch is similar to nursing care of the patient with an ileal conduit. However, these patients usually have additional drainage tubes (cecostomy catheter from the pouch, stoma catheter exiting from the stoma, ureteral stents, and Penrose drain, as well as a urethral catheter). All drainage tubes must be carefully monitored for patency and amount and type of drainage. In the immediate postoperative period, the cecostomy tube is irrigated two or three times daily to remove mucus and prevent blockage.

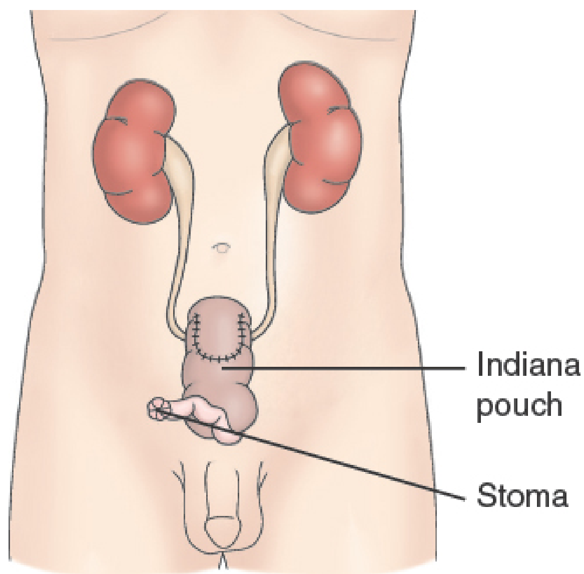


Figure 49-9 • Indiana pouch. The surgeon introduces the ureters into a segment of ileum and cecum. Urine is drained periodically by inserting a catheter into the stoma.

Other variations of continent urinary reservoirs are used occasionally (Chang & Lawrentschuk, 2015). With these methods, the pouch must be drained at regular intervals by inserting a catheter.

NURSING PROCESS

The Patient Undergoing Urinary Diversion Surgery

Preoperative Assessment

The following are key preoperative nursing assessment concerns:

- Cardiopulmonary function assessments are performed because patients undergoing cystectomy are often older adults who may be at greater risk for cardiac and respiratory complications.
- A nutritional status assessment is important because of possible poor nutritional intake related to underlying health problems.
- Learning needs are assessed in consultation with a WOC nurse to evaluate the patient's and the family's understanding of the procedure as well as the changes in physical structure and function that result from the surgery. The patient's self-concept and self-esteem are assessed in addition to methods for coping with stress and loss. The patient's mental status, manual dexterity and coordination, vision, and preferred method of learning are noted because they affect postoperative self-care.

Preoperative Diagnosis

Nursing Diagnoses

Based on the assessment data, preoperative nursing diagnoses may include the following:

- Anxiety associated with anticipated losses associated with the surgical procedure
- Impaired nutritional intake associated with inadequate nutritional ingestion
- Lack of knowledge about the surgical procedure and postoperative care

Preoperative Planning and Goals

The major goals for the patient may include relief of anxiety; improved preoperative nutritional status; and increased knowledge about the surgical procedure, expected outcomes, and postoperative care.

Preoperative Nursing Interventions

Relieving Anxiety

The threat of cancer and removal of the bladder create anxiety related to changes in body image. Patients may face problems adapting to an external appliance, a stoma, a surgical incision, and altered toileting habits. Men must also adapt to sexual impotency; a penile implant is considered if the patient is a candidate for the procedure. Women also have anxiety related to altered appearance, body image, and self-esteem. A supportive approach, both physical and psychosocial, is needed and includes assessing the patient's self-concept and manner of coping with stress and loss; helping the patient to identify ways to maintain their lifestyle and independence with as few changes as possible; and encouraging the patient to express fears and anxieties about the ramifications of the upcoming surgery. Support services are available through ostomy societies and agencies, and can provide emotional support and make adaptation easier both before and after surgery (see Resources section at the end of this chapter).

Ensuring Adequate Nutrition

A low-residue diet is prescribed to cleanse the bowel to minimize fecal stasis, decompress the bowel, and minimize postoperative ileus. In addition, antibiotic medications are given to reduce pathogenic flora in the bowel and to reduce the risk of infection. Because the patient undergoing a urinary diversion procedure for cancer may be severely malnourished due to the tumor, previous treatments, and anorexia, enteral or parenteral nutrition may be prescribed to promote healing. Adequate preoperative hydration is imperative to ensure urine flow during surgery and to prevent hypovolemia during the prolonged surgical procedure.

Explaining Surgery and Its Effects

Participation of a WOC nurse in patient education and care is invaluable for informed preoperative education and postoperative planning. Explanations of the surgical procedure, the appearance of the stoma, the rationale for preoperative bowel preparation, the reasons for wearing a collection device, and the anticipated effects of the surgery on sexual functioning are part of patient education. The placement of the stoma site is planned preoperatively with the patient standing, sitting, and lying down to locate the stoma away from bony prominences, skin creases, and folds. The stoma should also be placed away from old scars, the umbilicus, and the belt line.

For ease of self-care, the patient must be able to see and reach the site comfortably. The site is marked with indelible ink so that it can be located easily during surgery. The patient is assessed for allergies or sensitivity to tape or adhesives. Patch testing of certain appliances may be necessary before the ostomy equipment is selected. This is particularly important if the patient is or may be allergic to latex (see Chapter 14, Fig. 14-2).

Preoperative Evaluation

To measure the effectiveness of care, the nurse evaluates the patient's preoperative anxiety level and nutritional status as well as preexisting knowledge and expectations of surgery.

Expected patient outcomes may include:

1. Exhibits reduced anxiety about surgery and expected losses

   a. Verbalizes fears with health care team and family
   b. Expresses positive attitude about outcome of surgery
2. Exhibits adequate nutritional status
   a. Maintains adequate intake before surgery
   b. Maintains body weight
   c. States rationale for enteral or parenteral nutrition if needed
   d. Exhibits normal skin turgor, moist mucous membranes, adequate urine output, and absence of excessive thirst
3. Demonstrates knowledge about the surgical procedure and postoperative course
   a. Identifies limitations expected after surgery
   b. Discusses expected immediate postoperative environment (tubes, equipment, nursing surveillance)
   c. Practices deep-breathing, coughing, and foot exercises

Postoperative Assessment

The role of the nurse in the immediate postoperative period is to prevent complications and to assess the patient carefully for any signs and symptoms of complications. The catheters and any drainage devices are monitored closely. Urine volume, patency of the drainage system, and color of the drainage are assessed. A sudden decrease in urine volume or increase in drainage is reported promptly to the primary provider, because these may indicate obstruction of the urinary tract, inadequate blood volume, or bleeding. In addition, the patient's need for pain control is assessed regularly, as with all postoperative patients.

Postoperative Diagnosis

Nursing Diagnoses

Based on the assessment data, major postoperative nursing diagnoses may include the following:

- Risk for impaired skin integrity associated with problems in managing the urine collection appliance
- Acute pain associated with surgical incision
- Disturbed body image associated with urinary diversion
- Impaired sexual functioning associated with structural and physiologic alterations
- Lack of knowledge about management of urinary function

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Peritonitis due to disruption of anastomosis

- Stoma ischemia and necrosis due to compromised blood supply to stoma
- Stoma retraction and separation of mucocutaneous border due to tension or trauma

Postoperative Planning and Goals

The major goals for the patient may include maintaining skin integrity, relieving pain, increasing self-esteem, developing appropriate coping mechanisms to accept and deal with altered urinary function and sexuality, increasing knowledge about management of urinary function, and preventing potential complications.

Postoperative Nursing Interventions

Postoperative management focuses on monitoring urinary function, preventing postoperative complications (infection and sepsis, respiratory complications, fluid and electrolyte imbalances, fistula formation, and urine leakage), and promoting patient comfort. Catheters or drainage systems are monitored, and urine output is monitored carefully. A nasogastric tube is inserted during surgery to decompress the GI tract and to relieve pressure on the intestinal anastomosis. It is usually kept in place for several days after surgery. As soon as bowel function resumes—as indicated by bowel sounds, the passage of flatus, and a soft abdomen—oral fluids are permitted. Until that time, IV fluids and electrolytes are given. The patient is assisted to ambulate as soon as possible to prevent complications of immobility.

Maintaining Skin Integrity

Strategies to promote skin integrity begin with reducing and controlling those factors that increase the patient's risk of poor nutrition and poor healing. Meticulous skin care and management of the drainage system are provided by the nurse until the patient can manage them and is comfortable doing so. Care is taken to keep the system intact to protect the skin from exposure to drainage. Supplies must be readily available to manage the drainage in the immediate postoperative period. Consistency in implementing the skin care program throughout the postoperative period results in maintenance of skin integrity and patient comfort. In addition, maintenance of skin integrity around the stoma enables the patient and family to adjust more easily to the alterations in urinary function and helps them learn skin care techniques.

Relieving Pain

Analgesic medications are administered liberally postoperatively to relieve pain and promote comfort, thereby allowing the patient to turn, cough, and perform deep-breathing exercises. Patient-controlled analgesia and regular administration of analgesic agents around the clock are two options that may be used to ensure adequate pain relief. A pain intensity scale is used to evaluate the adequacy of the medication and the approach to pain management. See Chapter 9 for further discussion of pain management.

Improving Body Image

The patient's ability to cope with the changes associated with the surgery depends to some degree on their body image and self-esteem before the surgery and the support and reaction of others. Allowing the patient to express concerns and anxious feelings can help, especially in adjusting to the changes in toileting habits. The nurse can also help improve the patient's self-concept by educating about skills needed to be independent in managing the urinary drainage devices. Education about ostomy care is conducted in a private setting to encourage the patient to ask questions without fear of embarrassment. Explaining why the nurse must wear gloves when performing ostomy care can prevent the patient from misinterpreting the use of gloves as a sign of aversion to the stoma.

Exploring Sexuality Issues

Patients who experience altered sexual function as a result of the surgical procedure may mourn this loss. Encouraging the patient and partner to share their feelings about this loss with each other and acknowledging the importance of sexual function and expression may encourage the patient and partner to seek sexual counseling and to explore alternative ways of expressing sexuality. Using the support and expertise from another patient with an ostomy who is functioning fully in society and family life may also assist the patient and family in recognizing that full recovery is possible.

Monitoring and MAnaging Potential Complications

Complications are not unusual because of the complexity of the surgery, the underlying reason (cancer, trauma) for the urinary diversion procedure, and the patient's frequently less-than-optimal nutritional status. Complications may include respiratory disorders (e.g., atelectasis, pneumonia), fluid and electrolyte imbalances, breakdown of any anastomosis, sepsis, fistula formation, fecal or urine leakage, and skin irritation. If these occur, the patient will remain hospitalized for an extended length of time and will probably require parenteral nutrition, GI decompression by means of nasogastric suction, and further surgery. The goals of management are to establish drainage, provide adequate nutrition for healing to occur, and prevent sepsis.

Peritonitis. Peritonitis can occur postoperatively if urine leaks at the anastomosis. Signs and symptoms include abdominal pain and distention, muscle rigidity with guarding, nausea and vomiting, paralytic ileus (absence of bowel sounds), fever, and leukocytosis.

Urine output must be monitored closely, because a sudden decrease in output with a corresponding increase in drainage from the incision or drains may indicate urine leakage. In addition, the urine drainage device is observed for leakage. The pouch is changed if a leak is observed. Small leaks in the anastomosis may seal themselves, but surgery may be needed for larger leaks.

Vital signs (blood pressure, pulse and respiratory rates, temperature) are monitored. Changes in vital signs, as well as increasing pain, nausea and vomiting, and abdominal distention, are reported and may indicate peritonitis.

Stoma Ischemia and Necrosis. The stoma is monitored because ischemia and necrosis of the stoma can result from tension on the mesentery blood vessels, twisting of the bowel segment (conduit) during surgery, or arterial insufficiency. The new stoma must be inspected at least every 4 hours to assess the adequacy of its blood supply. The stoma should be red or pink. If the blood supply to the stoma is compromised, the color changes to purple, brown, or black. These changes are reported immediately. The surgeon or WOC nurse may insert a small, lubricated tube into the stoma and shine a flashlight into the lumen of the tube to assess for superficial ischemia or necrosis. A necrotic stoma requires surgical intervention. If the ischemia is superficial, the dusky stoma is observed and may slough its outer layer in several days.

Stoma Retraction and Separation. Stoma retraction and separation of the mucocutaneous border can occur as a result of trauma or tension on the internal bowel segment used for creation of the stoma. In addition, mucocutaneous separation can occur if the stoma does not heal as a result of accumulation of urine on the stoma and mucocutaneous border. Using a collection drainage pouch with an antireflux valve is helpful because the valve prevents urine from pooling on the stoma and mucocutaneous border. Meticulous skin care to keep the area around the stoma clean and dry promotes healing. If a separation of the mucocutaneous border occurs, surgery is not usually needed. The separated area is protected by applying karaya powder, stoma adhesive paste, and a properly fitted skin barrier and pouch. By protecting the separation, healing is promoted. If the stoma retracts into the peritoneum, surgical intervention is mandatory.

If surgery is needed to manage these complications, the nurse provides explanations to the patient and family. The need for additional surgery is usually perceived as a setback by the patient and family. Emotional support of the patient and family is provided along with physical preparation of the patient for surgery.

PROMOTING HOME, COMMUNITY-BASED, AND TRANSITIONAL CARE

Educating Patients About Self-Care. A major postoperative objective is to assist the patient to achieve the highest level of independence and self-care possible. The nurse and WOC nurse work closely with the patient and family to educate and assist them in all phases of managing the ostomy. Adequate supplies and complete instruction are necessary to enable the patient and a family member to develop competence and confidence in their skills. Written and verbal instructions are provided, and the patient is encouraged to contact the nurse or primary provider with follow-up questions. Follow-up telephone calls from the nurse to the patient and family after discharge may provide added support and provide another opportunity to answer their questions. Follow-up visits and reinforcement of correct skin care and appliance management techniques also promote skin integrity. Specific techniques for managing the appliance are described in Chart 49-13.

The patient is encouraged to participate in decisions regarding the type of collecting appliance and the time of day to change the appliance. The patient is assisted and encouraged to look at and touch the stoma early to overcome any fears. The patient and family need to know the characteristics of a normal stoma:

- Pink or red and moist, like the inside of the mouth
- Insensitive to pain because it has no nerve endings
- Vascular, which means it may bleed when cleaned

In addition, if a segment of the GI tract was used to create the urinary diversion, mucus may be visible in the urine. By learning what is normal, the patient and family become familiar with what signs and symptoms they should report and what problems they can handle themselves.

Information provided to the patient and the extent of involvement in self-care are determined by the patient's physical recovery and ability to accept and acquire the knowledge and skill needed for independence. Verbal and written instructions are provided, and the patient is given the opportunity to practice and demonstrate the knowledge and skills needed to manage urinary drainage.

Continuing and Transitional Care. Follow-up care is essential to determine how the patient has adapted to the changes in body image and lifestyle adjustments. Visits from a nurse are important to assess the patient's adaptation to the home setting and management of the ostomy. Education and reinforcement may assist the patient and family to cope with altered urinary function. It is important to assess for long-term complications that may occur, such as pouch leakage or rupture, stone formation, stenosis of the stoma, deterioration in kidney function, or incontinence.

Long-term monitoring for anemia is performed to identify vitamin B_{12} deficiency, which may occur when a significant portion of the terminal ileum is removed. This may take several years to develop and can be treated with vitamin B_{12} injections. The patient and family are informed about the United Ostomy Associations of America (UOAA) and any local ostomy support groups to provide ongoing support, assistance, and education (see Resources section at the end of this chapter).

Postoperative Evaluation

Expected patient outcomes may include:

1. Maintains skin integrity
    a. Maintains intact skin and demonstrates skill in managing drainage system and appliance
    b. States actions to take if skin excoriation occurs
2. Reports relief of pain
3. Exhibits improved body image as evidenced by the following:
    a. Voices acceptance of urinary diversion, stoma, and appliance
    b. Demonstrates increasingly independent self-care, including hygiene and grooming
    c. States acceptance of support and assistance from family members, health care providers, and another patient with an ostomy
4. Copes with sexuality issues
    a. Verbalizes concern about possible alterations in sexuality and sexual function
    b. Reports discussion of sexual concerns with partner and appropriate counselor
5. Demonstrates knowledge needed for self-care
    a. Performs self-care and proficient management of urinary diversion and appliance
    b. Asks questions relevant to self-management and prevention of complications
    c. Identifies signs and symptoms needing care from primary provider, nurse, or other health care providers
6. Absence of complications as evidenced by the following:
    a. Reports absence of pain or tenderness in abdomen
    b. Has temperature within normal range
    c. Reports no urine leakage from incision or drains
    d. Has urine output within desired volume limits
    e. Maintains stoma that is red or pink, moist, and appropriate in size without edema
    f. Has intact and healed border of the stoma

CRITICAL THINKING EXERCISES

1 ipc You are caring for a 53-year-old woman in the outpatient clinic where you work; she is newly diagnosed with urinary incontinence. What type of referrals might be appropriate for this patient? What members of the interprofessional health care team do you anticipate as being integral to the care of this patient?

2 ebp You notice an increase in the number of CAUTIs among patients on the medical-surgical unit where you work. What are the evidence-based management techniques used in CAUTI prevention? Identify the criteria used to evaluate the strength of the evidence for these practices. How will you individualize these techniques for your unit?

3 pq A 65-year-old man is admitted to the medical-surgical nursing unit where you work with bladder cancer. He is scheduled for a radical cystectomy with an orthotopic neobladder reconstruction. Identify the priorities, approach, and techniques you would use to provide care for this patient in the preoperative phase of care. How will your priorities, approach, and techniques differ in the postoperative phase of care?

REFERENCES

*Asterisk indicates nursing research.

Books

Alley, M. (2017). Congenital anomalies and malformations of the lower urinary tract. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

Blair, M. (2017). Genitourinary trauma. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

Cahill, M., & Haras, M. (2017). Disorders of calcium and phosphorus metabolism. In S. Bodin (Ed.). *Contemporary nephrology nursing*. Pitman, NJ: American Nephrology Nurses Association.

Caruso, A. M., Tyler, A., & Wolkowicz, S. B. (2017). Bladder cancer. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

Comerford, K. C., & Durkin, M. A. (2020). *Nursing 2020 drug handbook* (40th ed.). Philadelphia, PA: Wolters Kluwer.

Eliopoulos, C. (2018). *Gerontological nursing* (9th ed.). Philadelphia, PA: Wolters Kluwer.

Fischbach, F. T., & Fischbach, M. A. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Flagg, L., & Joiner, C. J. (2017). Urinary stone disease. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

Freeman, J., Martin, K., & Uithoven, R. (2017). Urinary tract infections. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

Hickey, J. V., & Strayer, A. L. (2020). *The clinical practice of neurological and neurosurgical nursing* (8th ed.). Philadelphia, PA: Wolters Kluwer.

King, S. J. (2017). Reconstructive surgery for incontinence. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

Miller, C. A. (2019). *Nursing for wellness in older adults* (8th ed.). Philadelphia, PA: Wolters Kluwer.

Newman, D. K. (2017). Catheters, devices, products, and catheter-associated urinary tract infections. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Weber, J., & Kelley, J. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.

Wooldridge, L. S. (2017). Urinary incontinence. In D. K. Newman, J. F. Wyman, & V. W. Welch (Eds.). *Core curriculum for urologic nursing*. Pitman, NJ: Society of Urologic Nurses and Associates.

Journals and Electronic Documents

American Urological Association (AUA). (2019a). Diagnosis and treatment of non-neurogenic overactive bladder in adults: An AUA/SUFU Guideline (2019). Retrieved on 5/13/2020 at: www.auanet.org/guidelines

American Urological Association (AUA). (2019b). Recurrent uncomplicated urinary tract infections in women: AUA/CUA/SUFU Guideline (2019). Retrieved on 5/13/2020 at: www.auanet.org/Guidelines

Chang, D. T. S., & Lawrentschuk, N. (2015). Orthotopic neobladder reconstruction. *Urology Annals*, *7*(1), 1–7.

Francis, K. (2019). Damage control: Differentiating incontinence-associated dermatitis from pressure injury. *Nursing 2019 Critical Care*, *14*(6), 28–35.

Gould, C. V., Umscheid, C. A., Agarwal, R. K., et al. (2019). Guideline for prevention of catheter-associated urinary tract infections 2009. Retrieved on 5/13/2020 at: www.cdc.gov/infectioncontrol/guidelines/cauti/

Martin, C. D., Wingo, N., & Holland, A. C. (2019). Evaluating suppressive therapies to prevent recurrent urinary tract infections: A literature review. *Women's Healthcare*, *7*(1), 28–32, 43.

McCoy, C., Paredes, M., Allen, S., et al. (2017). Catheter-associated urinary tract infections. *Clinical Journal of Oncology Nursing*, *21*(4), 460–465.

McDonald, C., Winge, K., & Burn, D. J. (2017). Lower urinary tract symptoms in Parkinson's disease: Prevalence, etiology, and management. *Parkinsonism and Related Disorders*, *35*, 8–16.
National Cancer Institute (NCI). (2020). Bladder cancer treatment (PDQ®)—Health professional version. Retrieved on 01/11/2020 at: www.cancer.gov/types/bladder/hp/bladder-treatment-pdq#section/all
Oh-oka, H. (2017). Clinical efficacy of 1-year intensive systematic dietary manipulation as complementary and alternative medicine therapies on female patients with interstitial cystitis/bladder pain syndrome. *Urology*, *106*, 50–54.
*Qiang, L., Xian, L. W., Bin, P. Y., et al. (2020). Investigating ICU nurses' understanding of incontinence-associated dermatitis: An analysis of influencing factors. *World Council of Enterostomal Therapists Journal*, *40*(1), 32–38.
Shi, H., Yu, H., Bellmont, J., et al. (2018). Comparison of health-related quality of life (HRQoL) between ileal conduit diversion and orthotopic neobladder based on validated questionnaires: A systematic review and meta-analysis. *Quality Of Life Research*, *27*(11), 2759–2775.
Tambunan, M. P., & Rahardjo, H. E. (2019). Cranberries for women with recurrent urinary tract infection: A meta-analysis. *Medical Journal of Indonesia*, *28*, 268–275.
*Taylor, J. (2018). Reducing the incidence of inappropriate indwelling catheterisation. *Journal of Community Nursing*, *32*(3), 50–56.
Wound Ostomy Continence Nurses (WOCN) Society. (2018). WOCN Society Clinical Guideline: Management of the adult patient with a fecal or urinary ostomy—An executive summary. *Journal of Wound 0stomy Continence Nursing*, *45*(1), 50–58.
*Wu, M., Grealish, L., Moyle, W., et al. (2020). The effectiveness of nurse-led interventions for preventing urinary tract infections in older adults in residential age care facilities: A systematic review. *Journal of Clinical Nursing*, *29*(9-10), 1432–1444.
Yang, Y., Bai, Y., Wang, X., et al. (2019). Internal double-J stent was associated with a lower incidence of ureteroileal anastomosis stricture than external ureteral catheter for patient undergoing radical cystectomy and orthotopic neobladder: A systematic review and meta-analysis. *International Journal of Surgery*, *72*(2019), 80–84.

Resources

American Urological Association, www.auanet.org
National Association for Continence (NAFC), www.nafc.org
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), National Institutes of Health, www.niddk.nih.gov
National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC), kidney.niddk.nih.gov/
National Kidney Foundation, www.kidney.org
United Ostomy Associations of America, www.ostomy.org

Wound Ostomy and Continence Nurses Society, www.wocn.org