CHRONIC KIDNEY DISEASE

Abstract

The renal system is a group of organs that form, stores, and excretes urine and has several other important functions including the vital role of maintaining homeostasis of the internal environment of the body. Chronic kidney disease can cause serious, long-term conditions and permanent harm involving irreversible damage to the kidneys. This damage is reflected by decreased kidney function, abnormal test results, renal system deterioration and medical complications. The incidence of chronic kidney disease varies based on patient demographics. Two types of dialysis are discussed, which include hemodialysis and peritoneal dialysis. The role of the Certified Nursing Assistant within the dialysis team is raised as pivotal to successful patient care outcomes.

Learning Objectives

1. Identify several basic functions of the kidneys and the renal system.
2. Identify common signs and symptoms of kidney disease.
3. Identify the two most common causes of chronic kidney failure.
4. Identify CNA responsibilities when caring for dialysis patients.

Introduction

Disorders of the kidney and the renal system are among the most common diseases that affect people in the United States. Some kidney diseases are relatively benign but others are the cause of serious, long-term conditions and permanent harm. Chronic kidney disease is one of the most serious and most common kidney diseases. The following sections will discuss the anatomy and physiology of the renal system, and chronic kidney disease.

Renal System Anatomy and Physiology

The renal system is a group of organs that form, stores, and excretes urine. It also has several other important functions. The renal system is one of the most important organ systems because it plays a vital role in maintaining homeostasis of the internal environment of the body.

Homeostasis is a term that means stability, or optimal conditions. Every living organism has an internal environment under which it functions best. This internal environment is complex and it includes such things as body temperature, acid-base balance, the amount and composition of body fluids such as the blood and the lymph, and the concentration of electrolytes. The renal system is an important organ system when it comes to maintaining homeostasis.

The renal system contributes to the maintaining of homeostasis by eliminating potentially toxic wastes, helping to regulate blood pressure, assisting in maintaining the normal acid-base level in the body, controlling the blood volume and fluid volume, and assisting in the formation of red blood cells. Additionally, homeostasis is maintained by the kidneys helping to control the blood level of electrolytes such as calcium, potassium, and sodium.

Each of these functions of the renal system is critically important for controlling the internal environment of the body. If the renal system is severely damaged and cannot eliminate toxic wastes, survival for any appreciable length of time is seriously compromised. If the renal system cannot help maintain the normal acid-base balance, the cardiovascular system and the neurological system, and the renal system itself cannot function properly. People with an impaired renal system cannot form a sufficient amount of red blood cells and consequently, they suffer from anemia.

The renal system is comprised of the kidneys, ureters, bladder, and urethra. Basically, the kidneys form urine, the ureters transport urine to the bladder, the bladder stores urine, and the urethra allows the body to excrete urine.

The Kidneys

In the normal person there are two kidneys. They are located in the abdominal cavity, below the lower edge of the rib cage and slightly above the hip bones, one on the right side and one on the left. The kidneys are supplied with blood by several large arteries and although the kidneys are not very large in comparison to some other organs, they receive over 20% of the blood that is pumped from the heart. The kidneys receive such a high percentage of the cardiac output because they are metabolically active, and therefore, they need a lot of blood and oxygen to function. Because of this the kidneys are very sensitive to any decrease in their blood supply.

Each kidney is comprised of an outer layer called the cortex and an inner layer called the medulla. The basic functional unit of the kidney is called the nephron, and the nephrons are located in the cortex and the medulla. Blood from the body flows into the kidneys and through the nephrons, and each nephron has a filtering unit, the glomerulus, and a system of tubules. As blood flows through the nephron, the glomerulus, and the tubules, fluid is reabsorbed back into the blood as needed and what is not reabsorbed is excreted as the urine. The nephrons, glomerulus, and tubules are also where electrolytes, acids, bases, and other substances can be reabsorbed or excreted as needed. The urine that is formed in the nephrons moves into a collecting area in the center of the kidney called the renal pelvis and from there it flows into the bladder.

The kidneys are highly complex organs and as mentioned before, they are very metabolically active and they need a lot of blood and oxygen. The primary functions of the kidneys include the elimination of toxic wastes.

Eliminating Toxic Wastes:

Normal metabolism produces compounds and by-products that are inherently toxic and must be eliminated, and this is one of the primary functions of the kidneys. Blood from the body enters the kidneys and into the nephrons. The nephrons filter and remove toxic wastes from the blood and these are then excreted in the urine. The two most important toxic products eliminated by the kidneys are blood urea nitrogen (BUN) and creatinine.

The blood urea nitrogen and creatinine are byproducts of metabolism and of the breakdown of protein. The BUN and creatinine must be removed from the blood and excreted in the urine as high levels of these compounds can be very harmful. The importance of BUN and creatinine will be discussed in more detail in a later section.

Regulating Blood Pressure:

The kidneys help to regulate blood pressure in two ways. The first is by controlling blood volume. If the blood pressure is too high or too low they can increase or decrease the amount of urine that is formed as blood flows into the kidneys, thus eliminating or conserving body fluid. The second is by a system of blood pressure sensors in the kidneys. These sensors respond to the level of blood pressure - too high or too low - by releasing an enzyme called renin that helps control blood pressure.

Maintaining Acid-Base Balance:

Acids and bases are produced by metabolism, and the correct balance between the two must be maintained - and maintained within very narrow parameters. If the balance between the two swings too far in one direction or the other (too many acids or too few bases, for example), many of our organ systems cannot function properly. The kidneys help maintain a normal acid-base balance by excreting or reabsorbing acids, excreting or reabsorbing bicarbonate (the most important base) or by producing new bicarbonate.

Red Blood Cell Formation:

Red blood cells contain a compound called hemoglobin. Hemoglobin is the carrier molecule for oxygen. During inhalation of the respiratory cycle, the oxygen in the air breathed in moves into the blood circulating through the lungs and attaches to the hemoglobin in the red blood cells. As blood circulates through the body, oxygen detaches from hemoglobin and is delivered to the organs and tissues. The kidneys produce a hormone called erythropoietin that stimulates the bone marrow to produce red blood cells. Without a sufficient supply of erythropoietin, someone will develop anemia.

Electrolytes:

There are many electrolytes in the blood, for example, calcium, potassium, and sodium. The kidneys help maintain the optimal concentration of electrolytes in the blood by reabsorbing them or excreting them in the urine as needed.

Regulating Blood and Fluid Volume:

The function of the kidney to regulate fluid volume was discussed above, but in the context of blood pressure control. The amount of blood and fluid in the body is also important for normal organ and tissue functions. For example, if the amount of body fluid and blood is decreased, this is dehydration, and the heart and the lungs will have to work harder to circulate blood and deliver oxygen, and organs and tissues may not be adequately perfused.

The kidneys are enormously important organs, and they are very metabolically active. If the supply of blood and oxygen is significantly decreased by hemorrhage, hypotension, toxins, or any other factor, the kidneys can suffer irreversible damage and this can have serious implications.

The Ureters

The ureters are short, muscular tubes that carry the urine from the renal pelvis to the bladder. The ureters are a common site for kidney stones to become lodged.

The Bladder

The bladder collects and stores urine. The capacity of the bladder is approximately 300-350 mL, although it can hold more. The walls of the bladder have several layers, and one of these layers is the detrusor muscle. As urine accumulates in the bladder, the bladder walls are stretched and nerve endings in the bladder wall are stimulated. Stimulation of these nerve endings sends a signal to the detrusor muscle to contract, and the bladder is emptied.

The Urethra

Urine exits the bladder via the urethra. The urethra is a narrow tube that starts at the bottom of the bladder and ends in an opening called the meatus. In males the urethra is part of the renal system and the reproductive system.

Chronic Kidney Disease Statistics

Chronic kidney disease is defined by the National Kidney Foundation as kidney damage that is present for three or more months. The damage is seen as structural injury to the kidney and abnormal blood and urine tests. Chronic kidney disease (CKD) may also be diagnosed on the basis of a glomerular filtration rate that is below a certain level for three months or longer. Chronic kidney disease means that a disease process has caused irreversible damage to the kidneys and the damage is reflected by decreased kidney function, abnormal test results, physical harm to the kidneys, and medical complications.

The National Kidney Foundation defines chronic kidney disease as having five stages. These stages are based on the level of kidney damage, and the level of damage to the kidneys' filtering ability.

Stage 3 chronic kidney disease is said to be present when the patient has evidence of kidney damage such as abnormal laboratory tests and/or physical damage to the kidneys. These laboratory tests could be an abnormally high BUN or creatinine, and the physical damage could be detected by a renal ultrasound. In addition, the patient's kidneys will have abnormal filtering ability, reflected in a moderate decrease in glomerular filtration rate (GFR).

Prevalence of CKD

Chronic kidney disease is very common. It has been estimated that one in every 10 adults in the United States has chronic kidney disease, and chronic kidney disease is the 9th leading cause of death in the United States. The incidence of chronic kidney disease increases with age, it affects males slightly more than females, and the incidence of chronic kidney disease is especially high in African American males. Also, because diabetes and hypertension are major causes of chronic kidney disease and these diseases are more common in African Americans, Hispanic Americans, and Native Americans, chronic kidney disease affects these populations especially hard.

Causes of CKD

There are many causes of chronic kidney disease, but diabetes mellitus, hypertension, and glomerulonephritis account for the great majority of cases (approximately 75% of all cases). Given the high number of people affected by diabetes mellitus and hypertension, it is not surprising that chronic kidney disease is so common, as well.

Diabetes mellitus, especially poorly controlled diabetes mellitus, is a significant risk factor for developing chronic kidney disease, and it is the number one cause of chronic kidney disease. Kidney damage caused by diabetes mellitus is called diabetic nephropathy, and approximately 50% of all people who have had diabetes for more than 20 years have some degree of diabetic nephropathy. It appears to affect males and females equally.

The incidence of kidney disease caused by diabetes is much higher in African Americans, Hispanics, and Native Americans. Diabetic nephropathy is particularly common in people who have hypertension, high blood sugar levels, and a genetic predisposition to the disease.

More than 72 million Americans have hypertension, and hypertension is the second leading cause of chronic kidney disease. More than 50% of people who have chronic kidney disease have hypertension, and chronic kidney disease itself can cause hypertension. There are several mechanisms by which hypertension causes chronic kidney disease. In many cases an elevated blood pressure over a period of years is thought to cause irreversible damage to the renal blood vessels and through that, damage to the functional units of the kidneys.

The third most common cause of chronic kidney disease is glomerulonephritis. Glomerulonephritis is defined as an inflammation of the glomeruli. It can be an acute or chronic problem, and there are multiple causes of glomerulonephritis. Some of the more common causes are infections (hepatitis, human immunodeficiency virus (HIV), strep throat), immune system diseases such as lupus, inflammation of the blood vessels (vasculitis) and inherited glomerulonephritis. Glomerulonephritis can be an acute or chronic problem, and the chronic form may cause chronic kidney disease and hypertension.

Other causes of chronic kidney disease are much less common. Polycystic kidney disease is an inherited cause of kidney damage. Kidney problems can also be caused by chronic urinary tract infections or obstruction of the urinary tract by a kidney stone.

Signs and Symptoms of CKD

Although there are some signs and symptoms that are characteristic of chronic kidney disease, there are literally dozens of causes of CKD; each affected patient can have a unique presentation. In addition, CKD is a slow, progressive illness and in its early stages the patient may be asymptomatic. Chronic kidney disease can only be detected through laboratory testing.

There are warning signs, however, that may indicate the presence of chronic kidney disease. If these occur in someone who has diabetes mellitus and/or hypertension, someone who is elderly, or someone who has an ethnic risk factor for the development of CKD, the patient should be examined for the presence of chronic kidney disease.

- Pain or burning during urination

- Difficulty urinating
- Fatigue
- Frequent urination, a persistent urge to urinate
- Blood in the urine
- Swelling in the ankles and/or feet
- Pain in the small of the back
- High blood pressure

Unfortunately, these signs and symptoms are nonspecific. Back pain and fatigue, for example, can have many causes aside from chronic kidney disease, and pain and burning during urination can be caused by a urinary tract infection, a very common problem; however, if these signs and symptoms are occurring in someone who is elderly, who has an ethnic risk factor for developing chronic kidney disease, and that person has diabetes mellitus, hypertension, or both of those diseases, an investigation for the presence of chronic kidney disease would be a high priority.

Diagnosis of CKD

Early detection of chronic kidney disease is very important. Certain people are at greater risk for kidney disease, such as people who have diabetes mellitus, hypertension, or both of those diseases. There is also a higher risk for kidney disease with certain ethnic groups. These people who are most at risk for developing kidney disease should make every effort to keep any of the above diseases under control and they should have periodic screening done to check for the presence of chronic kidney.

Chronic kidney disease is detected and diagnosed by laboratory testing. These tests measure the amount of kidney damage and the level of kidney functioning.

Blood Urea Nitrogen:

The blood urea nitrogen is a breakdown product of the protein we eat and from normal metabolic processes. The BUN is one of the most important waste products that are filtered out by the kidney, and if the kidneys have been damaged the BUN level will be elevated. It is easily measured by a blood test, and it is a very sensitive marker for detecting kidney damage. The normal range for BUN is 6-20 mg/dL.

Creatinine:

Creatinine is a byproduct of muscle metabolism, and it is another very sensitive marker of kidney integrity if the kidneys have been damaged the blood level of creatinine will be elevated. Creatinine is measured by taking a blood sample, and the normal range for creatinine is 0.5-1.0 mg/dL for women and 0.7-1.2 mg/dL for men.

Urine Protein:

If the kidneys are damaged, a protein called albumin will not be reabsorbed back into the blood as blood circulates through the kidneys; it will leak into the urine. Protein is not normally found in the urine, and its presence there may indicate chronic kidney disease.

Glomerular Filtration Rate:

The glomerular filtration rate (GFR) is a more sensitive test for measuring kidney function than the blood BUN and creatinine levels, which are used more as indicators of kidney damage. The glomerulus is the filtering unit of the kidneys, and the GFR will be decreased if the filtering ability of the glomeruli has been affected. The GFR is checked by measuring the creatinine level and then using a formula that takes into account the patient's age, body weight, ethnic status, and gender. The GFR is used (along with other factors) to determine what stage of chronic kidney disease is present.

There are other tests that will be performed in order to make the diagnosis of chronic kidney disease. A renal ultrasound may be done and other blood tests and some urine tests may be helpful, as well, but the four tests discussed above are the primary tools used to detect and diagnosis chronic kidney disease.

Some of the tests that were discussed previously are used to look for a level of kidney damage and others are used to determine the level of kidney functioning. This may seem a bit confusing at first, but if the kidneys are damaged, they will not be functioning properly so obtaining both types of tests may not be very useful.
The kidneys are like many other organ systems in the human body. They can adapt to a level of damage by increasing their level of functioning. If a certain amount of nephrons have been injured by diabetes or hypertension and they cannot filter the blood and form urine, the remaining nephrons will simply work a bit harder. In that case, the BUN may be elevated and there may be excess protein in the urine, but the GFR will not be markedly reduced. Of course, this sort of compensation will only be effective up to a point; if too many nephrons are nonfunctional, the GFR will be abnormally low.

Prognosis for CKD

In many cases, chronic kidney disease is a progressive disease. The patient who has the early stages of the disease will have a gradual decline in kidney function and a gradual increase in kidney damage. Whether or not someone eventually develops incurable, chronic kidney disease depends on several factors: the patient's age, the reason why the kidney disease is happening, how well the patient responds to treatment, and how early the kidney disease is detected. However, in the beginning stages of chronic kidney disease the BUN and creatinine can be abnormally high, there can be excessive protein in the urine, and the GFR can be decreased, but the patient will not have any specific signs and symptoms. So early detection is crucial and good management of diseases such as diabetes mellitus and hypertension is absolutely imperative in order to prevent chronic kidney disease from progressing.

Unfortunately, chronic kidney disease is often not detected until there is kidney damage and the kidney function is affected. If the disease progresses to a certain degree the patient is said to have end-stage renal disease (ESRD). At that point the waste products and fluid normally excreted by the kidney accumulate to a harmful level and the patient is said to have the uremic syndrome.

The uremic syndrome is a set of signs, symptoms, and clinical complications that reflect the end stage of chronic kidney disease. It is a very serious condition because at this point kidney function is severely impaired and will not recover. The patient who has the uremic syndrome must receive some form of dialysis or have a kidney transplant. If these cannot be done the patient will die.

The uremic syndrome is also a very serious condition because it affects not only the kidneys but other organ systems, as well. People who have end-stage renal disease and the uremic syndrome have an increased risk of heart attack and stroke. If they have hypertension, this may be aggravated and worsened because the kidneys cannot excrete excess fluid from the body.

Anemia is common because the kidneys cannot help make new red blood cells, and malnutrition is common because people with end-stage renal disease and the uremic syndrome often have anorexia and nausea. The patient with end-stage renal disease and the uremic syndrome often feels tired, weak, and short of breath.

End-Stage Renal Disease and Uremic Syndrome

There are two treatments available for the patient who has end-stage renal disease and the uremic syndrome: a kidney transplant or dialysis.

A kidney transplant is the preferred treatment. Dialysis can only perform a very small percentage of the work of the kidneys. It is a very time consuming process that must be performed three to six times a week. And although dialysis definitely helps people who have end-stage renal disease live longer, it could fairly be described as a "holding" technique. Patients who need dialysis generally have a life expectancy of only five years while someone who has received a kidney transplant will typically live for 12-20 years if the transplant was from a living donor or 8-12 years if the transplant was from a deceased donor. Dialysis can also cause serious health problems such as anemia, bone disease, infection, and nerve damage.

However, receiving a kidney transplant is not a simple matter. Finding a donor is difficult and there are many people who succumb to end-stage renal disease and the uremic syndrome while waiting for an organ. Some people may not be suitable candidates for transplant because of pre-existing medical problems or fragile health status. For those patients, the only treatment that can help prolong life and ease their symptoms is dialysis. The two types of dialysis available are *hemodialysis* and *peritoneal dialysis*. Both of these dialysis techniques are discussed next, followed by an interesting case study focusing on the importance of blood pressure control in dialysis patients.

Hemodialysis

Hemodialysis is an invasive procedure that acts as an artificial kidney. It filters out waste products and toxins from the blood and can help restore the normal fluid volume of the body. Hemodialysis is performed by first gaining access to the patient's vascular system. There are three ways this can be done, and these are called vascular access devices.

Arteriovenous Fistula

An arteriovenous (AV) fistula is a surgically created connection between an artery and a vein. The AV fistula is usually created on a patient's forearm.

Arteriovenous Graft

In some cases the patient's blood vessels are not suitable for creating an AV fistula. If that is the case a plastic graft can be surgically placed to make the connection between an artery and a vein. The AV graft is typically placed on a patient's forearm.

Central Venous Catheter

A central venous catheter is essentially a wide bore intravenous (IV) catheter that is placed in a large blood vessel in the neck or the groin. This type of access is temporary and is typically used only for emergency dialysis procedures or for very short-term dialysis needs. For example, a central venous catheter may be used for dialysis while waiting for an AV fistula to mature and be ready for use.

The AV fistula and the AV graft are both acceptable methods of providing access for performing hemodialysis. The method that is chosen will depend on several factors, but the AV fistula is the preferred choice if it is possible to use that technique. The fistula does take several months to mature after it has been created. However, a properly formed AV fistula will last for many years, and an AV fistula is less likely than an AV graft to become infected or to develop a clot. An AV graft can be used sooner than an AV fistula and there are more possibilities for placement, for example, the thigh or upper arm. Also, if the patient's arteries and veins are not considered strong enough for an AV fistula, a graft will be the only choice. But given the advantages of the AV fistula, this technique will be used if at all possible.

The AV fistula and the AV graft are accepted and proven methods for providing access for hemodialysis. Both techniques have been used for many years, but as with any surgery there are risks. The surgical site can become infected, thrombosis (blood clot) may form inside the fistula or graft, and the blood vessels may become narrowed, increasing the resistance to blood flow. Clotting is more common with AV grafts than with AV fistulas.

Once an AV fistula or an AV graft has been established most will remain trouble free, but they do need care and monitoring. The site of the fistula or graft should be inspected for signs of infection such as pain, redness, or swelling. The arm that contains the fistula or graft should not be used for venipunctures and it should not be used to measure blood pressure. Either of these may decrease the blood flow through the fistula or graft and increase the risk of clot formation.

The fistula or the graft should be periodically checked to make sure it is open and blood is flowing. This is usually done by feeling for blood flow and listening for blood flow with a stethoscope. And because blood clots in the fistula or graft are always a possibility, the arm that contains the vascular access device should be assessed for the presence of decreased blood flow. If the skin is cool, cyanotic, or pale or if there is numbness or tingling in the arm, hand, or fingers, there may be a clot that is blocking the circulation in the arm where the fistula or graft is located.

Healthcare professionals have a responsibility for monitoring an AV fistula or an AV graft, and the patient does, as well. Someone who has an AV fistula or an AV graft should be instructed in the following points.

- Do not wear tight fitting clothing on the arm that contains the vascular access device.
- Do not wear tight fitting jewelry on the area of the vascular access device.

- Try not to place pressure on the AV fistula or AV graft when sleeping or sitting.
- Notify the physician or other health care professional if there are signs or symptoms of infection or a blood clot.

The hemodialysis procedure starts by having one needle inserted into the venous side of the fistula or graft and another needle inserted into the arterial side of the fistula or graft. Each needle is connected to sterile plastic IV-type tubing and these tubes are connected to the dialysis machine.
Arterial blood is filtered through a dialysis canister in the hemodialysis machine and blood byproducts are removed, such as the BUN, protein, excess fluids, and metabolic waste products, *etc*. The cleansed blood is returned to the patient through the venous side of the fistula or graft.

Hemodialysis is usually done three to six times a week. The frequency and the duration of the treatments will depend on the patient's needs and on where the dialysis is being done. If hemodialysis is done in a hospital or a dialysis center, the procedure usually lasts between three to five hours and is done three times a week. If a patient is receiving hemodialysis at home, the duration of the procedure is shorter by several hours, and it is done six to seven times a week.

The procedure of hemodialysis has been performed for decades, the techniques are well established, and in many ways it could be considered routine. People who need hemodialysis certainly adapt to the procedure, but it is still stressful and there are complications. Some people experience low blood pressure during a hemodialysis treatment, and nausea and abdominal cramps are possible.

Peritoneal Dialysis

Peritoneal dialysis is another technique that can be used as an artificial kidney, and this type of dialysis uses the same principles as hemodialysis. The goals of peritoneal dialysis are to filter out metabolic waste products, filter out toxins, and maintain normal fluid status, similar to the goals of hemodialysis. However, there is a very big difference between these two dialysis techniques. Peritoneal dialysis does not require the use of a complicated dialysis machine. Instead, peritoneal dialysis uses a body structure called the peritoneum to perform the functions of the hemodialysis machine and the dialysis canisters.

The Peritoneum

The peritoneum is a thin, permeable membrane that lines the abdominal cavity. Peritoneal dialysis is performed by inserting a catheter through the abdominal wall and into the closed space between the peritoneum and the abdominal wall; this space is called the peritoneal cavity. Fluid that is called dialysate fluid is then instilled through IV-type tubing into the peritoneal cavity and left there for a specified period of time. Because of the highly specialized composition of the dialysate fluid, everything that needs to be removed, BUN, protein, excess fluids, *etc.*, is pulled from the blood vessels that line the peritoneum into the peritoneal cavity. That fluid is then drained out through another tube and discarded.

Peritoneal dialysis and hemodialysis are both effective but peritoneal dialysis offers several advantages that hemodialysis cannot provide. It can be used in people who do not have good circulation. Aside from the initial insertion of the peritoneal dialysis access catheter, the procedure does not require puncturing the skin with a needle. The procedure can be done by the patient, anywhere and any time, and one form of peritoneal dialysis can be done while the patient sleeps.

Hemodialysis is almost always done in a healthcare facility by medical professionals. There are fewer dietary and fluid restrictions with peritoneal dialysis than with hemodialysis. The biggest risk of peritoneal dialysis is peritonitis, an infection of the peritoneum. If a patient who is receiving peritoneal dialysis develops abdominal pain and a fever, the patient's medical provider or a specially trained and credentialed dialysis nurse should be notified immediately.

Kidney Dialysis: Role of the CNA

The healthcare system has been changing over the past decades, and this is especially true in the area of kidney dialysis both at an outpatient center and with in-home care. In many kidney dialysis outpatient centers, the Certified Nursing Assistant (CNA) is generally assigned a set list of patients with a specific function to check on patient vital signs and to assist with basic care as needed, such as helping a patient transfer to the bathroom or by providing assistance at the end of a dialysis treatment for discharge. The CNA is also a front-line healthcare worker and is able to listen to the patient's needs and may observe the patient more closely during treatment. The CNA is also the one who generally reports any changes or concerns to the registered nurse overseeing the patient's course of dialysis treatment. CNA's typically interact more actively with dialysis patients during treatment while serving snacks and checking vital signs; they have a principal role in quality care outcomes and in ensuring treatment satisfaction by patients and their families.

The CNA works closely with the dialysis team and under the supervision of a registered nurse. As part of the larger health team the CNA maintains a close relationship with the patients and their families, and has a pivotal role in ensuring treatment needs and questions are followed up. Often CNAs will be the ones calling patients to remind them of their appointments and perform the follow up calls at home after their treatment.

One study conducted by Nohabar and Tamadon (2016) focused on the barriers and facilitators to care for the hemodialysis patients. The authors stated that the lack of nursing aides and nursing assistants was a barrier to care for dialysis patients due to an existing shortage of trained staff that included both registered nurses and physicians who typically oversee dialysis treatment. The authors in this study referenced prior studies that suggested the provision of safety and quality care for dialysis patients required all healthcare team member roles, and these roles need to be better understood and enhanced to meet the patient’s full care needs. The CNA is often considered a *supportive* health team member in dialysis centers and for those receiving home-based care.

Case Study: Chronic Kidney Disease and Hemodialysis

The following case study was obtained from a PubMed search and discusses high blood pressure in the setting of hemodialysis. The authors reported on four end-stage renal disease patients in an outpatient setting undergoing hemodialysis with complications of hypertension who were also on a kidney transplant list. The authors discussed the use of trending blood pressures during dialysis as a better predictor of poor outcomes and death in hemodialysis patients.

Additionally, the purpose of the study included the benefit of a kidney catheter ablation (called an *intravascular renal denervation*) procedure for dialysis patients. The intention was to perform four ablations to each of the kidney arteries supplying blood to all major areas of the kidney to help normalize the patient's blood pressures that were resistant to blood pressure medications. This would improve the patient's overall success rate to treatment and risk of death due to blood pressure complications in a kidney patient.

In a kidney dialysis unit, patients were screened for therapy-resistant hypertension, which was defined as an outpatient blood pressure > 160/100 mmHg and a blood pressure by during dialysis of blood pressure monitoring > 130/80 mmHg.

Four patients were included in the study who were >18 years old, with end-stage renal disease (ESRD) and drug-resistant hypertension, defined as an outpatient blood pressure of >160/100 mmHg and blood pressure on ambulatory blood pressure monitoring of >130/80 mmHg. Blood pressure was calculated as the mean value before and after dialysis. The patients included a:

- 24-year-old man with neurogenic bladder undergoing hemodialysis
- 55-year-old woman with a history of type 1 diabetes mellitus undergoing peritoneal dialysis

- 56-year-old woman with a history of autosomal dominant polycystic kidney disease (ADPKD) undergoing peritoneal dialysis
- 72-year-old man with a history of ADPKD undergoing hemodialysis

The selection of patients included a variety of ages and backgrounds. All four patients were prescribed antihypertensive medications before hemodialysis treatment. The duration of dialysis was 29 months and the mean day-time blood pressure measurement was 178/97 mmHg and the mean nighttime blood pressure was 174/92 mmHg. The difference between the patients' blood pressures between day- and night-time were essentially unchanged. Three of the four patients on dialysis were on a kidney transplant waiting list. The elderly patient was not included on a kidney transplant waiting list, which is explained later on.

During dialysis, in the four cases, the patients' blood pressures were measured every 30 minutes during the day-time and every 60 minutes during the night-time. Blood pressure was taken before and after dialysis.

During the first three months, all four patients were still undergoing dialysis. Blood pressure was unchanged. At six months, however, one patient received a kidney transplant, and two other patients received a transplant within 24 months. Before kidney transplantation, the mean blood pressure was 154/80 mmHg and after 24 months the mean blood pressure was 144/75 mmHg. The authors reported that antihypertensive medicines were also able to be lowered in most of the patients. The doses were unchanged in one patient, decreased in two patients, and stopped in one patient during the follow-up. There were no immediate or late clinical complications during the study on all four patients.

In the 24-year-old man with neurogenic urinary bladder, he was a responder for intravascular renal denervation, stayed at a normal blood pressure without taking blood pressure medication for one year after the intravascular renal denervation procedure, and this success lasted until he had a kidney transplantation 24 months after intravascular renal denervation. Before this procedure, he had severe high blood pressure, which can be damaging to the kidneys and other smaller vessels in the body. Weight gain was noted with a concern for fluid retention, however further laboratory testing ruled out fluid retention and the weight gain was due to increased body mass from improved nutritional intake.

In the 55-year-old woman with type 1 diabetes mellitus she received a kidney transplant a few weeks after 12 months, at which time, her blood pressure was 190/84 mmHg and she required medical treatment for blood pressure control. Her blood pressure came down to 149/70 mmHg after the intravascular renal denervation procedure despite having other complications, such as heart valve stenosis (thickening of the heart valve) that can drive blood pressure up.

The 56-year-old woman with autosomal dominant polycystic kidney disease, received a kidney transplant shortly before six months following the intravascular renal denervation. Her blood pressure was unchanged at 168/100 mmHg after 3 months, but after kidney transplantation and antihypertensive medicines her blood pressure was 137/78 mmHg after 2 years at her medical follow up appointment.

The 72-year-old man was not considered for a kidney transplantation due to other medical diagnoses and chronic health problems that were age related. While he was not a good candidate for kidney transplantation, he did undergo the renal denervation without complications. He showed no change in blood pressure, however, compared to readings before renal denervation procedure.

Discussion

The authors raised the prevalence of hypertension in patients on dialysis while awaiting kidney transplantation. Frequently, these patients have high blood pressures even while taking medication to lower the blood pressure. An elevated blood pressure can be harmful for the overall health of an already compromised kidney system and can also harm the patient’s chance for successful kidney transplant. Patients with end-stage renal disease (ESRD) with severe drug-resistant hypertension >160/100 mmHg has been reported to be present in about 40% of patients. In the above four cases, the authors aimed to show that the effect of intravascular renal denervation on ambulatory blood pressure monitoring during dialysis varied between patients.

In brief, the intravascular renal denervation procedure was reported to help regulate blood pressure by interfering with the sympathetic system that is involved in the release of certain hormones that increase or boost the blood pressure. These hormones are typically used in the “fight or flight” type mechanisms in a person’s body, driving blood pressure higher. In hypertensive patients, the continued release of low-dose amounts of these hormones can increase blood pressure at the level of the kidney. This procedure is a new technique of catheter-based renal denervation where the surgeon will cut renal (kidney) nerves to help improve a person's blood pressure. It is generally considered a safe procedure.

In one patient all antihypertensive drugs used were stopped and he remained in a state of normal blood pressure until kidney transplantation. In two patients the ambulatory blood pressure was unchanged before kidney transplantation but decreased after kidney transplantation. The fourth patient, who was not a candidate for kidney transplantation, was a non-responder to the intravascular renal denervation procedure.

Healthcare workers need to know that a reduction in systolic blood pressure values of >10% between daytime to nighttime is a normal finding. A lack of variability in systolic blood pressure between day- and night-time is associated with kidney failure and exists in 82% of patients on hemodialysis. A lack of blood pressure variability between day- and night-time is a risk factor for increased death in the general population. When the blood pressure changes to allow for a difference between day- and night-time blood pressure values, there is a reduced risk of death due to cardiovascular disease.

In this case series, only one patient reversed blood pressure status completely between day- and night-time, and the author's point out that he was a young man with a short history of hypertension. Irreversible hypertensive changes in smaller vessels in the patient's kidney system and the rest of the patient's vascular system did not have time to develop; also, he did not have diabetes, which can complicate blood pressure health.

Fluid retention is a part of the pathophysiologic process in drug-resistant hypertension and end-stage renal disease, and the authors point out that in these four cases the body weight varied. For example, the authors discussed that the younger patient increased his weight in the 24 months after intravascular renal denervation, but this was due to an ability to retain body fat and not due to fluid retention.

This case series of four patients with end-stage renal disease undergoing dialysis while awaiting kidney transplantation, and who had hypertension unresponsive to medication, showed that by undergoing intravascular renal denervation there were primarily good outcomes, a low rate of complication, and improved control of ambulatory blood pressure monitoring. The authors stated that "although the outcome on the effects on blood pressure varied", this case series raised the important role of intravascular renal denervation in dialysis patients before and after kidney transplantation.

Summary

The renal system is a group of organs that have several important functions, which include forming, storing, and excreting urine. The renal system plays a vital role in maintaining homeostasis of the internal environment of the body. Chronic kidney disease can cause serious, long-term physical conditions and permanent harm, and is caused by irreversible damage to the kidneys that are clinically detected through abnormal test results and medical complications. The incidence of chronic kidney disease is affected by age, gender, and in certain racial groups.

The role of the CNA in caring for the dialysis patient has been discussed. The CNA has a primary role in the dialysis team and is often the principal person interfacing with the patient and family members during treatment and when they return home. There are basic health complications that could adversely affect dialysis outcomes and the long-term success of treatment, which involve factors unique to the patient's general health history and to the patient's environment both at home and at the dialysis center.