

Chronic Kidney Disease

By: Raymond Lengel, FNP, MSN, RN

Purpose: The purpose of this course is to provide an overview of chronic kidney disease including looking at its incidence, signs and symptoms, workup, complications and treatment options.

Objectives

- List the two most common causes of chronic kidney disease
- List five tests used in the evaluation of chronic kidney disease
- Discuss how to determine a patient's estimated glomerular filtration rate
- Demonstrate familiarity with three complications common in chronic kidney disease
- Discuss the treatment of hypertension in patients with chronic kidney disease
- List three indications for dialysis in chronic kidney disease

Introduction

The kidneys perform many functions that are critical to overall health. As the kidneys fail there is loss in many of these functions which can lead to many health problems, some of which being fatal. The kidneys are key players in balancing fluid, electrolytes and acid-base balance. The kidneys help the body excrete urea, creatinine, as well as many drugs and toxins. They are involved in the regulation and creation of hormones such as renin, erythropoietin and vitamin D.

Chronic kidney disease (CKD) is kidney damage or a reduced kidney filtration rate of less than 60 ml/min/1.73 m² for over three months. CKD can also be kidney damage for greater than or equal to 3 months with functional or structural abnormalities of the kidney with or without a reduced glomerular filtration rate (GFR) with either: pathological anomalies or markers of kidney damage such as abnormal renal imaging or protein in the urine (1). Acute

renal failure is now called acute renal injury and is defined as a rapid loss (less than three months) of kidney function that can result from a pre-renal, intra renal or post renal causes.

Chronic kidney disease can be broken down into five stages (one through five).

Individuals are placed in a category based on their GFR. The GFR is the best indicator of overall kidney function. The amount of GFR decrease helps clinicians classify CKD. Table one allows the clinician to place the patient in a stage of chronic kidney disease based on the GFR.

Table : Stages of Chronic Kidney Disease

Stage	Definition
Stage 1	Kidney damage with a normal or increased GFR
Stage 2	GFR 60-89 ml/min/1.73 m ²
Stage 3	GFR 30-59 ml/min/1.73 m ²
Stage 4	GFR 15-29 ml/min/1.73 m ²
Stage 5	GFR less than 15 ml/min/1.73 m ²

An estimated 20 million Americans have significantly reduced kidney function (2). CKD is under diagnosed and undertreated. It is important for clinicians to diagnose and manage CKD as this will improve quality of life and reduce progression of CKD, cardiovascular disease and death rates.

Death rates associated with CKD are high. Five year mortality rates of patients on dialysis are 35% (3). Cardiovascular disease is the leading cause of death in patients on dialysis. CKD also causes many health concerns. Individuals on dialysis have an average of two hospital admissions per year (3).

Race can have a profound impact on renal failure. Blacks are about 4 times more likely to have CKD than whites. In addition, blacks have a higher death rate than white patients at the same estimated GFR (3). The risk of CKD increases with age. The prevalence of CKD is much higher after the age of 60. Males and females are equally affected with CKD.

Pathophysiology

The normal kidney helps remove waste products and excess water from the blood – these products are excreted in the urine. Properly working kidneys require all of the parts of the kidney to work. This includes the arteries to the kidneys, the nephrons and the plumbing after the kidney. Any disease process before for kidney, in the kidney or after the kidney may lead to renal failure.

CKD develops due to damage to the kidneys. The functional unit of the kidney is the nephron. The nephron works to regulate fluid and electrolytes by filtering the blood, reabsorbing fluid and excreting urine. The average kidney has about one million nephrons. Nephrons are able to compensate when there is loss. When certain nephrons are destroyed other nephrons are able to maintain GFR. When the GFR drops 50% than the creatinine starts to rise.

To compensate the nephron hypertrophies and is able to hyperfiltrate. These adaptations may contribute to the progression of the renal failure possibly due to increased pressure within the capillary of the glomerulus. This may damage the capillary and lead to damage of the glomerulus.

Many other factors may contribute to progressive renal failure. Uncontrolled hypertension increases pressure in the kidney. Other cardiovascular risk factors are linked to progressive kidney damage including: increased cholesterol levels, smoking and abnormal blood glucose levels. Continued assault by nephrotoxic agents, such as certain medications (table 8), can lead to progressive kidney damage. Other factors that may propagate renal failure include:

protein in the urine, reduced nitrous oxide levels and elevated blood phosphorous levels with calcium phosphate deposition.

Causes

Determining the cause of the CKD is beyond the scope of this course. The two most common causes of renal failure are diabetes and hypertension. Table 2 discusses some other diseases that cause CKD. Clinical evaluation, the use of laboratory evaluation and selected diagnostic tests will help in determining the cause. In addition, checking the urine is a critical part in the evaluation of CKD and can help determine the cause.

Table : Causes of Chronic Renal Failure

Cause	Some Examples
Primary glomerular disease	Membranous nephropathy, immunoglobulin A nephropathy and minimal change disease
Secondary glomerular disease	Diabetes mellitus, hepatitis B & C, rheumatoid arthritis, post infectious glomerulonephritis, systemic lupus erythematosus, scleroderma and human immunodeficiency virus
Vascular disease	Renal artery stenosis, renal vein thrombosis and vasculitis
Urinary tract obstruction	Benign prostatic hypertrophy, tumors and urolithiasis
Tubulointerstitial disease	Some medications (sulfa drugs, allopurinol), multiple myeloma cast nephropathy, polycystic kidneys, infections and heavy metals

Complications

CKD is associated with many problems. Complications will be discussed throughout this course including how they are monitored for and how they are treated. Complications become much more common as CKD advances.

As CKD progresses into stage 4 and 5, hyperkalemia becomes more common. It is most common when the GFR is less than 25 ml/min, but can occur earlier especially in patients who take medications that increase potassium levels or eat diets high in potassium.

Aldosterone is a key hormone that helps regulate potassium. Individuals who have low aldosterone may also be at high risk for hyperkalemia. Low aldosterone levels may be noted in patients on aldosterone antagonists, angiotensin converting enzyme inhibitors, non steroidal anti inflammatory drugs or those with type IV renal tubular acidosis.

Metabolic acidosis can also occur in those with CKD. Acidosis becomes much more common when the GFR dips below 30 ml/min and becomes more common as the GFR falls further.

Other complications include: hypertension, edema, anemia, increased death rates, bone and mineral disease, nutritional compromise and a variety of neurological complications. Complications will be discussed more under the treatment section.

History and Physical Exam

Signs and symptoms are typically not noticed until later stages of CKD. Early stages (stage 1-3) of kidney disease do not cause symptoms. CKD is most commonly picked up with routine blood or urine tests. Currently, there is a bigger push for routine screening in those at high risk for CKD (table 4).

Symptoms are non-specific and develop slowly. When symptoms develop, typically in stage 4 and 5, they may include

- Malaise

- Fatigue
- Weakness
- Nausea/vomiting
- Swelling in the lower extremities
- Poor oral intake
- Metallic taste in the mouth
- Dry mouth
- Hiccups
- Itching
- Reduced concentration
- Restless legs
- Pericarditis (chest pain)
- Very advanced renal failure may lead to drowsiness, mental status changes, seizures and coma

Physical exam is often non-specific. Early CKD is not associated with many abnormal physical exam findings. As CKD advances complications of renal failure may be picked up.

Advanced renal failure may be associated with:

- Fluid in the lungs
- Peripheral edema
- Hypertension
- Cardiac arrhythmias
- Skin may be yellowish bronze and/or scaly and dry
- Bruising may be noted with petechiae, purpura or ecchymosis
- Brittle hair and fingernails may be noted

Laboratory Evaluation

Laboratory tests that help in the workup of CKD include:

1. Kidney function tests such as creatinine and blood urea nitrogen (BUN) will be elevated in CKD.
2. Electrolytes such as sodium, potassium, calcium, phosphorous should be assessed and managed as these are common electrolytes that are abnormal in CKD.
3. Bicarbonate is often low in CKD.
4. Complete blood count should be evaluated for anemia and platelet counts.
5. Serum albumin may be low in patients who are losing protein in the urine or those with malnutrition.
6. Urine and urine sediment analysis may detect protein in the urine, red blood cells, red blood cell casts, white blood cells or bacterial and can help determine the underlying cause of CKD.
7. The urine should be checked for protein-to-creatinine ratio to help estimate how much protein is in the urine. Protein in the urine is an important marker of kidney disease.
8. A lipid profile is done partly because CKD patients are at high risk of cardiovascular disease.
9. More specific tests to determine the underlying etiology may be done in select patients (see table 3).

Table : Less Common Tests in the Evaluation of Chronic Kidney Disease

Test	Disease it Might Pick up
Serum and urine protein electrophoresis	Multiple myeloma
Anti-glomerular basement membrane antibodies (anti-GBM)	Goodpasture syndrome
Serum complement levels	Glomerulonephritides
Antinuclear antibodies or double-stranded DNA antibody	Systemic lupus erythematosus
C-ANCA and P-ANCA	Wegener granulomatosis or polyarteritis nodosa
Hepatitis panel	Hepatitis B or C
HIV screen	HIV

The use of the Cockcroft-Gault formula or the Modification of Diet in Renal Disease equation for estimating glomerular filtration rate is becoming a standard of care in patients with chronic kidney disease. Many websites offer calculator to help clinicians find the estimated GFR. The GFR provides an approximation of the function of the nephrons and can be used to monitor kidney function. Websites are available to determine GFR at

<http://www.nephron.com/cgi-bin/CGSI.cgi> and

http://www.kidney.org/professionals/kdoqi/gfr_calculator.cfm .

The use of these formulas are accurate in the measurement of GFR. Certain individuals require the use of 24-hour urine collection for the estimation of GFR. Individuals who require this include those who have significant muscle mass abnormalities such as body builders or those with muscle wasting or malnutrition, those who consume creatine supplements, those

who eat a vegetarian diet, the very young and the very old, pregnancy and those who have had an amputation.

Tracking the GFR overtime helps the clinician determine if the kidney function is improving, worsening or remaining stable.

Testing for protein in the urine is another key factor in the evaluation and monitoring of someone with CKD. Most individuals do fine with a spot urine sample, which should ideally be collected in the morning. Collecting 24 hours worth of urine to test for protein is not necessary in most situation. Dipsticks are available to help clinicians detect protein and/or albumin. Patients who have protein that is detectable on dipstick should have a quantitative measure of urinary protein within 3 months (1). When there have been two or more quantifiable tests for protein in the urine that have been spaced out by 1-2 weeks, persistent proteinuria is present. This is indicative of more severe CKD.

Limited imaging tests are considered in the face of CKD (3). An abdominal x-ray is helpful if there are any radio-opaque stones or nephrocalcinosis.

A common test in CKD is the renal ultrasound. The renal ultrasound can pick up many abnormalities. A renal ultrasound may show:

- Obstructions in the urinary tract such as kidney stones
- Small kidneys which are seen in advanced renal failure
- Cysts or polycystic kidney disease
- Tumors or fibrosis in the retroperitoneum

If cancer or another mass is suspected than a computed tomography (CT) scan is a more sensitive test than the renal ultrasound. In addition, CT scans are the most sensitive test for picking up renal stones. CT scans should be avoided with IV contrast in those with significant CKD as this increases the risk of acute renal failure. Those with significant CKD may require

the use of magnetic resonance imaging (MRI). Magnetic resonance angiography or renal arteriography are the best choices if renal artery stenosis is suspected.

In some instances the use of a renal biopsy is considered. Analyzing tissues helps determine abnormalities of the kidney. Renal biopsy is not done in every case of renal failure, but can be useful when there is advancing renal failure in the face of an unknown cause. Bleeding is the major complication associated with renal biopsy.

Screening

Because CKD is under diagnosed, it is important for clinicians to screen patients. High risk patients should be screened. Anyone over the age of 18 with any of the risk factors in table 4 should be screened. Anyone over the age of 60 years-old is considered high risk and should be screened.

Table : Risk Factors for Chronic Kidney Disease

- Hypertension
- Diabetes
- Recurrent urinary tract infections or urinary obstruction
- Family history of chronic kidney disease
- Past medical history of vasculitis, systemic lupus erythematosus or other autoimmune disease

Screening has the advantage of detecting CKD early so it can be monitored, other risk factors optimized and complications treated. Screening involves a blood test for kidney function and urine samples for protein or albumin. Protein in the urine may occur before changes in the GFR are noted.

Treatment

Management of CKD involves a combination of monitoring, controlling symptoms, slowing progression of the disease, treating risk factors, managing and treated complications and evaluation for renal replacement therapy. Below multiple steps critical in the management of CKD.

Identify and Treat Underlying Causes

Treating the underlying cause of CKD is one of the first considerations in the management of CKD. For example, if the CKD is caused by diabetes and/or hypertension aggressively managing these two conditions will help slow down the CKD. Working up the patient as discussed above will help determine the etiology of the disease and help the clinician manage the disease properly.

Routinely see Patients to Monitor their Disease

Monitoring is a critical aspect in the treatment of patients with CKD. Routine follow up with the primary care provider or nephrologist to evaluate laboratory work and clinical measures is critical. Anyone who has a GFR below 60 ml/min should be regularly evaluated for anemia, bone disease, electrolyte disturbance, acid-based disturbance and nutritional status. The GFR should be checked annually, and more frequently in those with stage 3, 4 or 5 CKD.

Consider Referral to a Nephrologist

With the increased prevalence of CKD, more and more patients will be managed by their primary care provider. Some patients do warrant referral to a nephrologist (see table 5)

Table : Reasons to Refer to a Nephrologist

- Unclear cause of CKD
- Rapid progression
- Acute on chronic renal failure
- Need for biopsy
- Stage 3, 4 or 5 CKD

Early referral helps the primary doctor manage complications, educate the patient about renal replacement therapy and research has shown early referral reduces mortality (4).

Manage Hypertension

Hypertension can be a cause and/or complication of CKD. When hypertension is first diagnosed it should be aggressively treated to prevent progression to CKD. Target blood pressure should be less than 130/80 mm Hg. Ideally blood pressure should be managed with an angiotensin converting enzyme inhibitor (ACEI) or an angiotensin receptor blocker (ARB). These agents help protect the kidney and may help slow kidney failure and proteinuria.

Two concern with ACEIs and ARBs are their risk for hyperkalemia and progressive renal failure. Monitoring for and treating these complications can be life preserving.

ACEIs and ARBs can cause an initial increase in the creatinine which can be alarming to the clinician. If a small rise is noted in the creatinine the clinician should recheck the level in 1-2 weeks and monitor closely. If the rise in creatinine does not stabilize or worsens the medication may need to be discontinued.

Manage Acid-Base Disorders

Acid base disorders are common in those with CKD. Screening for metabolic acidosis should start when the GFR dips below 60 ml/min, but metabolic acidosis becomes more

common when the GFR dips below 30 ml/min. Screening should occur every 12 months in those with GFRs between 30-59 ml/min and every three months in those with GFRs below 30 ml/min

The use of bicarbonate supplements may help preserve kidney function. Those who take a bicarbonate supplement have a slower decline in creatinine clearance. Evidence also suggests that there is improved nutritional parameters in those who take bicarbonate supplements (3). The goal is to maintain a CO₂ at or above 22 mEq/L (2).

Monitor for Congestive Heart Failure

Congestive heart failure can occur as kidney failure enters into late stage 4 and stage 5. The failing kidney has a reduced ability to excrete salt and water and retention of sodium and fluid leads to peripheral as well as pulmonary edema.

Monitor for and Manage Anemia

Anemia can occur as the failing kidney has a reduced synthesis of erythropoietin (a hormone needed for making red blood cells). The red blood cell also suffers a reduced survival time. Bleeding risk is increased in advanced CKD, due to platelet dysfunction secondary to uremia, which further contributes to anemia.

Routine evaluation of blood counts will help monitor for anemia. Anyone with a GFR of less than 60 ml/min should be evaluated for anemia. When anemia is detected it is important to check iron stores and replace as needed. The use of erythropoietin may be indicated in advanced CKD with a goal of maintaining a hemoglobin between 11-12 g/dl.

Caution must be used in the treatment of anemia. When levels are corrected to above 13 g/dl there is an increased risk for cardiovascular events (4).

Monitor for and Manage Bone and Mineral Metabolism

Bone and mineral metabolism abnormalities are another common complication of advanced CKD. Anyone with stage 3, 4 or 5 CKD should be evaluated for bone disease and calcium/phosphorus disturbances.

Bone/mineral diseases related to CKD can lead to many problems including bone pain and increased risk of fractures. Abnormal calcification, due to mineral metabolism abnormalities, of the blood vessel may partially account for the increase in cardiovascular disease rates in CKD.

When patients have progressed to stage 3 or 4 CKD, evaluation and treatment of secondary hyperparathyroidism, low calcium and increased phosphorus levels becomes important. Treatment of elevated phosphorus includes implementing a low phosphorus diet (table 6), the use of phosphate binders and vitamin D supplementation (4). Treatment of hyperparathyroidism includes the use of vitamin D analogs or calcitriol. Low calcium in the blood is treated with calcium supplements or calcitriol (3).

Table : Foods High in Phosphorous

- Beef
- Yogurt
- Eggs
- Cheese - mozzarella
- Milk
- Soda pop
- Poultry – turkey, chicken
- Nuts and seeds – almonds, peanuts
- Fish and seafood – salmon, halibut
- Wild game
- Dried beans and peas

Table : Foods High in Potassium

- Cantaloupe
- Bananas
- Oranges
- Apricots
- Strawberries
- Potatoes
- Tomatoes
- Cucumbers
- Cabbage
- Cauliflower
- Bell peppers
- Eggplant
- Squash
- Spinach
- Broccoli
- Fish – Tuna and Halibut

Manage Electrolyte Disturbances

The kidneys are responsible for keeping many electrolytes in balance. Routine evaluation of electrolytes is important to assure normal levels. The evaluation and treatment of calcium and phosphorus were discussed in the above section.

Hyperkalemia is a common problem in those with renal failure. It typically occurs as CKD advances into stage 4 and 5. It is more common in those with diabetes or those with type IV

renal tubular acidosis. Patients should be taught which foods increase the risk for elevated potassium levels (see table 7). Many foods with high potassium levels are among the fruit and vegetable class. These foods should not be avoided completely, but foods high in potassium should not be consumed in high quantities.

Many medications have the potential to increase serum potassium levels in those with CKD including: angiotensin converting enzyme inhibitors, angiotensin receptor blockers, aldosterone antagonists (spironolactone) and non-steroidal anti-inflammatory drugs.

Monitor for and Treat Urinary Protein

The amount of protein in the urine should be monitored in patients with CKD. The ratio of protein or albumin to creatinine in urine samples should be evaluated in all patients with CKD (1). The use of ACEI and ARBs are helpful in reducing the amount of protein in the urine.

Optimize the Diet

Malnutrition – particularly protein energy malnutrition - is a common complication of CKD. Anyone with a GFR below 60 ml/min should be evaluated by a registered dietitian for energy intake, nutritional status, consumption of potassium and phosphorous and protein intake. When the GFR dips to 20 ml/min there should be more aggressive monitoring of nutritional status. Measures that should be looked at include: serum albumin, body weight and dietary interviews (1).

Patients should be taught to maintain a low phosphorus diet starting early in the course of renal failure (see table 6 for foods high in phosphorus). As renal disease advances restricting potassium becomes more important (see table 7 for foods high in potassium). Eating a diet low in sodium will help avoid volume overload.

The amount of protein in the diet has become a question of debate over the last number of years. Patients who are not undergoing dialysis who have a GFR of less than 25 ml/min should maintain a diet consisting of 0.60 grams of protein per kilogram per day. This level

may be increased to 0.75 grams of protein per kilogram per day in a patient who cannot maintain enough weight or refuses such a low protein diet (1).

To prevent weight loss and malnutrition, eating an adequate number of calories is important. Patients with CKD who are not being treated with dialysis should consume 35 calories per kilogram per day if under 60 years old and 30-35 calories per kilogram per day in those who are over 60 (1).

More research will need to define the exact role of protein in CKD. High protein diets worsen kidney function and may damage the glomerulus, but studies have shown no benefits of a low protein diet (4). In addition, low protein diets increase the risk of malnutrition.

Control Cardiovascular Risk Factors

Part of the treatment of CKD involves the treatment of cardiovascular risk factors. Cardiovascular disease is the number one cause of death in patients with CKD and controlling risk factors is an important step in the prevention of mortality. In addition, optimizing cardiovascular function improves renal function (4). Cardiovascular risk factors include: hypertension, hyperlipidemia, physical inactivity and tobacco use.

In CKD, blood pressure should be treated to less than 130/80 mm Hg or ideally 120/80 mm Hg. The use of ACEIs or ARBs are the ideal treatment in someone with CKD as they provide protection to the kidney, slow progression to overt nephropathy and reduce the rates of cardiovascular death, heart attacks and strokes (1).

Optimizing lipid levels is another important step in the management to CKD. Standard lipid levels that are evaluated include low density lipoproteins (LDL), high density lipoproteins (HDL) and triglycerides. Ideally LDL cholesterol should be below 100 mg/dl, HDL should be above 60 mg/dl and triglycerides should be below 150 mg/dl.

Statins – a popular cholesterol lowering medication – are good agents in the management of dyslipidemia. In addition to controlling lipid levels, the statins may have the extra benefit of

slowing GFR decline (4). Examples of statins include: atorvastatin (Lipitor), simvastatin (Zocor) and pravastatin (Pravachol).

All patients, especially those with CKD, should be encouraged to cease smoking. Smokers are more likely to progress to end stage renal disease sooner than non-smokers (3). Regular exercise will reduce the risk cardiovascular disease and improve functional well-being.

Avoid Nephrotoxic Agents

Patients with CKD need to be taught which medications are toxic to the kidneys. Some over-the-counter medications are nephrotoxic and should be avoided in those with CKD. In addition to avoiding over-the-counter medications, some prescription medications are nephrotoxic and need to be avoided. Patients should be given a list of agents that are nephrotoxic (see table 8).

Table : Nephrotoxic Agents

- Non steroidal anti-inflammatory drugs [ibuprofen (Advil, Motrin), naproxen (Aleve) and celecoxib (Celebrex)]
- Aminoglycoside antibiotics
- Intravenous contrast gadolinium
- Intravenous radiocontrast

Monitor for Other Complications

Advanced renal disease can be complicated by life threatening complications. Pericarditis is an inflammation of the fibrous sac around the heart, which can lead to cardiac tamponade and death. Uremic encephalopathy may present with memory loss, reduced concentration, fatigue, insomnia, psychosis, depression, stupor or coma and also has the potential to be fatal.

Other neurological complications can be seen in CKD. Routine evaluation of neurological disease is not recommended, but patients who have signs or symptoms suggestive of neurological disease warrant evaluation. Common neurological conditions that may be seen in patients with CKD include: restless leg syndrome, peripheral neuropathy and autonomic dysfunction.

It is unclear the exact mechanism as to why CKD leads to neurological conditions. It is thought that high levels of creatinine, parathyroid hormone and urea may damage nerves.

Evaluate for Renal Replacement Therapies

Some patients with chronic renal failure will remain stable with good medical care, but others will progress on to end stage renal disease (ESRD). Those who go on to ESRD will need to consider renal replacement therapy. Options include hemodialysis, peritoneal dialysis or kidney transplant.

The absolute level of creatinine is not a pure indicator of the need for dialysis. Certain factors require urgent dialysis such as: pericarditis, pleuritis, fluid overload that is not responsive to diuretics, persistent hyperkalemia, metabolic acidosis, significant refractory hypercalcemia or hyperphosphatemia, progressive uremia with encephalopathy or neuropathy and refractory hypertension (2,3,4).

In chronic renal failure, nephrologists typically do not wait for one of these urgent complications to arise. Dialysis is often started in those when slowly progressive renal failure becomes severe and complications become difficult to manage with medical therapy.

Early in the disease process it is important for health care providers to discuss the natural course of the disease, so patients are aware that there is a possibility of the future need for renal replacement therapy. Preparing for renal replacement therapy also includes placement of vascular access in a timely manner. Those who opt to have hemodialysis need to have surgical placement of an arteriovenous fistula 6 months before dialysis.

Peritoneal dialysis (PD) uses the peritoneum (the membrane that covers the abdominal organs and lines the abdomen) as a membrane to dialyze fluids, electrolytes, albumin, urea and glucose from the blood. PD involves infusing a fluid through a catheter into the peritoneal space. The fluid is left in the abdomen for a period of time to allow waste products from the blood to pass into the fluid and then the dialysate is drained.

It can be performed with less complex equipment than hemodialysis (HD) and can be performed at home with some training. It is not linked to blood loss and is not associated with major strain on the cardiovascular system. It provides maximal independence as the exchanges can be done at night to allow the patients less interruptions in daily living. PD is associated with a lower infection rate than HD.

PD does not clear urea as well as hemodialysis. It is also associated with a risk of peritonitis and repeated bouts of peritonitis may lead to scarring and make future treatment with PD not possible. It is also associated with more protein loss in some individuals. For other complications see table 9.

Hemodialysis is typically done three times a week and requires 3-5 hours per treatment. The implementation of HD is like having a part time job. While treatment time is actually less than PD, it requires treatment by trained professional and needs to be done in a health care setting during business hours and consequently interrupts life more than PD, as PD is often done while the patient sleeps. In the acute setting, HD provides quicker corrections of renal complications than PD.

Table : Complications of Dialysis by Type

Peritoneal Dialysis	Hemodialysis
<ul style="list-style-type: none">• Peritonitis• Catheter site infection• Pneumonia• Atelectasis• Shortness of breath• Protein loss• Abdominal pain• Anorexia• Abdominal hernia	<ul style="list-style-type: none">• Sepsis• Itching• Pain• Air embolism• Electrolyte imbalance• Hepatitis• Hypotension/Hypertension• Headache• Leg cramps• Nausea and vomiting

Case Study

A 62-year-old white female presents to her primary care doctor for a routine annual physical exam. The exam is unremarkable except for a slightly elevated blood pressure at 138/88 mm Hg. This patient is a 5' 4" and weighs 138 pounds.

The next week her doctor calls and asks her to see a nephrologist to be evaluated for chronic kidney disease and starts the patient on a low dose of an ACEI, lisinopril. The patient has already reviewed her labs on-line and noticed that everything was in the normal range including her kidney function (creatinine 1.5 mg/dl) and is very confused as to why her doctor wants her to go see a kidney specialist. The doctor explains that while her labs look normal on the report (based on the range given on the lab report) her estimated glomerular filtration rate given her age and gender is 37 ml/min. This places her in stage 3 CKD.

The nephrologist requests that the PCP perform a cardiac workup including an electrocardiogram and echocardiogram. The nephrologist orders a repeat of the kidney function, a complete blood count, electrolytes, a calcium and phosphorous level, lipid panel, vitamin D level and a PTH.

Here some selected lab results

Serum creatinine – 1.7 mg/dl
Blood urea nitrogen – 28 mg/dl
Serum potassium – 4.4 mEq/dl
Serum glucose (fasting) – 88 mg/dl
Serum sodium – 136 mEq/dl
Hemoglobin – 10.8 g/dl
Serum ferritin - 58
Total cholesterol – 198 mg/dl
Low density lipoproteins – 126 mg/dl
Serum calcium – 9.8 mg/dl
Serum phosphorous - 4.1 mg/dl
Serum vitamin D – 15 ng/dl
Parathyroid hormone – 50 pg/ml

The nephrologist wants to see the patient back in 6 months and encourages that he and the primary care provider work together to co-manage her CKD.

The nephrologist spent 10 minutes discussing with the patient the importance of lifestyle modifications to help improve the quality and quantity of her life. She was encouraged to exercise, not use tobacco products, maintain and healthy weight and he referred her to a dietitian.

The dietitian provided a full evaluation and taught about the importance of a renal diet. The patient was given lists of foods that are high in potassium, phosphorous and sodium and told not to consume large quantities of these foods. She is taught about protein, but no specific limit was placed on the protein level. She and the dietitian discussed the future need to limit protein in the diet if there is any worsening of the renal failure.

The nephrologist increased the lisinopril to control her blood pressure to less than 120/80 mm Hg. He also added simvastatin to drive the low density lipoprotein to less than 100 mg/dl.

Over a period of six months the nephrologist and primary care provider work to get the patient's blood pressure to 116/72 mm Hg on a combination of lisinopril 40 mg and hydrochlorothiazide 12.5 mg.

Over the next year, the total cholesterol was lowered to 156 mg/dl and the low density lipoprotein level is decreased to 94 mg/dl. This was accomplished with a combination of lifestyle interventions and simvastatin.

Over the course of five years her serum phosphorous levels rise and her nephrologist placed her on phosphate binding agents. She was unable to tolerate these agents but works very hard with the dietitian to avoid foods high in phosphorous to keep her phosphorous levels in the normal range. Her parathyroid hormone level and calcium level remain stable, but are closely monitored.

The patient is started on iron supplementation as her iron stores (serum ferritin) are low with a minimally reduced hemoglobin. As her iron stores normalize her hemoglobin counts normalize. She is checked each year for anemia to evaluate the need for further intervention in regard to treatment of anemia.

She is started on vitamin D supplementation of 50,000 IU once a week for 8 weeks and the recheck on the vitamin D level is increased to 33 ng/dl.

This patient was aggressively managed including monitoring her kidney function, managing her cardiovascular risk factors and her CKD complications. Her kidney function slowly declined, but likely at a much slower rate due to her aggressive management.

Nurse's Role

The nurse's role in the management of the patient with CKD includes monitoring and teaching. Nurses need to encourage their patients to be diligent about their follow up appointments. Follow up appointments are critical in the management of risk factors and monitoring for any complications.

Nurses also need to encourage patients to comply with lifestyle factors that are associated with improved renal function.

Nurses are set up in key positions to assess functional capacity of patients with CKD and help them improve the quality of their life. The National Kidney Foundation (2) recommends that everyone with a GFR below 60 ml/min should have routine assessment for functional impairment and for their well being.

CKD is a chronic disease and as the population ages its prevalence will increase. Some patients will have a slow decline and other will decline rapidly. Nurses need to take the lead in helping manage and monitor CKD.

Helpful links

National Institute of Diabetes and Digestive and Kidney Disease – www.niddk.nih.gov

National Kidney Foundation – www.kidney.org

American Kidney Fund – www.kidneyfund.org

American Association of Kidney Patients – www.aakp.org

References

1. National Kidney Foundation. *KDOQI Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification, and Stratification*. 2002. (cited 2010 May 2). Available from: http://www.kidney.org/professionals/kdoqi/guidelines_ckd/toc.htm
2. National Kidney and Urologic Diseases Information Clearinghouse. *Chronic Kidney Disease: A Family Affair*. 2005. (cited 2010 May 5). Available from: URL: <http://kidney.niddk.nih.gov/kudiseases/pubs/chronickidneydiseases/>
3. Arora P & Verrelli M. *Chronic Renal Failure*. 2010. (cited 2010 May 1). Available from: URL: <http://emedicine.medscape.com/article/238798-print>
4. Radbill BD. *Chronic Kidney Disease: The Role of the Internist*. 2009. (cited 2010 May 3). Available from URL: <http://www.audio-digest.com>