CHRONIC KIDNEY DISEASE

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ABSTRACT

The care of individuals with chronic kidney disease includes a complete physical assessment, health screening to aid in the diagnosis of a disease process and development of a holistic health plan throughout the course of the disease. When kidney disease becomes chronic there are unique and often challenging aspects to care that can develop, including dietary and lifestyle changes, the use of pharmaceutical agents, dialysis and surgical interventions. Patients and families require ongoing support and education about what to anticipate throughout the course of a chronic disease and the treatment plan. The biopsychosocial aspects of having a diagnosis of chronic kidney disease require health teams to adopt an integrated, holistic, approach to caring for individuals and families faced with kidney disease.
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Policy Statement
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Continuing Education Credit Designation
This educational activity is credited for 2 hours. Nurses may only claim credit commensurate with the credit awarded for completion of this course activity.

Statement of Learning Need
Nurses are active participants in the disease management and education of patients and families dealing with chronic kidney disease. The progression of kidney disease often involves other disease processes, such as diabetes and hypertension. Early identification of and educating individuals about chronic kidney disease management and treatment options improves outcomes.

Course Purpose
This course will provide nurses with an overview of chronic kidney disease, including its incidence, signs and symptoms, clinical workup, complications, and treatment options.
Target Audience
Advanced Practice Registered Nurses and Registered Nurses
(Interdisciplinary Health Team Members, including Vocational Nurses and Medical Assistants may obtain a Certificate of Completion)

Course Author & Planning Team Conflict of Interest Disclosures
Dana Bartlett, RN, BSN, MSN, MA; William S. Cook, PhD; Douglas Lawrence, MA;
Susan DePasquale, MSN, FPMHNP – all have no disclosures.

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Please take time to complete a self-assessment of knowledge, on page 4, sample questions before reading the article.

Opportunity to complete a self-assessment of knowledge learned will be provided at the end of the course.
1) Which laboratory test is LEAST helpful in the initial evaluation of a patient with chronic kidney disease (CKD)?
   a. Serum creatinine
   b. Blood urea nitrogen
   c. Serum potassium
   d. Liver function tests

2) Which are the most common symptoms present in stage 3 chronic kidney disease?
   a. Itching
   b. Low back pain
   c. Shortness of breath
   d. None of the above

3) CKD is staged using which of the laboratory tests?
   a. Renal ultrasound
   b. CBC
   c. GFR
   d. Serum creatinine

4) African Americans have a higher incidence of CKD than white Americans.
   a. True
   b. False

5) The two most common causes of CKD are:
   a. Hypertension and hepatitis C
   b. Diabetes and thyroid disease
   c. Diabetes and hypertension
   d. Atherosclerosis and urinary tract infection
Introduction

The kidneys perform many functions that are critical to overall health. Kidney failure can lead to many health problems, many of them serious and some fatal. The kidneys are key players in balancing fluid, electrolytes and acid-base status. The kidneys help the body excrete urea, creatinine, and 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.¹² 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 pre-renal, intra-renal, or post-renal causes.

Chronic kidney disease can be broken down into six stages. Individuals are placed in a category based on their GFR. The GFR is the best indicator of overall kidney function, and GFR is used to classify CKD. Table one allows the clinician to place the patient in a stage of chronic kidney disease based on the GFR.

The GFR is a calculated measurement of how well the kidneys are functioning, specifically how much filtrate is passing through the kidney tubules. It is estimated using the patient’s age, body weight, gender, race, and the serum creatinine. The result is expressed in mL/min/body surface area.
Table 1: Stages of Chronic Kidney Disease

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Kidney damage with a normal or increased GFR</td>
</tr>
<tr>
<td>Stage 2</td>
<td>GFR 60-89 ml/min/1.73 m²</td>
</tr>
<tr>
<td>Stage 3a</td>
<td>GFR 45-59 ml/min/1.73 m²</td>
</tr>
<tr>
<td>Stage 3b</td>
<td>GFR 30-44 ml/min/1.73 m²</td>
</tr>
<tr>
<td>Stage 4</td>
<td>GFR 15-29 ml/min/1.73 m²</td>
</tr>
<tr>
<td>Stage 5</td>
<td>GFR less than 15 ml/min/1.73 m²</td>
</tr>
</tbody>
</table>

An estimated 20 million Americans have significantly reduced kidney function. 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%. 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.

Racial background can have a profound impact on renal failure. African Americans are about 4 times more likely to have CKD than Caucasians, and African Americans have a higher incidence of end-stage renal disease at all levels of GFR. In addition, the onset of CKD is earlier and the progression of CKD is more rapid for African Americans than it is for Caucasian Americans. 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 by filtering them through the nephrons and excreting them in the urine. In order for the kidneys to do this, the renal vascular supply, renal parenchyma, and the ureters must all be functioning properly, and any pre-renal, renal, or post-renal disease process can lead to kidney damage and/or kidney failure.

CKD develops due to damage to the functional units of the kidneys, the nephrons. 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 and maintain the GFR when certain nephrons are destroyed. However, if enough of the nephrons are damaged and the GFR is decreased by 50% then serum creatinine will start to rise.

To compensate, the remaining healthy nephrons hypertrophy and begin to hyperfiltrate. These adaptations can help maintain kidney function. But they also 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 and metabolic risk factors are linked to progressive kidney damage including: increased cholesterol levels, smoking, and abnormal blood glucose levels. Continued use of nephrotoxic agents such as certain medications (see: Table 8) can also 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

Discussing all of the causes of CKD is beyond the scope of this course. The two most common causes of renal failure are diabetes and hypertension.\textsuperscript{7-9} Table 2 outlines some other diseases that cause CKD. Clinical evaluation and the use of laboratory and selected diagnostic tests are used to determine the cause of CKD. Urine analysis is a critical part of the evaluation of CKD and can help determine the cause.

**Table 2: Causes of Chronic Renal Failure**

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

Complications

Chronic kidney disease is associated with many complications, and the monitoring and treatment of these complications will be discussed throughout this course. 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 patients who have type IV renal tubular acidosis.

Metabolic acidosis is another complication of 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, peripheral edema, anemia, increased death rates, bone and mineral disease, nutritional compromise, and a variety of neurological complications.

**History and Physical Exam**

Signs and symptoms are typically not noticed until later stages of CKD, and, in stages 1-3, kidney disease does not cause symptoms. CKD is most commonly detected by a routine blood or urine test. Routine screening for the detection of CKD in patients at risk is strongly recommended (see: Table 4).⁹

The symptoms of CKD are non-specific and develop slowly. When symptoms develop, typically in stage 4 and 5, they may include:⁵

- 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)
• In advanced renal failure patients may have drowsiness, mental status changes, seizures and coma

The physical exam is often non-specific, especially in early cases of CKD. As CKD advances, signs and symptoms of serious complications may be noticed.

• 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 used for the detection and evaluation of CKD include:

1. Kidney function tests: The serum creatinine and blood urea nitrogen (BUN) will be elevated in CKD.
2. Sodium, potassium, calcium, phosphorous should be assessed as levels of these often are abnormal in patients who have CKD.
3. Bicarbonate is often low in CKD.
4. Complete blood count: Anemia and platelet dysfunction are common.
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, red blood cells, red blood cell casts, white blood cells, or bacteria, and an examination of the urine 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 should be done: CKD patients are at high risk for the development of cardiovascular disease.

9. More specific tests to determine the underlying etiology may be done in select patients (see: table 3).

Table 3: Less Common Tests in the Evaluation of Chronic Kidney Disease

<table>
<thead>
<tr>
<th>Test</th>
<th>Disease it Might Pick up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum and urine protein electrophoresis</td>
<td>Multiple myeloma</td>
</tr>
<tr>
<td>Anti-glomerular basement membrane antibodies</td>
<td>Goodpasture syndrome</td>
</tr>
<tr>
<td>Serum complement levels</td>
<td>Glomerulonephritides</td>
</tr>
<tr>
<td>Antinuclear antibodies or double-stranded DNA antibody</td>
<td>Systemic lupus erythematosus</td>
</tr>
<tr>
<td>C-ANCA and P-ANCA</td>
<td>Wegener granulomatosis or polyarteritis nodosa</td>
</tr>
<tr>
<td>Hepatitis panel</td>
<td>Hepatitis B or C</td>
</tr>
<tr>
<td>HIV screen</td>
<td>HIV</td>
</tr>
</tbody>
</table>

The use of the Cockcroft-Gault formula or the Modification of Diet in Renal Disease equation for estimating GFR is becoming a standard of care in patients with chronic kidney disease.\textsuperscript{10,11} Several websites offer a calculator to help clinicians measure the estimated GFR. The GFR provides an approximation of the function of the nephrons and kidney health. The GFR is also used to monitor kidney function, and tracking the GFR over time helps the clinician determine if the kidney function is improving, worsening, or remaining stable. Websites with GFR calculators include:

- http://.nephron.com/cgi-bin/mdrd/cgi.

The use of these formulas can accurately measure 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 (i.e., body
builders), patients who have muscle wasting or malnutrition, people who consume creatine supplements or a vegetarian diet, the very young and the very old, women who are pregnant, or people who have had amputations.

Testing for protein in the urine is another key factor in the evaluation and monitoring of someone with CKD. For most patients, this can be done by collecting a spot urine sample and, ideally, this should be collected in the morning. Collecting a 24-hour urine sample to test for protein is not necessary in most situations. 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. When there have been two or more quantifiable tests for protein in the urine, separated by 1-2 weeks, proteinuria is present. Proteinuria is indicative of more severe CKD.

Limited imaging tests are considered for diagnosing/evaluating CKD. An abdominal X-ray can detect kidney stones or nephrocalcinosis. A renal ultrasound can detect many structural abnormalities, such as:

- Obstructions in the urinary tract such as kidney stones
- Small kidneys
- Cysts or polycystic kidney disease
- Tumors or fibrosis in the retroperitoneum

If cancer or another mass is suspected then a computed tomography (CT) scan should be done. The CT scan is a more sensitive test than the renal ultrasound, especially for detecting kidney stones. CT scans with IV contrast should not be used for patients with significant CKD as the contrast can cause acute renal failure. Patients who have 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 and an unknown cause.

**Screening**

Because CKD is under-diagnosed the process of screening is very important, especially for high-risk patients. Anyone over the age of 18 with any of the risk factors (see: Table 4) should be screened. Anyone over the age of 60 is considered high-risk and should be screened.

**Table 4: 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 that it can be monitored, the risk factors modified, 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 treating complications and evaluation for renal replacement therapy.
Identify and Treat Underlying Causes

Treating the underlying cause of CKD is one of the first considerations in the management of CKD. If the CKD is caused by diabetes and/or hypertension, aggressively managing these two conditions will help slow down the progression of CKD.

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, cardiovascular disease, electrolyte disturbance, acid-base disturbances, 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 there will be more patients being managed by their primary care provider. Some patients do warrant referral to a nephrologist. (see: Table 5)

Table 5: 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 may help reduce mortality.
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. The optimal blood pressure level in hypertensive patients with chronic kidney disease is not entirely clear, but loss of GFR appears to worsen if the mean arterial pressure is ≥ 100 mmHg. In patients with proteinuric chronic kidney disease the blood pressure should be maintained at < 130/80 mmHg and in patients with non-proteinuric chronic kidney disease the blood pressure should be maintained at < 140/90 mmHg. 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 concerns with ACEIs and ARBs are the risk for hyperkalemia and progressive renal failure. Monitoring for and treating these complications can be life preserving. ACEIs and ARBs can also cause an initial increase in the creatinine. 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 or sodium citrate, 0.5-1.0 mEq/kg/day may help preserve kidney function, and people who take a bicarbonate supplement
or citrate have a slower decline in creatinine clearance. The goal is to maintain a CO₂ between 23-29 mEq/L.¹³

**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 in CKD for three reasons. First, the failing kidney has a reduced ability to synthesize erythropoietin, a hormone needed for making red blood cells. Second, red blood cell survival time is decreased. Finally, CKD also causes platelet dysfunction, increasing the risk of bleeding.

The hemoglobin level should be measured if the GFR is < 60 ml/min/1.73 m² or if there is a clinical indication to do so; the hemoglobin should be measured at least annually if the GFR is 30-59 ml/min/1.73 m²; the hemoglobin should be measured at least twice a year if the GFR is < 30 ml/min/1.73 m².¹⁴ When anemia is detected it is important to check iron stores and replace as needed. Erythropoietin can be used to treat anemia caused by CKD, but the hemoglobin should not be increased to > 11.5 g/dl.¹⁴ When levels are over-corrected, the risk for cardiovascular events is increased.

**Monitor for and Manage Bone and Mineral Metabolism**

Bone and mineral metabolism abnormalities are another common complication of advanced CKD.⁸,¹⁴ 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 serum phosphorus levels becomes important. Treatment of elevated phosphorus includes implementing a low phosphorus diet (see: Table 6), the use of phosphate binders and vitamin D supplementation. Treatment of hyperparathyroidism includes the use of vitamin D analogs or calcitriol. Low calcium in the blood is treated with calcium supplements or calcitriol.

Table 6: 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 7: 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 fruits and vegetables are high in potassium. These foods should not be avoided completely, but patients should be given guidelines for how much is safe to eat.
Many medications have the potential to increase serum potassium levels in those with CKD including: ACEIs, ARBs, aldosterone antagonists (spironolactone), and non-steroidal anti-inflammatories such as ibuprofen.

**Monitor for and Treat Urinary Protein**

The amount of protein in the urine should be monitored in patients with CKD because increases in the level of urine protein are associated with a faster rate of decline in kidney function.\(^\text{14}\) The ratio of protein or albumin to creatinine in urine samples should be evaluated in all patients with CKD.\(^\text{9}\) The use of ACEIs 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: measurement/monitoring of serum albumin and body weight and dietary interviews.\(^\text{14}\)

Patients should be taught early in the course of renal failure to maintain a low phosphorus diet (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 that can be safely consumed by patients who have CKD is an unresolved issue, but there are some guidelines. Patients who have diabetes or patients who do *not* have diabetes but have a GFR of <30 ml/min/ 1.73 m\(^2\) should consume no more than 0.8 grams of protein per kg of body weight a day.\(^\text{14}\) Adults who have CKD and are at high risk for progression should avoid a
protein intake of > 1.3 grams/kg a day. 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.

More research will need to define the exact role of protein in CKD. High protein diets can worsen kidney function and may damage the glomerulus, but studies have shown no benefits of a low protein diet. 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 (CVD) is the number one cause of death in patients with CKD and controlling factors that increase the risk of developing CVD is very important. In addition, optimizing cardiovascular function improves renal function. Risk factors for the development of CVD includes hypertension, hyperlipidemia, physical inactivity, and tobacco use.

In CKD, blood pressure should be less than 140/90 mmHg or 130/80 mmHg, depending on patient characteristics. The use of ACEIs or ARBs are the ideal treatment in someone who has CKD as these drugs provide renal protection, slow progression of CKD, and reduce the rates of cardiovascular death, heart attacks and strokes.

Optimizing lipid levels is another important step in the management of 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.
The statins are the medications most commonly used to lower serum cholesterol and manage dyslipidemia. In addition to controlling lipid levels, the statins may also slow the progression of CKD, and decrease the incidence of cardiovascular-related mortality, myocardial infarction, and stroke. Examples of statins include: atorvastatin (Lipitor®), simvastatin (Zocor®) and pravastatin (Pravachol®).

All patients with CKD should be encouraged to exercise, stop smoking and if needed, to lose weight.

**Avoid Nephrotoxic Agents**

Patients with CKD need to be taught which medications are toxic to the kidneys. Certain prescription medications and over-the-counter medications are nephrotoxic and should be avoided. Patients should be given a list of agents that are nephrotoxic (see: Table 8).

**Table 8: Nephrotoxic Agents**

- Non steroidal anti-inflammatory drugs such as ibuprofen (Advil®, Motrin®), naproxen (Aleve®) and celecoxib (Celebrex®)
- Aminoglycoside antibiotics, *i.e.*, gentamicin, tobramycin
- Intravenous contrast gadolinium
- Intravenous radiocontrast

Medications must be used carefully in patients who have CKD, and dosage adjustments and frequent monitoring will be needed. Commonly used medications that should be used with these precautions include: antihypertensives, antimicrobials, hypoglycemics, statins, chemotherapeutic drugs that contain platinum, anticoagulants and lithium.
Monitor for Other Complications

Advanced renal disease can cause many complications, some relatively minor and others life threatening.\textsuperscript{7,8}

1. Fluid and electrolyte disturbances:
   Hyperkalemia, hyperphosphatemia, hyponatremia, volume expansion.

2. Endocrine and metabolic disturbances:
   Vitamin-d deficiency, osteomalacia, hypertriglyceridemia.

3. Neuromuscular disturbances:
   Fatigue, sleep disorders, lethargy, memory loss, peripheral neuropathy, restless legs, seizures.

4. Cardiovascular disturbances:
   Hypertension, CHF, pericarditis.

5. Dermatologic disturbances:
   Pruritus, uremic frost.

6. Gastrointestinal disturbances:
   Anorexia, nausea, peptic ulcer, vomiting.

7. Hematologic disturbances:
   Anemia

It is unclear why CKD causes neurological conditions; 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 to end stage renal disease (ESRD). People who develop ESRD will need to consider renal replacement therapy options: hemodialysis, peritoneal dialysis, or kidney transplant.

The absolute level of creatinine is not a pure indicator of the need for dialysis. Indicators for dialysis include: severe metabolic acidosis; hyperkalemia; pericarditis; encephalopathy; intractable volume overload; failure to thrive and
malnutrition; peripheral neuropathy; intractable gastrointestinal symptoms; or, a GFR of 5-9 mL/min/1.73 m², regardless of the cause of the CKD or the presence of absence of other comorbidities.⁶

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. Peritoneal dialysis requires less complex equipment than hemodialysis (HD) and can be performed at home with some training. Unlike HD, PD does not cause 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 interruption 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 impossible. It is also associated with more protein loss in some individuals (see: Table 9 for other complications).
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, HD must be done by trained professionals in a health care setting during business hours and consequently interrupts life more than PD. In the acute setting, HD provides quicker corrections of renal complications than PD.

**Table 9: Complications of Dialysis**

<table>
<thead>
<tr>
<th>Peritoneal Dialysis</th>
<th>Hemodialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peritonitis</td>
<td>Sepsis</td>
</tr>
<tr>
<td>Catheter site infection</td>
<td>Itching</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Pain</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>Air embolism</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>Electrolyte imbalance</td>
</tr>
<tr>
<td>Protein loss</td>
<td>Hepatitis</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>Hypotension/Hypertension</td>
</tr>
<tr>
<td>Anorexia</td>
<td>Headache</td>
</tr>
<tr>
<td>Abdominal hernia</td>
<td>Leg cramps</td>
</tr>
<tr>
<td></td>
<td>Nausea and vomiting</td>
</tr>
</tbody>
</table>

**Case Study:**

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

The next week her doctor calls and refers to a nephrologist to be evaluated for chronic kidney disease; the physician also 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 primary care physician perform a cardiac workup including an electrocardiogram and echocardiogram. The nephrologist orders a repeat of the kidney function, a complete blood count, electrolytes, calcium and phosphorous level, lipid panel, vitamin D level, and a PTH level.

The laboratory test results were:

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum creatinine</td>
<td>1.7 mg/dl</td>
</tr>
<tr>
<td>Blood urea nitrogen</td>
<td>28 mg/dl</td>
</tr>
<tr>
<td>Serum potassium</td>
<td>4.4 mEq/dl</td>
</tr>
<tr>
<td>Serum glucose (fasting)</td>
<td>88 mg/dl</td>
</tr>
<tr>
<td>Serum sodium</td>
<td>136 mEq/dl</td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>10.8 g/dl</td>
</tr>
<tr>
<td>Serum ferritin</td>
<td>58</td>
</tr>
<tr>
<td>Total cholesterol</td>
<td>198 mg/dl</td>
</tr>
<tr>
<td>Low density lipoproteins</td>
<td>126 mg/dl</td>
</tr>
<tr>
<td>Serum calcium</td>
<td>9.8 mg/dl</td>
</tr>
<tr>
<td>Serum phosphorous</td>
<td>4.1 mg/dl</td>
</tr>
<tr>
<td>Serum vitamin D</td>
<td>15 ng/dl</td>
</tr>
<tr>
<td>Parathyroid hormone</td>
<td>50 pg/ml</td>
</tr>
</tbody>
</table>

The nephrologist advised the patient of the importance of lifestyle modifications to help improve the quality and length of her life. She was encouraged to exercise, not use tobacco products, and maintain a healthy weight, and she was referred to a dietitian. The dietitian did a nutritional evaluation and taught the patient about a renal diet, what it is and why it is important. 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, and she was given guidelines on protein consumption.
The nephrologist increased the lisinopril to control her blood pressure to less than 120/80 mm Hg. He also prescribed simvastatin to decrease the low-density lipoprotein to less than 100 mg/dl. Over a period of six months the nephrologist and primary care provider worked to get the patient’s blood pressure to 116/72 mmHg 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 worked 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 since her iron stores (serum ferritin) are low with 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. Because this patient was aggressively managed, her kidney function slowly declined, but likely at a much slower rate due to early intervention and close monitoring.

**Nurse’s Role**

The nurse’s role in the management of the patient with CKD includes monitoring and teaching (for helpful online links (see: pg. 33). Nurses need to encourage their patients to be diligent about their follow up appointments. Follow up appointment 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. CKD is a chronic disease and as the population ages its prevalence will increase. Some patients will have a slow decline and others will decline rapidly. Nurses need to take the lead in helping manage and monitor CKD.

**Summary**

The medical management of chronic kidney disease, including a case study, and the nursing role has been reviewed here. CKD can affect any individual, however, certain predisposing factors have been identified, such as, co-occurring diseases, family history and age. Nurses support patients with CKD to understand their medical plan of care and, if required, hemodialysis and surgical options. Kidney transplantation, not covered in this course, involves another area of highly specialized nursing knowledge and skills, including many of the biopsychosocial and lifestyle adaptations also discussed in this course.

Please take time to help NurseCe4Less.com course planners evaluate the nursing knowledge needs met by completing the self-assessment of Knowledge Questions after reading the article, and providing feedback in the online course evaluation.

Completing the study questions is optional and is NOT a course requirement.
1) Which laboratory test is LEAST helpful in the initial evaluation of a patient with chronic kidney disease (CKD)?
   a. Serum creatinine
   b. Blood urea nitrogen
   c. Serum potassium
   d. Liver function tests

2) Which of these is a common symptom present in stage 3 chronic kidney disease?
   a. Itching
   b. Low back pain
   c. Shortness of breath
   d. None of the above

3) CKD is staged using which of the laboratory tests?
   a. Renal ultrasound
   b. CBC
   c. GFR
   d. Serum creatinine

4) African Americans have a higher incidence of CKD than white Americans.
   a. True
   b. False

5) The two most common causes of CKD are:
   a. Hypertension and hepatitis C
   b. Diabetes and thyroid disease
   c. Diabetes and hypertension
   d. Atherosclerosis and urinary tract infection
6) Managing cardiovascular risk factors is an important step to reducing death rates in CKD patients. Which of these is NOT a cardiovascular risk factor?
   a. Elevated low-density lipoproteins
   b. Elevated high-density lipoproteins
   c. Hypertension
   d. Physical inactivity

7) People who have CKD should be monitored for the presence of
   a. Anemia
   b. Pancreatitis
   c. Liver damage
   d. Lung disease

8) Which of these drugs is typically used to treat HTN in people who have CKD?
   a. Calcium channel blockers
   b. Beta-blockers
   c. ACEIs
   d. Alpha-adrenergic blockers

9. Complications of CKD include
   a. Thyroid disorders and malabsorption syndrome
   b. Pulmonary embolism and hepatitis A
   c. Pulmonary infections and hypokalemia
   d. Metabolic acidosis and electrolyte disturbances
10. **Indications for dialysis include:**
   a. Severe metabolic acidosis and hyperkalemia
   b. Female gender and age > 55 years
   c. Stage 2 disease and elevated serum cholesterol
   d. Atherosclerotic heart disease, a GFR < 90

**Correct Answers:**
1. d) Liver function tests
2. d) None of the above
3. c) GFR
4. a) True
5. c) Diabetes and hypertension
6. b) Elevated high density lipoproteins
7. a) Anemia
8. c) ACEIs
9. d) Metabolic acidosis and electrolyte disturbances
10. a) Severe metabolic acidosis and hyperkalemia

**Helpful Web Links:**
American Kidney Fund – www.kidneyfund.org
American Association of Kidney Patients – www.aakp.org
Reference Section

The reference section of in-text citations include published works intended as helpful material for further reading. Unpublished works and personal communications are not included in this section, although may appear within the study text.


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