

Health Reference Series

**KIDNEY DISEASE  
AND URINARY TRACT  
DISORDERS  
SOURCEBOOK**

**THIRD EDITION**

**Basic Consumer Health Information about the Kidneys and Urinary System,  
Including the Causes, Symptoms, Diagnosis, and Treatment of Diseases and  
Disorders That Affect Various Components of the Urinary System**

**Along with Information about End-of-Life Care, a Glossary of Related Terms,  
and a Directory of Resources for Additional Help and Information**



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OMNIGRAPHICS

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OMNIGRAPHICS  
Kevin Hayes, *Managing Editor*

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# Preface

## **ABOUT THIS BOOK**

Millions of Americans experience difficulties involving the kidneys, ureters, bladder, and urethra—the components of the urinary system. Problems can be caused by illness, injury, genetics, or aging and include disorders such as urinary incontinence, urinary tract infections and cancers, kidney stones, and kidney failure. According to the Centers for Disease Control and Prevention (CDC), about 37 million U.S. adults are estimated to have chronic kidney disease (CKD), and most of them do not know they have it. Although kidney disease and urinary tract disorders can have a significant impact on a person's physical, emotional, and social well-being, recent medical advances offer the promise of more effective treatments and they provide the means by which those affected can learn to cope more successfully with related challenges. Additionally, by understanding the risk factors associated with these types of disorders, people can make lifestyle adjustments and take preventive measures to preserve urological health.

*Kidney Disease and Urinary Tract Disorders Sourcebook, Third Edition* provides information about the vital organs of the urinary system and explains how they work. It talks about the causes, symptoms, diagnosis, and treatment of various problems that impact the kidney and urinary system, including acute kidney injury, bladder stones, chronic kidney disease, kidney cysts, kidney stones, solitary kidney, urethral stricture, urinary tract infections (UTIs), and so on. It also discusses the genetic and congenital disorders along with the cancers that affect the kidneys and urinary tract. Various diagnostic tests such as creatinine test, blood urea nitrogen test, cystatin marker test, kidney biopsy, renal panel test, urine test, and urinary tract imaging that are used to detect kidney disease are also discussed in detail. It explains the treatments used to replace lost kidney function such as hemodialysis, peritoneal dialysis, and kidney transplantation. Information about Medicare coverage available for dialysis and kidney transplant service

is also provided. The book concludes with a glossary of related terms, and a directory of additional resources that provide help and information to patients with kidney disease and urinary tract disorders.

## **HOW TO USE THIS BOOK**

This book is divided into parts and chapters. Parts focus on broad areas of interest. Chapters are devoted to single topics within a part.

*Part 1: Understanding the Urinary System* provides information about the vital organs of the urinary system and explains how they work. It talks about risk factors for kidney disease and provides statistical data on the prevalence of kidney disease in the United States.

*Part 2: Acute and Chronic Kidney Diseases* focuses on diseases and disorders affecting the kidneys, including acute kidney injury, chronic kidney disease, kidney cysts, renal artery stenosis, and diabetes insipidus. Kidney diseases that affect children are also explained in detail along with the information about immune disorders of kidney.

*Part 3: Diagnostic Tests for Kidney Disease* provides information about various tests used to diagnose kidney disease such as creatinine test, blood urea nitrogen test, cystatin marker test, kidney biopsy, renal panel test, urine test, and urinary tract imaging.

*Part 4: Disorders of the Urinary Tract* provides an overview about urinary tract infections (UTIs) and explains how they can affect adults, children, and pregnant women. Facts about novel treatment approach and complementary therapy for UTI are also provided. It provides information about various other disorders of the urinary tract such as solitary kidney, glomerular diseases, amyloidosis, urethral stricture, and so on. The congenital defects of the urinary tract and genitals are also explained.

*Part 5: Disorders of the Bladder* pays particular attention to problems of the bladder including bladder stones, urinary incontinence, urinary retention, interstitial cystitis, etc. Symptoms, diagnostic tests, and available treatments are discussed.

*Part 6: Genetic and Congenital Disorders that Affect the Kidneys* offers information about the causes, symptoms, diagnosis, and treatment of various genetic and congenital disorders that affect the kidney such as Alport syndrome, Bartter syndrome, ectopic kidney, Fabry disease, medullary sponge kidney, and primary hyperoxaluria.

*Part 7: Cancers of the Kidneys and Urinary Tract* describes the causes, symptoms, diagnosis, and treatment of various cancers that can affect the different components of the urinary system, including kidney cancer, bladder cancer, urethral cancer, and prostate cancer.

*Part 8: Kidney Failure: End-Stage Renal Disease* explains treatments used to replace lost kidney function such as hemodialysis, peritoneal dialysis, and kidney transplantation. It talks about conservative management for kidney failure along with Medicare coverage available for dialysis and kidney transplant service. Information about end-of-life care for patients suffering from kidney disease is also provided.

*Part 9: Additional Help and Information* offers a glossary of important terms and a directory of government and private organizations that provide help and information to patients with kidney disease and urinary tract disorders.

## **BIBLIOGRAPHIC NOTE**

This volume contains documents and excerpts from publications issued by the following U.S. government agencies: Agency for Toxic Substances and Disease Registry (ATSDR); Agricultural Research Service (ARS); Centers for Disease Control and Prevention (CDC); Centers for Medicare & Medicaid Services (CMS); Genetic and Rare Diseases Information Center (GARD); Genetics Home Reference (GHR); National Cancer Institute (NCI); National Center for Complementary and Integrative Health (NCCIH); National Institute of Biomedical Imaging and Bioengineering (NIBIB); National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK); National Institute of Neurological Disorders and Stroke (NINDS); National Institute on Aging (NIA); National Institutes of Health (NIH); *NIH News in Health* Office on Women's Health (OWH); U.S. Department of Veterans Affairs (VA); and U.S. Food and Drug Administration (FDA).

It may also contain original material produced by Omnigraphics and reviewed by medical consultants.

## **ABOUT THE HEALTH REFERENCE SERIES**

The *Health Reference Series* is designed to provide basic medical information for patients, families, caregivers, and the general public. Each volume provides comprehensive coverage on a particular topic. This is especially important for people who may be dealing with a newly diagnosed disease or a chronic disorder in themselves or in a family member. People looking

for preventive guidance, information about disease warning signs, medical statistics, and risk factors for health problems will also find answers to their questions in the *Health Reference Series*. The *Series*, however, is not intended to serve as a tool for diagnosing illness, in prescribing treatments, or as a substitute for the physician–patient relationship. All people concerned about medical symptoms or the possibility of disease are encouraged to seek professional care from an appropriate healthcare provider.

## **A NOTE ABOUT SPELLING AND STYLE**

*Health Reference Series* editors use *Stedman’s Medical Dictionary* as an authority for questions related to the spelling of medical terms and *The Chicago Manual of Style* for questions related to grammatical structures, punctuation, and other editorial concerns. Consistent adherence is not always possible, however, because the individual volumes within the *Series* include many documents from a wide variety of different producers, and the editor’s primary goal is to present material from each source as accurately as is possible. This sometimes means that information in different chapters or sections may follow other guidelines and alternate spelling authorities. For example, occasionally a copyright holder may require that eponymous terms be shown in possessive forms (Crohn’s disease vs. Crohn disease) or that British spelling norms be retained (leukaemia vs. leukemia).

## **MEDICAL REVIEW**

Omnigraphics contracts with a team of qualified, senior medical professionals who serve as medical consultants for the *Health Reference Series*. As necessary, medical consultants review reprinted and originally written material for currency and accuracy. Citations including the phrase “Reviewed (month, year)” indicate material reviewed by this team. Medical consultation services are provided to the *Health Reference Series* editors by:

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### **HEALTH REFERENCE SERIES UPDATE POLICY**

The inaugural book in the *Health Reference Series* was the first edition of *Cancer Sourcebook* published in 1989. Since then, the *Series* has been enthusiastically received by librarians and in the medical community. In order to maintain the standard of providing high-quality health information for the layperson the editorial staff at Omnigraphics felt it was necessary to implement a policy of updating volumes when warranted.

Medical researchers have been making tremendous strides, and it is the purpose of the *Health Reference Series* to stay current with the most recent advances. Each decision to update a volume is made on an individual basis. Some of the considerations include how much new information is available and the feedback we receive from people who use the books. If there is a topic you would like to see added to the update list, or an area of medical concern you feel has not been adequately addressed, please write to:

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# Chapter 8 | Chronic Kidney Disease

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## Section 8.1 | Chronic Kidney Disease Basics

This section includes text excerpted from “Chronic Kidney Disease Basics,” Centers for Disease Control and Prevention (CDC), February 7, 2020.

Kidneys that function properly are critical for maintaining good health, however, more than one in seven American adults are estimated to have chronic kidney disease (CKD). Besides this, there are a few other facts too regarding CKD.

- Kidney diseases are the ninth leading cause of death in the United States.
- Early CKD has no signs or symptoms.
- Specific blood and urine tests are needed to check for CKD.
- Chronic kidney disease tends to get worse over time.
- Chronic kidney disease can be treated (the earlier treatment starts the better).
- Chronic kidney disease can progress to kidney failure.
- Overall Medicare costs for people with CKD were over \$84 billion in 2017 or more than \$22,000 per person.
- Total Medicare spending (excluding prescription drugs) for patients with end-stage renal disease (ESRD) or kidney failure reached \$36 billion in 2017, or nearly \$80,000 per person, accounting for about 7 percent of the Medicare paid claims costs.

### **ABOUT CHRONIC KIDNEY DISEASE**

Chronic kidney disease is a condition in which the kidneys are damaged and cannot filter blood as well as they should. Because of this, excess fluid and waste from blood remain in the body and may cause other health problems, such as heart disease and stroke.

Some other health consequences of CKD include:

- Anemia or a low number of red blood cells (RBCs)
- Increased occurrence of infections
- Low calcium levels, high potassium levels, and high phosphorus levels in the blood

- Loss of appetite or eating less
- Depression or lower quality of life (QOL)

Chronic kidney disease has varying levels of seriousness. It usually gets worse over time though treatment has been shown to slow progression. If left untreated, CKD can progress to kidney failure and early cardiovascular disease. When the kidneys stop working, dialysis or kidney transplant is needed for survival. Kidney failure treated with dialysis or kidney transplant is called “ESRD.”

Not all patients with kidney disease progress to kidney failure. To help prevent CKD and lower the risk for kidney failure, control risk factors for CKD, get tested yearly, make lifestyle changes, take medicines as needed, and see your healthcare team regularly.

## **RISK FACTORS OF CHRONIC KIDNEY DISEASE**

Talk to your doctor about getting tested if you have any of these risk factors:

- Diabetes
- High blood pressure
- Heart disease
- Family history of CKD
- Obesity

## **SYMPTOMS OF CHRONIC KIDNEY DISEASE**

People with CKD may not feel ill or notice any symptoms. The only way to find out for sure if you have CKD is through specific blood and urine tests. These tests include measurement of both the creatinine level in the blood and protein in the urine.

## **KIDNEY-FRIENDLY TIPS**

- Keep your blood pressure below 140/90 mm Hg (or the target your doctor establishes for you).
- If you have diabetes, stay in your target blood sugar range as much as possible.
- Get active—physical activity helps control blood pressure and blood sugar levels.

## Chronic Kidney Disease

- Lose weight if you are overweight.
- Get tested for CKD regularly if you are at risk.
- If you have CKD, meet with a dietician to create a kidney-healthy eating plan. The plan may need to change as you get older or if your health status changes.
- Take medications as instructed, and ask your doctor about blood pressure medicines called “angiotensin-converting enzyme (ACE) inhibitors” and “angiotensin II receptor blockers,” which may protect your kidneys in addition to lowering blood pressure.
- If you smoke, quit. Smoking can worsen kidney disease and interfere with medication that lowers blood pressure.
- Include a kidney doctor (nephrologist) in your healthcare team.

### Section 8.2 | Chronic Kidney Disease in the United States

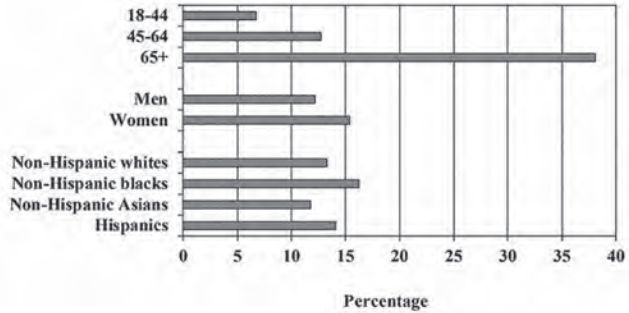
This section includes text excerpted from “Chronic Kidney Disease in the United States, 2019,” Centers for Disease Control and Prevention (CDC), March 11, 2019.

With chronic kidney disease (CKD), kidneys become damaged over time or cannot clean the blood as well as healthy kidneys. When the kidneys do not work well, wastes and extra water build up in the body and may cause other health problems, including heart disease and high blood pressure. However, people with CKD and people at risk for CKD can take steps to protect their kidneys.

### CHRONIC KIDNEY DISEASE IS COMMON AMONG U.S. ADULTS

According to estimates:

- Chronic kidney disease is more common in people 65 years of age or older (38%) than in people 45 to 64 years of age (13%) or 18 to 44 years of age (7%)
- Chronic kidney disease is more common in women (15%) than men (12%)



**Figure 8.1.** Percentage of CKD among U.S. Adults 18 Years of Age or Older, by Age, Sex, and Race or Ethnicity

- Chronic kidney disease is more common in non-Hispanic blacks (16%) than in non-Hispanic whites (13%) or non-Hispanic Asians (12%)
- About 14 percent of Hispanics have CKD

## **WAYS TO PREVENT CHRONIC KIDNEY DISEASE OR DETECT IT EARLY**

- Control risk factors for CKD:
  - High blood pressure
  - High blood sugar levels
- Keeping a healthy body weight through a balanced diet and physical activity may help.
- Test for CKD regularly in people who have diabetes, high blood pressure, or other risk factors for CKD.

## **TESTING AND TREATMENT**

People may not feel ill or notice any symptoms until CKD is advanced.

The only way to find out if people have CKD is through simple blood and urine tests. The blood test checks for creatinine (a waste product produced by muscles) in the blood to see how well the kidneys work. The urine test checks for protein in the urine (a sign of kidney damage).



## Chronic Kidney Disease

Following a healthy diet and taking medicine for diabetes and high blood pressure may keep CKD from getting worse and may prevent other health problems, such as heart disease.

### **CHRONIC KIDNEY DISEASE-RELATED HEALTH PROBLEMS**

#### **Early Death**

Adults with CKD are at a higher risk of early death compared to adults without CKD of the same age.

#### **Heart Disease and Stroke**

- Having CKD increases the chances of also having heart disease and stroke.
- Managing high blood pressure, blood sugar, and cholesterol levels—all factors that increase the risk of heart disease and stroke—is very important for people with CKD.

#### **Other Health Problems**

As CKD worsens over time—related health problems become more likely, including:

- Anemia or low red blood cell (RBC) count (can cause fatigue and weakness)
- Low calcium levels and high phosphorus levels in the blood (can cause bone problems)
- High potassium levels in the blood (can cause an irregular or abnormal heartbeat)
- Loss of appetite or nausea
- Extra fluid in the body (can cause high blood pressure, swelling in the legs, or shortness of breath)
- Infections or a weakened immune system
- Depression

#### **Kidney Failure**

If kidney damage is severe and kidney function is very low, dialysis or a kidney transplant is needed for survival. Kidney failure treated

with dialysis or a kidney transplant is called “end-stage kidney disease” (ESKD). Treatment may slow the decline in kidney function and delay kidney failure. However, not everyone with CKD develops ESKD, and in some cases, ESKD develops even with treatment.

### **Facts about End-Stage Kidney Disease**

- In 2016, nearly 125,000 people in the United States started treatment for ESKD, and more than 726,000 (2 in every 1,000 people) were on dialysis or were living with a kidney transplant.
- Every day, more than 240 people on dialysis die.
- For every 2 women who develop ESKD, 3 men develop ESKD.
- African Americans are about 3 times more likely than Whites to develop ESKD.
- For every 3 non-Hispanics who develop ESKD, 4 Hispanics develop ESKD.
- Adults who were 18 years of age or older, diabetes and high blood pressure are the main reported causes of ESKD.
- In children and adolescents younger than 18 years of age, polycystic kidney disease (PKD) and glomerulonephritis (inflammation of the kidneys) were the main causes of ESKD.

### **PEOPLE WITH CHRONIC KIDNEY DISEASE CAN LOWER THEIR RISK FOR KIDNEY FAILURE**

- Learn about CKD from a kidney doctor (nephrologist) to better understand the treatment and protect the kidneys. People with nephritis, polycystic kidney disease (PKD)—a cause of CKD and kidney failure, or other kidney diseases should talk about specific treatment options with their kidney doctor.
- Manage blood sugar and blood pressure.
- To manage CKD:
  - Make lifestyle changes (e.g., healthy eating, exercise) to prevent more kidney damage. Meet with a dietitian

## Chronic Kidney Disease

to create a kidney-healthy eating plan that is low in salt and fat and has the right amount of protein. As CKD gets worse, the plan may also include limiting phosphorus and potassium.

- Use medicines (e.g., drugs to lower blood pressure) to slow the decline in kidney function.
- Stop smoking.
- Avoid below conditions or exposures that can harm the kidneys or cause kidney function to suddenly get worse:
  - Over-the-counter (OTC) pain medicines, such as ibuprofen and naproxen
  - Some antibiotics
  - Proton pump inhibitors used to reduce stomach acids, such as omeprazole and lansoprazole
  - Herbal supplements (always talk to your doctor before taking any supplements)
  - Certain dyes (contrast agents) used to make blood vessels or organs visible on x-rays or other imaging tests
  - Kidney infections (preventing bladder infections may help)

Check with a doctor about other things to avoid.

### Section 8.3 | Causes of Chronic Kidney Disease

This section includes text excerpted from “Causes of Chronic Kidney Disease,” National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), October 2016. Reviewed April 2020.

Diabetes and high blood pressure are the most common causes of chronic kidney disease (CKD). Your healthcare provider will look at your health history and may do tests to find out why you have kidney disease. The cause of your kidney disease may affect the type of treatment you receive.

## **DIABETES**

Too much glucose, also called “sugar,” in your blood damages your kidneys’ filters. Over time, your kidneys can become so damaged that they no longer do a good job filtering wastes and extra fluid from your blood.

Often, the first sign of kidney disease from diabetes is a protein in your urine. When the filters are damaged, a protein called “albumin,” which you need to stay healthy passes out of your blood and into your urine. A healthy kidney does not let albumin pass from the blood into the urine.

“Diabetic kidney disease,” is the medical term for kidney disease caused by diabetes.

## **HIGH BLOOD PRESSURE**

High blood pressure can damage blood vessels in the kidneys so they do not work as well. If the blood vessels in your kidneys are damaged, your kidneys may not work as well to remove wastes and extra fluid from your body. Extra fluid in the blood vessels may then raise blood pressure, even more, creating a dangerous cycle.

## **OTHER CAUSES OF KIDNEY DISEASE**

Other causes of kidney disease include:

- A genetic disorder that causes many cysts to grow in the kidneys—polycystic kidney disease (PKD)
- An infection
- A drug that is toxic to the kidneys
- A disease that affects the entire body, such as diabetes or lupus. “Lupus nephritis” is the medical name for kidney disease caused by lupus.
- IgA glomerulonephritis
- Disorders in which the body’s immune system attacks its own cells and organs, such as Goodpasture syndrome
- Heavy metal poisoning, such as lead poisoning
- Rare genetic conditions, such as Alport syndrome
- Hemolytic uremic syndrome in children

## Chronic Kidney Disease

- Henoch-Schönlein purpura
- Renal artery stenosis

### Section 8.4 | Anemia in Chronic Kidney Disease

This section includes text excerpted from “Anemia in Chronic Kidney Disease,” National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), July 2014. Reviewed April 2020.

#### **WHAT IS ANEMIA?**

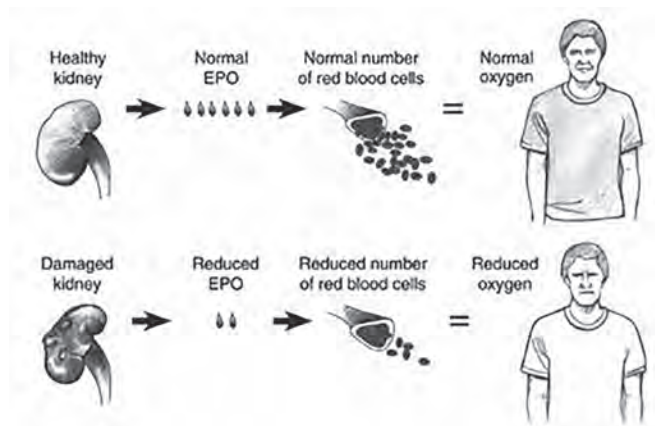
Anemia is a condition in which the body has fewer red blood cells than normal. Red blood cells (RBCs) carry oxygen to tissues and organs throughout the body and enable them to use energy from food. With anemia, RBCs carry less oxygen to tissues and organs—particularly the heart and brain—and those tissues and organs may not function as well as they should.

#### **HOW IS ANEMIA RELATED TO CHRONIC KIDNEY DISEASE?**

Anemia commonly occurs in people with chronic kidney disease (CKD)—the permanent, partial loss of kidney function. Anemia might begin to develop in the early stages of CKD when someone has 20 to 50 percent of normal kidney function. Anemia tends to worsen as CKD progresses. Most people who have total loss of kidney function, or kidney failure, have anemia. A person has kidney failure when she or he needs a kidney transplant or dialysis in order to live. The two forms of dialysis include hemodialysis and peritoneal dialysis. Hemodialysis uses a machine to circulate a person’s blood through a filter outside the body. Peritoneal dialysis uses the lining of the abdomen to filter blood inside the body.

#### **WHAT CAUSES ANEMIA IN CHRONIC KIDNEY DISEASE**

When kidneys are diseased or damaged, they do not make enough erythropoietin (EPO). As a result, the bone marrow makes fewer RBCs, causing anemia. When blood has fewer RBCs, it deprives the body of the oxygen it needs.



**Figure 8.2. Kidney Affected due to Anemia**

*Healthy kidneys produce a hormone called “erythropoietin” (EPO). EPO prompts the bone marrow to make red blood cells (RBCs), which then carry oxygen throughout the body. When the kidneys are diseased or damaged, they do not make enough EPO. As a result, the bone marrow makes fewer RBCs, causing anemia.*

Other common causes of anemia in people with kidney disease include blood loss from hemodialysis and low levels of the following nutrients found in food:

- Iron
- Vitamin B12
- Folic acid

These nutrients are necessary for RBCs to make hemoglobin, the main oxygen-carrying protein in the RBCs.

If treatments for kidney-related anemia do not help, the health-care provider will look for other causes of anemia, including:

- Other problems with bone marrow
- Inflammatory problems—such as arthritis, lupus, or inflammatory bowel disease (IBD)—in which the body’s immune system attacks the body’s own cells and organs
- Chronic infections such as diabetic ulcers
- Malnutrition

## Chronic Kidney Disease

### **WHAT ARE THE SIGNS AND SYMPTOMS OF ANEMIA IN SOMEONE WITH CHRONIC KIDNEY DISEASE?**

The signs and symptoms of anemia in someone with CKD may include:

- Weakness
- Fatigue, or feeling tired
- Headaches
- Problems with concentration
- Paleness
- Dizziness
- Difficulty breathing or shortness of breath
- Chest pain

Anyone having difficulty breathing or with shortness of breath should seek immediate medical care. Anyone who has chest pain should call 911.

### **WHAT ARE THE COMPLICATIONS OF ANEMIA IN SOMEONE WITH CHRONIC KIDNEY DISEASE?**

Heart problems are a complication of anemia and may include:

- An irregular heartbeat or an unusually fast heartbeat, especially when exercising
- The harmful enlargement of muscles in the heart
- Heart failure, which does not mean the heart suddenly stops working. Instead, heart failure is a long-lasting condition in which the heart cannot pump enough blood to meet the body's needs.

### **HOW IS ANEMIA IN CHRONIC KIDNEY DISEASE DIAGNOSED?**

A healthcare provider diagnoses anemia based on the following:

#### **Medical History**

Taking a medical history is one of the first things a healthcare provider may do to diagnose anemia. She or he will usually ask about the patient's symptoms.

## Physical Exam

A physical exam may help diagnose anemia. During a physical exam, a healthcare provider usually examines a patient's body, including checking for changes in skin color.

## Blood Tests

To diagnose anemia, a healthcare provider may order a complete blood count (CBC), which measures the type and number of blood cells in the body. A blood test involves drawing a patient's blood at the healthcare provider's office or a commercial facility. A healthcare provider will carefully monitor the amount of hemoglobin in the patient's blood, one of the measurements in a CBC.

The Kidney Disease: Improving Global Outcomes Anemia Work Group recommends that healthcare providers diagnose anemia in males older than 15 years of age when their hemoglobin falls below 13 grams per deciliter (g/dL) and in females older than 15 years of age when it falls below 12 g/dL. If someone has lost at least half of normal kidney function and has low hemoglobin, the cause of anemia may decrease EPO production.

Two other blood tests help measure iron levels:

- The ferritin level helps assess the amount of iron stored in the body. A ferritin score below 200 nanograms (ng) per milliliter may mean a person has an iron deficiency that requires treatment.
- The transferrin saturation score indicates how much iron is available to make RBCs. A transferrin saturation score below 30 percent can also mean low iron levels that require treatment.

In addition to blood tests, the healthcare provider may order other tests, such as tests for blood loss in stool, to look for other causes of anemia.

## HOW IS ANEMIA IN CHRONIC KIDNEY DISEASE TREATED?

Depending on the cause, a healthcare provider treats anemia with one or more of the following treatments:



## Chronic Kidney Disease

### Iron

The first step in treating anemia is raising low-iron levels. Iron pills may help improve iron and hemoglobin levels. However, for patients on hemodialysis, many studies show pills do not work as well as iron when given intravenously.

### Erythropoietin

If blood tests indicate kidney disease as the most likely cause of anemia, treatment can include injections of a genetically engineered form of EPO. A healthcare provider, often a nurse, injects the patient with EPO subcutaneously, or under the skin, as needed. Some patients learn how to inject the EPO themselves. Patients on hemodialysis may receive EPO intravenously during hemodialysis.

Studies have shown the use of EPO increases the chance of cardiovascular events, such as heart attack and stroke, in people with CKD. The healthcare provider will carefully review the medical history of the patient and determine if EPO is the best treatment for the patient's anemia. Experts recommend using the lowest dose of EPO that will reduce the need for RBC transfusions. Additionally, healthcare providers should consider the use of EPO only when a patient's hemoglobin level is below 10 g/dL. Healthcare providers should not use EPO to maintain a patient's hemoglobin level above 11.5 g/dL. Patients who receive EPO should have regular blood tests to monitor their hemoglobin so the healthcare provider can adjust the EPO dose when the level is too high or too low. Healthcare providers should discuss the benefits and risks of EPO with their patients.

Many people with kidney disease need iron supplements and EPO to raise their RBC count to a level that will reduce the need for red blood cell transfusions. In some people, iron supplements and EPO will improve the symptoms of anemia.

### Red Blood Cell Transfusions

If a patient's hemoglobin falls too low, a healthcare provider may prescribe an RBC transfusion. Transfusing red blood cells into the patient's vein raises the percentage of the patient's blood that

**Table 8.1. Good Dietary Sources of Iron, Vitamin B12, and Folic Acid**

<b>Food</b>	<b>Serving Size</b>	<b>Iron</b>	<b>Vitamin B12</b>	<b>Folic Acid</b>
<b>Recommended Daily Value</b>		18 mg	6 mcg	400 mcg
100 percent fortified breakfast cereal	¾ cup (1 oz)	18 mg	6 mcg	394 mcg
Beans, baked	1 cup (8 oz)	8 mg	0 mcg	37 mcg
Beef, ground	3 oz	2 mg	2 mcg	8 mcg
Beef liver	3 oz	5 mg	67 mcg	211 mcg
Clams, fried	4 oz	3 mg	1 mcg	66 mcg
Spinach, boiled	1 cup (3 oz)	2 mg	0 mcg	115 mcg
Spinach, fresh	1 cup (1 oz)	1 mg	0 mcg	58 mcg
Trout	3 oz	0 mg	5 mcg	16 mcg
Tuna, canned	3 oz	1 mg	1 mcg	2 mcg

consists of RBCs, increasing the amount of oxygen available to the body.

### **Vitamin B<sub>12</sub> and Folic Acid Supplements**

A healthcare provider may suggest vitamin B<sub>12</sub> and folic acid supplements for some people with CKD and anemia. Using vitamin supplements can treat low levels of vitamin B<sub>12</sub> or folic acid and help treat anemia. To help ensure coordinated and safe care, people should discuss their use of complementary and alternative medical practices, including their use of dietary supplements, with their healthcare provider.

### **EATING, DIET, AND NUTRITION**

A healthcare provider may advise people with kidney disease who have anemia caused by iron, vitamin B12, or folic acid deficiencies to include sources of these nutrients in their diets. Some of these

## Chronic Kidney Disease

foods are high in sodium or phosphorus, which people with CKD should limit in their diet. Before making any dietary changes, people with CKD should talk with their healthcare provider or with a dietitian who specializes in helping people with kidney disease. A dietitian can help a person plan healthy meals.

Table 8.1 illustrates some good dietary sources of iron, vitamin B12, and folic acid.

### Section 8.5 | Mineral and Bone Disorder in Chronic Kidney Disease

This section includes text excerpted from “Mineral and Bone Disorder in Chronic Kidney Disease,” National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), November 2015. Reviewed April 2020.

#### **WHAT IS MINERAL AND BONE DISORDER IN CHRONIC KIDNEY DISEASE?**

Mineral and bone disorder in chronic kidney disease (CKD) occurs when damaged kidneys and abnormal hormone levels cause calcium and phosphorus levels in a person’s blood to be out of balance. Mineral and bone disorder commonly occurs in people with CKD and affects most people with kidney failure receiving dialysis.

In the past, healthcare providers used the term “renal osteodystrophy,” to describe mineral and hormone disturbances caused by kidney disease. Today, renal osteodystrophy only describes bone problems that result from mineral and bone disorders in CKD. Healthcare providers might use the phrase “chronic kidney disease mineral and bone disorder,” or CKD-MBD, to describe the condition that affects the bones, heart, and blood vessels.

#### **WHY ARE HORMONES AND MINERALS IMPORTANT?**

Hormones and minerals are important because they help bones stay strong. If a person’s hormones and minerals are out of balance, her or his bones can become weak and malformed. Healthy bones

continuously rebuild, sometimes taking a slightly altered shape or structure. To grow and rebuild, bones need:

- The hormone calcitriol—the active form of vitamin D
- Calcium
- Phosphorus
- Parathyroid hormone

The kidneys play an important role in maintaining healthy bone mass and structure by balancing phosphorus and calcium levels in the blood. Healthy kidneys activate a form of vitamin D that a person consumes in food, turning it into calcitriol, the active form of the vitamin. Calcitriol helps the kidneys maintain blood calcium levels and promotes the formation of bone.

The kidneys also remove extra phosphorus, helping balance phosphorus and calcium levels in the blood. Keeping the proper level of phosphorus in the blood helps maintain strong bones.

The parathyroid glands, four pea-sized glands in the neck, create the parathyroid hormone, or PTH. The parathyroid hormone plays an important role in controlling calcium levels in the blood. When the kidneys do not function properly, extra parathyroid hormone is released into the blood to move calcium from inside the bones into the blood.

## **WHAT CAUSES MINERAL AND BONE DISORDER IN CHRONIC KIDNEY DISEASE**

Chronic kidney disease causes mineral and bone disorder because the kidneys do not properly balance the mineral levels in the body.

The kidneys:

- **Stop activating calcitriol.** The low levels of calcitriol in the body create an imbalance of calcium in the blood.
- **Do not remove the phosphorus in the blood properly, so phosphorus levels rise in the blood.** The extra phosphorus pulls calcium out of the bones, causing them to weaken.

Another factor contributes to the cause of mineral and bone disorder. When the kidneys are damaged, the parathyroid gland

## Chronic Kidney Disease

releases a parathyroid hormone into the blood to pull calcium from the bones and raise blood calcium levels. This response restores the balance of phosphorus and calcium; however, it also starves the bones of much-needed calcium.

### **WHAT ARE THE SIGNS AND SYMPTOMS OF MINERAL AND BONE DISORDER IN CHRONIC KIDNEY DISEASE?**

In adults, symptoms of mineral and bone disorder in CKD may not appear until bone changes have taken place for many years. For this reason, people often refer to the disease as a “silent crippler.” Eventually, a person with the condition may begin to feel bone and joint pain.

### **MINERAL AND BONE DISORDER IN CHILDREN WITH CHRONIC KIDNEY DISEASE**

Mineral and bone disorder in CKD is most serious when it occurs in children because their bones are still developing and growing. Growing children can show symptoms of mineral and bone disorder even in the early stages of CKD. Slowed bone growth leads to short stature, which may remain with a child into adulthood. One deformity caused by mineral and bone disorder in CKD occurs when the legs bend inward or outward, a condition often referred to as “renal rickets.”

### **WHAT ARE THE COMPLICATIONS OF MINERAL AND BONE DISORDER IN CHRONIC KIDNEY DISEASE?**

The complications of mineral and bone disorder in CKD include slowed bone growth and deformities, and heart and blood vessel problems.

#### **Slowed Bone Growth and Deformities**

Damaged kidneys must work harder to clear phosphorus from the body. High levels of phosphorus cause lower levels of calcium in the blood, resulting in the following series of events:

- When a person’s blood calcium level becomes too low, the parathyroid glands release parathyroid hormone.

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- Parathyroid hormone removes calcium from bones and places it into the blood, raising a person's blood calcium level at the risk of harming bones.
- A low calcitriol level also leads to an increased level of parathyroid hormone.

If mineral and bone disorder in CKD remains untreated in adults, bones gradually become thin and weak, and a person with the condition may begin to feel bone and joint pain. Mineral and bone disorders in CKD also increases a person's risk of bone fractures.

### **Heart and Blood Vessel Problems**

In addition to harming bones, mineral and bone disorders in CKD can cause problems in the heart and blood vessels.

- High levels of blood calcium can damage blood vessels and lead to heart problems.
- High phosphorus levels also can cause blood vessels to become similar to bone, leading to the hardening of the arteries.
- High phosphorus levels also cause abnormal hormone regulation, even if the calcium level is acceptable.

Parathyroid hormone and another hormone made in the bones called "FGF23," can also affect bone and heart health, leading to the following series of problems:

- When parathyroid hormone or FGF23 levels are high, a person can have heart problems.
- The complex hormone abnormalities that cause bone deformities can also harm a person's heart and blood vessels.

## **HOW IS MINERAL AND BONE DISORDER IN CHRONIC KIDNEY DISEASE DIAGNOSED?**

### **Family and Medical History**

Taking a medical and family history is one of the first things a healthcare provider may do to help diagnose mineral and bone

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disorders in CKD. She or he will ask the patient or caretaker questions about when the patient was first diagnosed with CKD and whether any family members have also had mineral and bone disorder with or without CKD.

### Physical Exam

A physical exam may help diagnose mineral and bone disorders in CKD. During a physical exam, a healthcare provider usually examines a patient's body for changes in bone structure.

### Blood Test

A blood test involves drawing blood at a healthcare provider's office or a commercial facility and sending the sample to a lab for analysis. The blood test shows levels of calcium, phosphorus, parathyroid hormone, and sometimes vitamin D.

### Bone Biopsy

A bone biopsy is a procedure that removes a piece of bone tissue for examination with a microscope. A healthcare provider performs the biopsy in a hospital with light sedation and local anesthetic. The healthcare provider uses imaging techniques such as ultrasound or a computerized tomography (CT) scan to guide the biopsy needle into the hip bone. A pathologist—a doctor who specializes in diagnosing diseases—examines the bone tissue in a lab. The test can show whether a person's bone cells are building normal bone.

### X-Ray

An x-ray is a picture created by using radiation and recorded on film or on a computer. The amount of radiation used is small. A radiographer performs the x-ray at a hospital or an outpatient center, and a radiologist—a doctor who specializes in medical imaging—interprets the images. Patients do not need anesthesia. The patient will lie on a table or stand during the x-ray. The technician will position the x-ray machine over the bone area. The patient will hold her or his breath as the x-ray machine takes the picture

so that the picture will not be blurry. The radiographer may ask the patient to change position for additional pictures. An x-ray can show extra calcium in blood vessels.

Each of these tests can help the healthcare provider determine whether CKD or some other condition is causing the mineral and bone disorder and decide on a course of treatment.

## **HOW IS MINERAL AND BONE DISORDER IN CHRONIC KIDNEY DISEASE TREATED?**

Treating mineral and bone disorder in CKD includes preventing damage to bones by controlling parathyroid hormone levels through changes in eating, diet, and nutrition; medications and supplements; and dialysis. If these treatments do not bring parathyroid hormone levels under control, a healthcare provider may remove a person's parathyroid glands surgically, a procedure called a "parathyroidectomy."

### **Eating, Diet, and Nutrition**

Changes in diet can treat mineral and bone disorders in CKD. Reducing dietary intake of phosphorus is one of the most important steps in preventing bone disease. Most foods contain phosphorus; however, processed and packaged foods contain especially high levels of phosphorus. Food producers use phosphorus as an additive to preserve the food on the shelf. People who have CKD or are on dialysis should avoid packaged foods containing ingredients that include the letters PHOS. A renal dietitian can help develop a dietary plan to control phosphorus levels in the blood. Some drinks and natural foods also contain high amounts of phosphorus, including:

- Beer
- Cheese
- Cocoa
- Dark sodas
- Dried beans
- Milk



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- Nuts
- Peanut butter
- Peas

### Medications and Supplements

Medications protect the bones by restoring the proper balance of minerals and hormones. If the kidneys do not make adequate amounts of calcitriol, a healthcare provider may prescribe synthetic calcitriol as a pill (Rocaltrol) or, for dialysis patients, in an injectable form (Calcijex). Calcitriol helps reduce parathyroid hormone levels. Medications called “doxercalciferol” (Hectorol) and “paricalcitol” (Zemlar) act similar to calcitriol because they are also activated forms of vitamin D. A healthcare provider may prescribe a calcium supplement in addition to calcitriol or another activated form of vitamin D.

Certain forms of vitamin D—available by prescription or as over-the-counter (OTC) vitamin supplements—require activation by a person’s kidneys before they can act as calcitriol does. However, the benefits of some of these not-yet-activated forms of vitamin D—for example, ergocalciferol (Calciferol, Drisdol) or cholecalciferol (Delta D3)—are unclear. To help ensure coordinated and safe care, people should discuss their use of alternative medications, including the use of vitamin and mineral supplements, with their healthcare provider.

Cinacalcet hydrochloride (Sensipar) belongs to another class of prescription medications called “calcimimetics.” Cinacalcet lowers parathyroid hormone levels by imitating calcium’s effects on the parathyroid gland. Generally, this medication is used only in people on dialysis.

Often, healthcare providers will prescribe medications called “phosphate binders”—such as calcium carbonate (Tums), calcium acetate (PhosLo), sevelamer carbonate (Renvela), or lanthanum carbonate (Fosrenol)—to take with meals and snacks to bind phosphorus in the bowel. These medications decrease the absorption of phosphorus into the blood.

## Dialysis

Dialysis is the process of filtering wastes and extra fluid from the body by means other than the kidneys. The two forms of dialysis are hemodialysis and peritoneal dialysis.

- **Hemodialysis** uses a machine to circulate a person's blood through a filter outside the body. The blood passes from a patient's body through a needle, at nearly one pint per minute. The blood then travels through a tube that takes it to the filter, called a "dialyzer." Inside the dialyzer, the blood flows through thin fibers that filter out wastes and extra fluid. After the machine filters the blood, it passes back to the body through another tube.
- **Peritoneal dialysis** uses the lining of the abdomen to filter a person's blood inside the body. A soft tube called a "catheter" is placed in the patient's abdomen a few weeks before peritoneal dialysis begins. A person uses the catheter to fill the empty space inside the abdomen with a dialysis solution—a kind of salty water—from a plastic bag. While inside the body, the dialysis solution absorbs wastes and extra fluid. After a few hours, the person drains the used dialysis solution into another bag for disposal. The person then restarts the process with a fresh bag of dialysis solution.

Increasing a person's dialysis dose can help control the blood phosphorus level. In hemodialysis, the healthcare provider can adjust the dose by increasing how quickly the blood flows to and from the dialyzer. Another way to adjust the dose involves increasing the time of a person's dialysis session or the number of sessions. In peritoneal dialysis, using more dialysis solution in each fill or increasing the number of fills each day increases the dose.

## Parathyroidectomy

If diet, medications, and dialysis cannot control parathyroid hormone levels, a surgeon can remove one or more of the

## Chronic Kidney Disease

parathyroid glands. She or he performs the procedure using general anesthesia.

A good treatment program, including a low-phosphorus diet, appropriate medications, adequate dialysis, and, if necessary, surgery, can improve the body's ability to repair bones damaged by mineral and bone disorder in CKD. Overall, people can improve their bone health by exercising and not smoking. People should consult a healthcare provider before beginning any exercise program.

### **Section 8.6 | Growth Failure in Children with Chronic Kidney Disease**

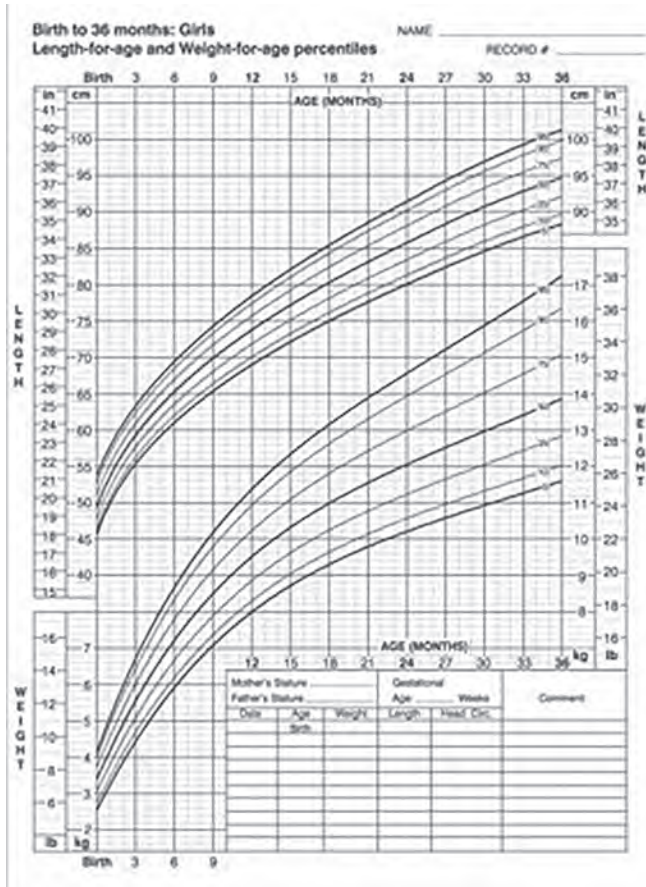
This section includes text excerpted from "Growth Failure in Children with Chronic Kidney Disease," National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), September 2014. Reviewed April 2020.

Growth failure is a complication of chronic kidney disease (CKD) in which children do not grow as expected. When a child is below the third percentile—meaning 97 percent of children the same age and gender are taller—she or he has growth failure. CKD is a kidney disease that does not go away with treatment and tends to get worse over time.

Healthcare providers use charts to monitor the growth of children with CKD and look for signs of growth failure. Growth charts for children use percentiles to compare a particular child's height with the height of children of the same age and gender. For example, a child whose height is at the 50th percentile on a growth chart means half the children in the United States are taller than that child and half the children are shorter.

About one-third of children with CKD have growth failure. Children diagnosed with CKD at a younger age:

- Have a higher chance of developing growth failure
- Have more health issues related to growth failure and CKD



**Figure 8.3.** Growth Flow Chart—Girls

*Developed by the National Center for Health Statistics (NCHS) in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP) 2000. The Centers for Disease Control and Prevention (CDC).*

## KIDNEYS AND THEIR ROLE

The kidneys are two bean-shaped organs, each about the size of a fist. They are located just below the rib cage, one on each side of the spine. Every day, the 2 kidneys filter about 120 to 150 quarts of blood to produce about 1 to 2 quarts of urine, composed of wastes and extra fluid. Children produce less urine than adults and the



## WHAT CAUSES GROWTH FAILURE IN CHILDREN WITH CHRONIC KIDNEY DISEASE

Researchers have found that many factors cause growth failure in children with CKD. In addition to removing wastes and extra fluid from the blood, the kidneys perform important functions for a child's growth. Understanding normal kidney function and growth helps families understand what causes growth failure in children with CKD.

Normal kidney function helps maintain the:

- **Balance of nutrients and minerals, such as calcium and phosphorus, in the blood.** These minerals are essential for normal bone growth. The kidneys use a hormone called “calcitriol,” a form of vitamin D, to help bones absorb the right amount of calcium from the blood. The kidneys also remove extra phosphorus, helping balance phosphorus and calcium levels in the blood.
- **Body's ability to use growth hormones.** The growth hormone is necessary during childhood to help bones grow and stay healthy. The pituitary gland naturally produces growth hormone, which acts as a messenger to help the body grow. The growth hormone tells the liver to produce another hormone, called “insulin-like growth factor,” that travels to muscles, organs, and bones and tells them to grow.
- **Correct levels of erythropoietin in the body.** Erythropoietin (EPO) is a hormone that helps bone marrow make red blood cells (RBCs).
- **A proper balance of sodium also called “salt,” potassium; and acid-base levels in the blood.** Acid-base balance refers to the amount of acid in the blood.

Damaged kidneys can slow a child's growth by:

- Causing mineral and bone disorder, which occurs when:
  - Vitamin D is not turned into calcitriol, which starves the bones of calcium.

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- Phosphorus levels rise in the blood and draw calcium out of the bones and into the blood, causing the bones to weaken.
- **Creating an imbalance of sodium, potassium, and acid-base levels in the blood, also called “acidosis.”** When blood is not balanced, the body slows growth to focus energy on restoring the balance.
- **Decreasing appetite.** A child with CKD may not be hungry, or she or he may not have the energy to eat, which may lead to poor nutrition and slower growth.
- **Decreasing the production of EPO.** When erythropoietin levels are low, a child may develop anemia—a condition that develops when the blood does not have enough healthy red blood cells to carry oxygen to cells throughout the body. Anemia can cause growth to slow or stop.
- **Making an abnormally large amount of urine, called “polyuria,” which disrupts the body’s fluid balance.** A child with polyuria loses minerals as well. The body slows growth to make up for the lost fluid and minerals.
- **Preventing the body from correctly using growth hormone.** When the kidneys are damaged, waste builds up in the blood and the body does not properly process growth hormone.

### **HOW IS GROWTH FAILURE TREATED IN CHILDREN WITH CHRONIC KIDNEY DISEASE?**

Healthcare providers treat growth failure in children with CKD with:

- Changes in eating, diet, and nutrition
- Medications
- Growth hormone therapy

Most children with growth failure grow to about one-third of their adult height within the first two years of life; therefore, it is important to start treatment for growth failure early.



## EATING, DIET, AND NUTRITION

Children with CKD may lose their appetite or lack the energy to eat. To treat growth failure in children, a healthcare provider may recommend dietary changes, such as:

- **Adding calcium.** Children with CKD should get the recommended level of calcium for their age from their diet or from calcium supplements.
- **Monitoring liquids.** Balancing the child's liquid intake based on her or his kidney disease is important. Some children will need to increase liquid intake, while other children will need to restrict liquid intake.
- **Limiting phosphorus.** Children with CKD may need to limit phosphorus intake if they have mineral and bone disorders.
- **Monitoring protein.** Children with CKD should eat enough protein for growth; however, they should avoid high protein intake, which can put an extra burden on the kidneys.
- **Monitoring sodium.** The amount of sodium children with CKD need depends on the stage of their kidney disease, their age, and sometimes other factors. The healthcare provider may recommend either limiting or adding sodium, often from salt to the child's diet.
- **Adding vitamin D.** Children who do not get enough vitamin D through the diet may need to take vitamin D supplements.

To help ensure coordinated and safe care, parents and caregivers should discuss the use of complementary and alternative medical practices, including the use of dietary supplements, with the child's healthcare provider.

Some children will use a feeding tube to receive all their nutrition. A feeding tube is a small, soft plastic tube placed through the nose or mouth into the stomach. The child will receive supplements through the tube to provide a full supply of fluid and nutrients to help her or him grow and develop. Feeding tubes are most often used in infants; however, sometimes older children and adolescents benefit from them as well.



## Chronic Kidney Disease

Encouraging children to develop healthy eating habits can help prevent poor nutrition and promote healthy growth. The healthcare team will work with parents or caretakers to develop a healthy diet tailored to meet the needs of the child.

### Medications

A healthcare provider may prescribe medications that can help correct the underlying problems causing growth failure.

- **Phosphate binders.** A healthcare provider may prescribe phosphate binders when phosphorus levels in the blood rise and interfere with bone formation and normal growth. In the intestine, the medications bind or attach, to some of the phosphorus found in food, causing the phosphorus to move through the intestine without being absorbed and exit the body through the stool. This process can decrease blood phosphorus levels and increase blood calcium levels. Phosphate binders come as chewable tablets, liquids, capsules, and pills.
- **Alkaline agents.** A healthcare provider may prescribe alkaline agents, such as sodium bicarbonate to restore the acid-base balance in a child with acidosis.
- **Synthetic erythropoietin (EPO)** is a human-made form of EPO given by injection to treat anemia.

### Growth Hormone Therapy

When a healthcare provider diagnoses a child with CKD and the child begins to show signs of growth failure, the healthcare provider may prescribe daily human growth hormone injections. The injections are a human-made growth hormone that mimics the natural hormone found in the body. Researchers have shown that using growth hormone therapy is effective in helping children reach normal adult height.

## Section 8.7 | Metformin and Chronic Kidney Disease

This section includes text excerpted from “Metformin and Chronic Kidney Disease (CKD),” National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), September 18, 2019.

The story of metformin is really a story of guilt by association. Metformin belongs to a class of drugs called “biguanides.” From the 1950s to the 1970s, the leading drug in the biguanide class was phenformin. Globally, metformin was rarely used because phenformin was much more effective in lowering blood sugar. However, phenformin had a big problem; it was killing people. In 1977, phenformin was pulled from the U.S. market because it caused a fatal condition called “lactic acidosis.”

Biguanide research continued, and by the early 1990s, studies showed that metformin was safer than phenformin. However, because metformin is cleared from the body through the kidneys, there was concern that it would build up the toxic levels in people with chronic kidney disease (CKD), and just as phenformin, cause lactic acidosis. When the U.S. Food and Drug Administration (FDA) approved metformin in 1994, they attached a boxed warning that cautioned against the use of the drug in people who had even the slightest bit of abnormal kidney function, that is, men who had serum creatinine at or above 1.5 mg/dL and women who had serum creatinine at or above 1.4 mg/dL. However, for many years, clinicians have been concerned that this restriction might be excessively cautious.

### **HOW HAS THE FOOD AND DRUG ADMINISTRATION CHANGED THE BOXED WARNING ABOUT METFORMIN USE IN PEOPLE WITH CHRONIC KIDNEY DISEASE?**

In 2016, the FDA relaxed restrictions on metformin use in people with CKD in two ways. First, they included people who had worse kidney function. Second, they moved away from using the serum creatinine blood test as the marker of kidney disease, and they instead used the estimated glomerular filtration rate (eGFR). For a variety of reasons, eGFR is a much more accurate method of assessing kidney function.

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The FDA's new boxed warning indicates that metformin can be initiated in patients who have an eGFR greater than 45 mL/min, and treatment can be continued in existing patients as long as the eGFR remains above 30 mL/min.

Estimates suggest the changed guidance allows one million more people to take metformin. So, it is a substantial shift in the population that is eligible for the drug. Due to nuances in the conversion between creatinine and eGFR, people newly eligible to take metformin will tend to be younger and/or African American.

### **WHAT THE RESEARCH SAYS REGARDING USE OF METFORMIN IN PEOPLE WITH CHRONIC KIDNEY DISEASE AND OTHER HISTORICAL CONTRAINDICATIONS**

Researchers have tried to evaluate the benefits and harms of metformin use among populations with type 2 diabetes and moderate to severe CKD, congestive heart failure, or chronic liver disease with hepatic impairment. They wanted to confirm whether the published literature supports the change in FDA guidance.

A systematic review led by Dr. Matthew Crowley, Dr. Clarissa Diamantidis, and Dr. John Williams, was part of a report that was commissioned by the U.S. Department of Veterans' Affairs (VA) as part of the VA Evidence-based Synthesis Program. While the VA was the primary audience, the study has much broader implications. Also, even before the FDA changed its guidance, the researchers knew that about 20 or 30 percent of patients who were taking metformin fell inside the original boxed warning. They found that the evidence supports the FDA's change in the boxed warning. Among people with diabetes and moderate CKD, there is a 22 percent reduction in death due to any cause in those taking metformin compared with those who were not taking metformin. So, not only does metformin appear to be safe for people with diabetes and moderate CKD, but it appears to improve health and survival compared to alternative treatments.

## **WHAT SHOULD HEALTHCARE PROFESSIONALS KNOW ABOUT PRESCRIBING METFORMIN FOR PATIENTS WITH DIABETES AND CHRONIC KIDNEY DISEASE?**

All prescribers should take a look at the current FDA guidance on metformin if they have not done so. Again, this is a substantial change in terms of who and how metformin should be prescribed to these patients.

### **Section 8.8 | Managing Chronic Kidney Disease**

This section includes text excerpted from “Managing Chronic Kidney Disease,” National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), October 2016. Reviewed April 2020.

If you have chronic kidney disease (CKD), you can take steps to protect your kidneys from more damage. The sooner you know you have kidney disease, the better. The steps you take to protect your kidneys from damage also may help prevent heart disease—and improve your overall health. Making these changes when you have no symptoms may be hard, but it is worthwhile.

#### **CONTROL YOUR BLOOD PRESSURE**

The most important step you can take to treat kidney disease is to control your blood pressure. High blood pressure can damage your kidneys. You can protect your kidneys by keeping your blood pressure at or less than the goal set by your healthcare provider. For most people, the blood pressure goal is less than 140/90 mm Hg.

Work with your healthcare provider to develop a plan to meet your blood pressure goals. Steps you can take to meet your blood pressure goals may include eating heart-healthy and low-sodium meals, quitting smoking, being active, getting enough sleep, and taking your medicines as prescribed.

#### **MEET YOUR BLOOD GLUCOSE GOAL IF YOU HAVE DIABETES**

To reach your blood glucose goal, check your blood glucose level regularly. Use the results to guide decisions about food, physical

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activity, and medicines. Ask your healthcare provider how often you should check your blood glucose level.

Your healthcare provider will also test your A1C. The A1C is a blood test that measures your average blood glucose level over the past three months. This test is different from the blood glucose checks you do regularly. The higher your A1C number, the higher your blood glucose levels have been during the past three months. Stay close to your daily blood glucose numbers to help you meet your A1C goal.

The A1C goal for many people with diabetes is below seven percent. Ask your healthcare provider what your goal should be. Reaching your goal numbers will help you protect your kidneys.

### **WORK WITH YOUR HEALTHCARE TEAM TO MONITOR YOUR KIDNEY HEALTH**

The tests that healthcare providers use to test for kidney disease can also be used to track changes to kidney function and damage. Kidney disease tends to get worse over time. Each time you get checked, ask your provider how the test results compare to the last results. Your goals will be to:

- Keep your glomerular filtration rate (GFR) the same
- Keep your urine albumin the same or lower

Your healthcare provider will also check your blood pressure and, if you have diabetes, your A1C level, to make sure you are meeting your blood pressure and blood glucose goals.

### **How Can I Prepare for Visits with My Healthcare Provider?**

The more you plan for your visits, the more you will be able to learn about your health and treatment options.

### **MAKE A LIST OF QUESTIONS**

It is normal to have a lot of questions. Write down your questions as you think of them so that you can remember everything you want to ask when you see your healthcare provider. You may want to ask about what tests are being done, what test results mean, or the changes you need to make to your diet and medicines.

## **Sample Questions to Ask Your Provider for People with Kidney Disease**

### **ABOUT YOUR TESTS**

- What is my GFR? What does that mean?
- Has my GFR changed since last time?
- What is my urine albumin? What does it mean?
- Has my urine albumin changed since the last time it was checked?
- Is my kidney disease getting worse?
- Is my blood pressure where it needs to be?

### **ABOUT TREATMENT AND SELF-CARE**

- Do any of my medicines or doses need to be changed?
- What time of day should I take each of my medicines?
- Do I need to change what I eat?
- Will you refer me to a dietitian for diet counseling?
- When will I need to see a nephrologist (kidney specialist)?
- Do I need to worry about dialysis or a kidney transplant?
- What do I need to do to protect my veins?

### **ABOUT COMPLICATIONS**

- What other health problems may I face because of my kidney disease?
- Should I be looking for any symptoms? If so, what are they?

### **BRING A FRIEND OR RELATIVE WITH YOU FOR SUPPORT**

A trusted friend or family member can take notes, ask questions you may not have thought of, offer support, and help remember what the provider said during the visit. Talk ahead of time about what you want to get out of the visit and the role you would like your friend or relative to play.

### **Who Is Part of My Healthcare Team?**

The following healthcare providers may be part of the healthcare team involved in your treatment:

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- **Primary-care provider.** Your primary-care provider (PCP)—doctor, nurse practitioner, or physician assistant—is the person you see for routine medical visits. Your PCP may monitor your kidney health and help you manage your diabetes and high blood pressure. A PCP also prescribes medicines and may refer you to specialists.
- **Nurse.** A nurse may help with your treatment and teach you about monitoring and treating kidney disease, as well as managing your health conditions. Some nurses specialize in kidney disease.
- **Registered dietitian.** A registered dietitian is a food and nutrition expert who helps people create a healthy eating plan when they have a health condition such as kidney disease. Dietitians can help you by creating an eating plan based on how your kidneys are doing. “Renal dietitians” often work in dialysis centers and are specially trained to work with people with kidney failure.
- **Diabetes educator.** A diabetes educator teaches people with diabetes how to manage their disease and handle diabetes-related problems.
- **Pharmacist.** A pharmacist educates you about your medicines and fills your prescriptions. An important job for the pharmacist is to review all of your medicines, including over-the-counter (OTC) medicines, and supplements, to avoid unsafe combinations and side effects.
- **Social worker.** When you are close to needing dialysis, you may have a chance to meet with a social worker. A dialysis social worker helps people and their families deal with life changes and costs that come with having kidney disease and kidney failure. A dialysis social worker also can help people with kidney failure apply for help to cover treatment costs.
- **Nephrologist.** A nephrologist is a doctor who is a kidney specialist. Your PCP may refer you to a

nephrologist if you have a complicated case of kidney disease, your kidney disease is quickly getting worse, or your kidney disease is advanced.

## **TAKE MEDICINES AS PRESCRIBED**

Many people with CKD take medicines prescribed to lower blood pressure, control blood glucose, and lower cholesterol.

Two types of blood pressure medicines, angiotensin-converting-enzyme (ACE) inhibitors, and angiotensin II receptor blockers (ARBs) may slow kidney disease and delay kidney failure, even in people who do not have high blood pressure. The names of these medicines end in “pril” or “sartan.”

Many people need to take two or more medicines for their blood pressure. You may also need to take a diuretic, sometimes called a “water pill.” The aim is to meet your blood pressure goal. These medicines may work better if you limit your salt intake.

## **Know That Your Medicines May Change Over Time**

Your healthcare provider may change your medicines as your kidney disease gets worse. Your kidneys do not filter as well as they did in the past, and this can cause an unsafe buildup of medicines in your blood. Some medicines can also harm your kidneys. As a result, your provider may tell you to:

- Take a medicine less often or take a smaller dose
- Stop taking medicine or switch to a different one

Your pharmacist and healthcare provider needs to know about all the medicines you take, including OTC medicines, vitamins, and supplements.

## **Be Careful about the Over-the-Counter Medicines You Take**

If you take OTC or prescription medicines for headaches, pain, fever, or colds, you may be taking nonsteroidal anti-inflammatory drugs (NSAIDs). NSAIDs include commonly used pain relievers and cold medicines that can damage your kidneys and lead to acute



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<b>Drug Facts</b>		
<b>Active Ingredients (In each caplet)</b>	<b>Purposes</b>	
Ibuprofen 200mg (NSAID)*.....	Pain reliever/Fever reducer	
Pseudoephedrine HCl 30mg.....	Nasal decongestant	
*nonsteroidal anti-inflammatory drug		
<b>Uses:</b> Temporarily relieves these symptoms associated with the common cold, or flu:		
■ headache	■ fever	■ sinus pressure
■ nasal congestion	■ minor body aches and pains	

**Figure 8.5.** Drug Facts Label

kidney injury, especially in those with kidney disease, diabetes, and high blood pressure.

Ibuprofen and naproxen are NSAIDs. NSAIDs are sold under many different brand names, so ask your pharmacist or healthcare provider if the medicines you take are safe to use.

You also can look for NSAIDs on Drug Facts labels, such as the one in figure 8.6.

If you have been taking NSAIDs regularly to control chronic pain, you may want to ask your healthcare provider about other ways to treat pain, such as meditation or other relaxation techniques.

### Tips for Managing Your Medicines

The next time you pick up a prescription or buy an OTC medicine or supplement, ask your pharmacist how the product may:

- Affect your kidneys
- Affect other medicines you take

Fill your prescriptions at only one pharmacy or pharmacy chain so your pharmacist can:

- Keep track of your medicines and supplements
- Check for harmful interactions

To keep track of your medicines and supplements:

- Keep an up-to-date list of your medicines and supplements in your wallet. Take your list with you,

or bring all of your medicine bottles, to all healthcare visits.

## **WORK WITH A DIETITIAN TO DEVELOP A MEAL PLAN**

What you eat and drink can help you:

- Protect your kidneys
- Reach your blood pressure and blood glucose goals
- Prevent or delay health problems caused by kidney disease

As your kidney disease gets worse, you may need to make more changes to what you eat and drink.

A dietitian who knows about kidney disease can work with you to create a meal plan that includes foods that are healthy for you and that you enjoy eating. Cooking and preparing your food from scratch can help you eat healthier.

Nutrition counseling from a registered dietitian to help meet your medical or health goals is called “medical nutrition therapy” (MNT). If you have diabetes or kidney disease and a referral from your primary-care provider, your health insurance may cover MNT. If you qualify for Medicare, MNT is covered.

Your healthcare provider may be able to refer you to a dietitian. You can also find a registered dietitian online through the Academy of Nutrition and Dietetics. Work closely with your dietitian to learn to eat right for CKD.

## **MAKE PHYSICAL ACTIVITY PART OF YOUR ROUTINE**

Be active for 30 minutes or more on most days. Physical activity can help you reduce stress, manage your weight, and achieve your blood pressure and blood glucose goals. If you are not active now, ask your healthcare provider about the types and amounts of physical activity that are right for you.

## **AIM FOR A HEALTHY WEIGHT**

Being overweight makes your kidneys work harder and may damage your kidneys. The NIH Body Weight Planner ([www.niddk.nih.gov](http://www.niddk.nih.gov))

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gov/health-information/weight-management/body-weight-planner) is an online tool to help you tailor your calorie and physical activity plans to achieve and stay at a healthy weight.

### **GET ENOUGH SLEEP**

Aim for seven to eight hours of sleep each night. Getting enough sleep is important to your overall physical and mental health and can help you meet your blood pressure and blood glucose goals. You can take steps to improve your sleep habits.

### **STOP SMOKING**

Cigarette smoking can make kidney damage worse. Quitting smoking may help you meet your blood pressure goals, which is good for your kidneys, and can lower your chances of having a heart attack or stroke.

### **FIND HEALTHY WAYS TO COPE WITH STRESS AND DEPRESSION**

Long-term stress can raise your blood pressure and your blood glucose levels and lead to depression. Some of the steps that you are taking to manage your kidney disease are also healthy ways to cope with stress. For example, physical activity and sleep help reduce stress. Listening to your favorite music, focusing on something calm or peaceful, or meditating may also help you. Learn more about healthy ways to cope with stress.

Depression is common among people with a chronic, or long-term illness. Depression can make it harder to manage your kidney disease. Ask for help if you feel down. Seek help from a mental-health professional. Talking with a support group, clergy member, friend, or family member who will listen to your feelings may help.

## Section 8.9 | Nutrition for Children with Chronic Kidney Disease

This section includes text excerpted from “Nutrition for Children with Chronic Kidney Disease,” National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), December 2019.

### **WHY IS NUTRITION IMPORTANT FOR CHILDREN WITH CHRONIC KIDNEY DISEASE?**

Eating the right foods in the right amounts may improve your child’s growth, help your child feel better, and prevent or delay health problems from chronic kidney disease (CKD).

Healthy kidneys balance the salts and minerals—such as calcium, phosphorus, sodium, and potassium—in blood. When your child has kidney disease, her or his kidneys are damaged and cannot filter blood the way they should. What your child eats and drinks can help maintain a healthy balance of salts and minerals in her or his body.

Eating right can also make your child’s CKD medicines work better.

Your child’s healthcare team will work with you to create an eating plan with the right foods and nutrients in the right amounts for your child to grow properly. The team may suggest changes in both the amount and types of food your child needs as she or he gets older or if your child’s kidney disease gets worse. Learning about nutrients in the food will help you understand what changes you need to make to your child’s diet. You should always talk with the healthcare team before making any major changes to your child’s diet.

### **WHY ARE CALORIES IMPORTANT?**

Food provides the energy your child needs to grow and be active. Children with CKD tend to avoid eating because they do not feel hungry. Talk with your child’s kidney specialist or dietitian to make sure your child is getting enough calories for proper growth and to fight infections.

Children’s calorie needs change depending on their age, height, and weight. Your child’s healthcare team will determine your child’s daily calorie needs, which will change as your child gets older.

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To make sure your child is growing properly, her or his health-care professional will compare your child's height and weight against growth charts that show the normal ranges of growth for children by age. If your child is not growing well, the healthcare team can suggest healthy ways to add calories to your child's diet. Feeding tubes—thin, flexible tubes that carry liquid food into the stomach or small intestine—are often used for infants and, occasionally, situations arise in which older children and teenagers may also benefit from them.

### **WHY IS KNOWING ABOUT PROTEIN IMPORTANT?**

Protein is an important part of any diet. As your child's body uses protein, it produces waste that the kidneys must remove from the blood. Too much protein can cause waste to build up in your child's blood.

However, in children with CKD, too little protein can prevent them from growing normally and getting important nutrients. The goal is for children to eat enough protein to grow but to avoid excessive amounts of protein.

### **Sources of Protein**

#### **ANIMAL-PROTEIN FOODS**

- Dairy products such as milk, yogurt, cheese
- Eggs
- Fish
- Meat such as pork, beef, chicken, turkey, duck

#### **PLANT-PROTEIN FOODS**

##### High protein

- Beans, lentils, peas
- Nuts and nut spreads such as almond butter, peanut butter, soy nut butter
- Soy foods such as soy milk, tofu
- Sunflower seeds

##### Low protein

- Bread, tortillas

- Oatmeal, grits, cereals
- Pasta, noodles, rice
- Rice milk (not enriched)

Talk with a dietitian about how much protein is in your child's eating plan and where the protein comes from. A dietitian can suggest dietary changes to help meet your child's protein needs.

### **Children on Dialysis**

Children on dialysis need to eat somewhat more protein because the dialysis treatment removes some protein from the blood. The amount of protein removed from the blood depends on the type of dialysis treatment. Peritoneal dialysis typically removes more protein than hemodialysis.

Your child's protein needs will change over time. A dietitian can work with you and your child to adapt meal plans to your child's changing needs.

### **WHY IS KNOWING ABOUT SODIUM IMPORTANT?**

Sodium is a part of salt. Different children with CKD have very different sodium needs. In some children with CKD, too little sodium can lead to dehydration and poor weight gain. In other children, too much sodium may cause high blood pressure. What your child eats and drinks can help control the amount of sodium in her or his diet.

The amount of sodium your child needs will depend on the type of CKD your child has and how severe it is, your child's age, and other factors. You may need either to limit or add sodium to your child's diet. Talk with your child's healthcare team about how much sodium your child should have.

If your child's healthcare team suggests lowering the amount of sodium in her or his diet, you can help your child by:

- Buying fresh fruits and vegetables
- Choosing unprocessed meats instead of processed foods
- Cooking from scratch

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- Using spices, herbs, and salt-free seasonings instead of salt
- Looking for products labeled “sodium-free” or “low sodium”
- Draining and rinsing canned foods to remove salt

## Higher- and Lower-Sodium Foods

Foods higher in sodium include:

- Bacon, corned beef, ham, hot dogs, luncheon meats, sausage
- Bouillon, canned soups, instant soups, ramen noodle packages
- Boxed mixes, such as hamburger meals and pancake mix
- Canned and pickled vegetables, vegetable juice
- Canned beans, chicken, fish, meat
- Canned tomato products, including juice
- Cottage cheese
- Frozen meals
- Frozen vegetables with sauce
- Olives, pickles, relish
- Pretzels, chips, crackers, salted nuts
- Ready-to-eat boxed meals and side dishes
- Salad dressings, bottled sauces, marinades
- Salt and salt seasonings, such as garlic salt
- Seasoning mix, sauce packets
- Some ready-to-eat cereals, baked goods, bread
- Soy sauce

Foods lower in sodium include:

- Air-popped popcorn
- Cooked cereal without added salt
- Fresh meat, poultry, seafood
- Fresh or frozen fruits and vegetables
- Low- and reduced-sodium frozen dinners, peanut butter, salad dressings

- Low-fat, low-sodium cheese
- Rice, noodles
- Unsalted nuts

### **WHY IS KNOWING ABOUT POTASSIUM IMPORTANT?**

In some children with CKD, the kidneys do a poor job of removing potassium from the blood, and blood potassium levels can become very high. Too little or too much potassium can cause heart and muscle problems. Children with CKD should have their blood checked regularly to make sure their potassium levels are normal. Your child's food and drink choices can affect her or his potassium level. Talk with your child's healthcare team about how much potassium your child should have.

If the healthcare team suggests your child needs to lower the amount of potassium in her or his diet, you can help your child by:

- Avoiding high-potassium fruits and vegetables
- Tracking the portion sizes of fruits and vegetables that have moderate amounts of potassium. Checking with your healthcare professional about using salt substitutes, which can be very high in potassium.
- Talking with your child's dietitian about choosing foods your child likes that have the right amount of potassium

### **Higher- and Lower-Potassium Foods**

In the lists below, the potassium level is based on one serving. One serving of fruit is one small piece; ½ cup fresh, canned, or cooked fruit; ¼ cup dried fruit; or ½ cup juice. One serving of vegetables is ½ cup fresh or cooked vegetables, 1 cup leafy vegetables, or ½ cup juice.

Foods higher in potassium include:

- Fruits
  - Apricots (fresh)
  - Bananas
  - Cantaloupe
  - Dates



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- Kiwi
- Nectarines
- Oranges/orange juice
- Prunes/prune juice
- Raisins
- Vegetables
  - Acorn and butternut squash
  - Avocado
  - Baked beans
  - Beet and other greens
  - Broccoli (cooked)
  - Brussels sprouts (cooked)
  - Chard
  - Chili peppers
  - Mushrooms (cooked)
  - Potatoes
  - Pumpkin
  - Spinach (cooked)
  - Split peas, lentils, beans
  - Sweet potatoes, yams
  - Tomatoes/tomato juice/tomato sauce
  - Vegetable juice

Foods lower in potassium (200 mg or less) include:

- Fruits
- Apples/apple juice/applesauce
- Apricots (canned)/apricot nectar
- Berries
- Cranberry juice
- Fruit cocktail
- Grapefruit
- Grapes/grape juice
- Lemons and limes
- Papayas
- Peaches
- Pears
- Pineapple
- Plums
- Rhubarb

- Tangerines
- Watermelon
- Vegetables
- Alfalfa sprouts
- Bamboo shoots (canned)
- Bell peppers
- Broccoli (fresh)
- Cabbage
- Carrots
- Cauliflower
- Celery and onions (raw)
- Corn
- Cucumber
- Eggplant
- Green beans
- Kale
- Lettuce
- Mushrooms (fresh)
- Okra
- Summer squash (cooked)

### **WHY IS KNOWING ABOUT PHOSPHORUS IMPORTANT?**

Phosphorus can build up in the blood of children with CKD. Too much phosphorus can weaken your child's bones.

Phosphorus is found naturally in foods rich in protein and is also added to many processed foods. Phosphorus added to food may cause your child's blood phosphorus levels to go up more than phosphorus found naturally in food. A dietitian can help you find ways for your child to get enough protein without getting too much phosphorus.

### **High- and Low-Phosphorus Foods**

Foods higher in phosphorus include:

- Beans, lentils, nuts
- Bran cereals, oatmeal
- Cola, some bottled iced tea

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- Dairy foods (milk, cheese, yogurt)
- Ice-cream
- Processed meats (hot dogs, canned meat)

Foods lower in phosphorus include:

- Corn and rice cereals
- Fresh fruits and vegetables
- Home-brewed iced tea
- Rice milk (not enriched)
- Sorbet
- Unprocessed meats

As kidney disease gets worse, your child may need to take a phosphate binder with meals to lower the amount of phosphorus in the blood. A phosphate binder is a medicine that acts like a sponge to soak up, or bind, phosphorus while it is in the stomach. Because it is bound, the phosphorus does not get into the child's blood. Instead, the child's body removes the phosphorus through her or his stool.

## **SHOULD YOUR CHILD TAKE VITAMIN AND MINERAL SUPPLEMENTS?**

Children with CKD may not get enough of certain vitamins and minerals because they have to limit some foods or they may not feel hungry and do not eat enough of certain foods. If your child is on dialysis, your child may lose water-soluble vitamins during the dialysis treatment.

Your child's kidney care specialist may prescribe vitamin and mineral supplements specifically designed for children with kidney failure.

**Warning.** Never give your child vitamin and mineral supplements you can buy over the counter (OTC). OTC vitamin and mineral supplements may be harmful to children with kidney failure. For safety reasons, talk with your child's healthcare team before giving your child any medicines, vitamin and mineral supplements, or probiotics that have not been prescribed for your child.

## **WHY IS KEEPING TRACK OF HOW MUCH SOLID OR LIQUID YOUR CHILD EATS OR DRINKS IS IMPORTANT?**

In the early stages of kidney disease, a child's damaged kidneys may make too much or too little urine. When the kidneys make too little urine, this may cause high blood pressure or swelling of the face, legs, arms, or abdomen. If the kidneys make too much urine, the child may get dehydrated. Tell your child's healthcare team if you notice a change in the amount of urine your child makes or if you notice any swelling.

If your child is on dialysis, too much fluid can build up between dialysis sessions. Children on dialysis may feel better if they take in a limited amount of liquid. The amount your child drinks is often related to how much sodium she or he eats. Talk with your child's healthcare team about how to control excess thirst if that is a problem. The healthcare team can help you figure out the right amount of liquid for your child.

## **WHAT ARE SOME SPECIAL PROBLEMS FOR INFANTS WITH CHRONIC KIDNEY DISEASE?**

Because infants grow so quickly, the healthcare team will need to follow an infant with CKD closely. Often, infants will take special formulas with extra supplements and calories to be sure they get the right amount of fluid and nutrients. If an infant cannot drink the needed amount of formula, the healthcare professional may suggest tube feeding. Tube feeding is often the best way to make sure a child gets the full supply of fluid and nutrients needed to grow and develop properly.

## **UNDERSTANDING LAB REPORTS AND MAKING HEALTHY FOOD CHOICES FOR YOUR CHILD WITH CHRONIC KIDNEY DISEASE**

Your child's healthcare team will order regular blood tests to track your child's health. You may need to make changes to what your child eats and drinks, based on the blood test results. You may find that keeping track of test results helps you see how well your child is doing. You can ask your child's healthcare professional for copies of the lab reports and to explain them to you, so you can note any results out of the normal range.