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## **What Do My Kidneys Do?**

Your kidneys are bean-shaped organs, each about the size of your fist. They are located near the middle of your back, just below the rib cage. The kidneys are sophisticated trash collectors. Every day, your kidneys process about 200 quarts of blood to sift out about 2 quarts of waste products and extra water. The waste and extra water become urine, which flows to your bladder through tubes called ureters. Your bladder stores urine until you go to the bathroom.

The wastes in your blood come from the normal breakdown of active muscle and from the food you eat. Your body uses the food for energy and self-repair. After your body has taken what it needs from the food, waste is sent to the blood. If your kidneys did not remove these wastes, the wastes would build up in the blood and damage your body.

The actual filtering occurs in tiny units inside your kidneys called nephrons. Every kidney has about a million nephrons. In the nephron, tiny blood vessels called capillaries intertwine with tiny urine-carrying tubes called tubules. A complicated chemical exchange takes place, as waste materials and water leave your blood and enter your urinary system.

At first, the tubules receive a combination of waste materials and chemicals that your body can still use. Your kidneys measure out chemicals like sodium, phosphorus, and potassium and release them back to the blood to return to the body. In this way, your kidneys regulate the body's level of these substances. The right balance is necessary for life, but excess levels can be harmful. In the nephron (left), tiny blood vessels intertwine with urine-collecting tubes. Each kidney contains about 1 million nephrons.

### **In addition to removing wastes, your kidneys release three important hormones:**

- Erythropoietin (eh-RITH-ro-POYeh-tin), or EPO, which stimulates the bones to make red blood cells.
- Renin (REE-nin), which regulates blood pressure.
- The active form of vitamin D, which helps maintain calcium for bones and for normal chemical balance in the body.

Your health care team may talk about the work your kidneys do as renal function. If you have two healthy kidneys, you have 100 percent of your renal function. This is more renal function than you really need. Some people are born with only one kidney, and these people are able to lead normal, healthy lives. Many people donate a kidney for transplantation to a family member or friend. Small declines in renal function do not cause a problem. In fact, you can be healthy with 50 percent of your renal function if it remains stable.

But many people with 50 percent of their renal function have a kidney disease that will get worse. You will have some serious health problems if you have less than 20 percent of your renal function. If your renal function drops below 10 to 15 percent, you cannot live long without some form of renal replacement therapy--either dialysis or transplantation.

## Why Do Kidneys Fail?

Most kidney diseases attack the nephrons, causing them to lose their filtering capacity. Damage to the nephrons may happen quickly, often as the result of injury or poisoning. But most kidney diseases destroy the nephrons slowly and silently. It may take years or even decades for the damage to become apparent. The two most common causes of kidney disease are diabetes and high blood pressure. If your family has a history of any kind of kidney problems, you may be at risk for kidney disease.

### ***Diabetic Nephropathy***

Diabetes is a disease that keeps the body from using sugar as it should. If sugar stays in your blood instead of breaking down, it can act like a poison. Damage to the nephrons from unused sugar in the blood is called diabetic nephropathy. If you keep your blood sugar levels down, you can delay or prevent diabetic nephropathy.

### ***High Blood Pressure***

High blood pressure can damage the small blood vessels in your kidneys. The damaged vessels cannot filter poisons from your blood as they are supposed to. Your doctor may prescribe blood pressure medication. A group of blood pressure medicines called ACE inhibitors appears to give extra protection to the kidneys in patients with diabetes.

### ***Inherited and Congenital Kidney Diseases***

Some kidney diseases result from hereditary factors. Polycystic kidney disease (PKD), for example, is a genetic disorder in which many cysts grow in the kidneys. PKD cysts can slowly replace much of the mass of the kidneys, reducing kidney function and leading to kidney failure. Some kidney problems may show up when a child is still developing in the womb. Examples include autosomal recessive PKD, a rare form of PKD, and other developmental problems that interfere with the normal formation of the nephrons. The signs of kidney disease in children vary. A child may grow unusually slowly, may vomit often, or may have back or side pain. Some kidney diseases may be "silent" for months or even years.

If your child has a kidney disease, your child's doctor should find it during a regular checkup. Be sure your child sees a doctor regularly. The first sign of a kidney problem may be high blood pressure, a low number of red blood cells (anemia), or blood or protein in the child's urine. If the doctor finds any of these problems, further tests may be necessary, including additional blood and urine tests or radiology studies. In some cases, the doctor may need to perform a biopsy-removing a piece of the kidney for inspection under a microscope. Some hereditary kidney diseases may not be detected until adulthood. The most common form of PKD was once called "adult PKD" because the symptoms of high blood pressure and renal failure usually do not occur until patients are in their twenties or thirties. But with advances in diagnostic imaging technology, doctors have found cysts in children and adolescents before any symptoms appear.

### ***Other Causes of Kidney Disease***

Poisons and trauma, for example a direct and forceful blow to your kidneys, can lead to kidney disease.

Some over-the-counter medicines can be poisonous to your kidneys if taken regularly over a long period of time. Products that combine aspirin, acetaminophen, and other medicines such as ibuprofen have been found to be the most dangerous to the kidneys. If you take painkillers regularly, check with your doctor to make sure you are not putting your kidneys at risk.

## How Do Kidneys Fail?

Many factors that influence the speed of kidney failure are not completely understood. Researchers are still studying how protein in the diet and cholesterol levels in the blood affect kidney function.

### ***Acute Renal Failure***

Some kidney problems happen quickly, like an accident that injures the kidneys. Losing a lot of blood can cause sudden kidney failure. Some drugs or poisons can make your kidneys stop working. These sudden drops in kidney function are called acute renal failure (ARF). ARF may lead to permanent loss of kidney function. But if your kidneys are not seriously damaged, acute renal failure may be reversed.

### ***Chronic Renal Failure***

Most kidney problems, however, happen slowly. You may have "silent" kidney disease for years. Gradual loss of kidney function is called chronic renal failure or chronic renal disease.

### ***End-Stage Renal Disease***

The condition of total or nearly total and permanent kidney failure is called end-stage renal disease (ESRD). People with ESRD must undergo dialysis or transplantation to stay alive.

## What Are the Signs of Kidney Disease?

People in the early stages of kidney disease may not feel sick at all. The first signs that you are sick may be general: frequent headaches or feeling tired or itchy all over your body. If your kidney disease gets worse, you may need to urinate more often or less often. You may lose your appetite or experience nausea and vomiting. Your hands or feet may swell or feel numb. You may get drowsy or have trouble concentrating. Your skin may darken. You may have muscle cramps.

## How Will My Doctor Detect Kidney Disease?

First, your doctor will probably send blood and urine samples to a lab to test for substances that should not be there. If the blood contains too much creatinine or urea nitrogen and the urine contains protein, your kidneys may not be functioning properly.

### ***Creatinine***

Creatinine is a waste product in the blood created by the normal breakdown of muscle during activity. Healthy kidneys take creatinine out of the blood and put it in the urine to leave the body. When kidneys are not working well, creatinine builds up in the blood.

In the lab, your blood will be tested to see how many milligrams of creatinine are in one deciliter of blood (mg/dl). Creatinine levels in the blood can vary, and each laboratory has its own normal range. In many labs, the normal creatinine range is 0.6 to 1.2 mg/dl. If your creatinine level is only slightly above this normal range, you probably will not feel sick, but the elevation is a sign that your kidneys are not working at full strength. One formula for estimating kidney function equates a creatinine level of 2.0 mg/dl to 50 percent of normal kidney function and 4.0 mg/dl to 25 percent. But, because creatinine values are so variable and can be affected by diet, you may need to have your creatinine measured regularly to see whether your kidney function is decreasing. The doctor may refer to the measure of creatinine in your blood as your serum creatinine. Do not confuse your serum creatinine number with your creatinine clearance number.

### ***Creatinine Clearance***

A creatinine clearance test shows how fast your kidneys remove creatinine from the blood. Clearance is measured in milliliters per minute (ml/min). To measure your creatinine clearance, you will need to collect urine for 24 hours. Your doctor or nurse will give you a container to collect urine and special instructions for timing the 24-hour collection. When you take the collected urine to your doctor or laboratory, you will also give a blood sample at that time. Your doctor will measure your creatinine clearance by comparing the amount of creatinine in your urine to the amount of creatinine in your blood. For men, a normal creatinine clearance rate is 97 to 137 ml/min. For women, the normal rate is 88 to 128 ml/min. If your number is below this normal range, your kidneys are not working at full strength.

### ***Blood Urea Nitrogen (BUN)***

Blood carries protein for use by cells throughout the body. After the cells use the protein, the remaining waste product is returned to the blood as urea, a compound containing nitrogen. Healthy kidneys take urea out of the blood and send it to the bladder in the urine. If your kidneys are not working well, the urea will stay in the blood. Normal blood contains 7 to 20 milligrams of urea per deciliter of blood. If your BUN is more than 20 mg/dl, your kidneys may not be working at full strength. Other possible causes of an elevated BUN include dehydration and heart failure.

### ***Proteinuria***

Healthy kidneys take wastes out of the blood but leave in protein. Impaired kidneys may fail to separate the protein from the wastes. Proteinuria means protein in the urine, and it is a sign of poor kidney function. If your urine makes foam in the toilet, it may contain high levels of protein. Your doctor may test for protein using a dipstick in a small sample of your urine taken in the doctor's office. The color of the dipstick indicates the presence or absence of proteinuria. For a more precise measurement, you may need to collect urine for 24 hours.

### ***Additional Tests***

Renal imaging. If blood and urine tests indicate reduced kidney function, your doctor may recommend additional tests to help identify the cause of the problem. Renal imaging (taking pictures of the kidneys) methods include ultrasound, computed tomography (CAT scan), and magnetic resonance imaging (MRI). These tools are most helpful in finding unusual growths or blockages to the flow of urine.

Renal biopsy. Your doctor may want to see a tiny piece of your kidney tissue under a microscope. To obtain this tissue sample, the doctor will perform a renal biopsy--a hospital procedure in which the doctor inserts a needle through your skin into the back of the kidney. The needle retrieves a strand of tissue about 1/2 to 3/4 of an inch long. You will lie prone (on your stomach) on a table and will receive local anesthetic to numb the skin. The sample tissue will help the doctor identify problems at the cellular level.

## **What Can I Do About Kidney Disease?**

Unfortunately, kidney disease cannot be cured. But if you are in the early stages of a kidney disease, you may be able to make your kidneys last longer by taking certain steps.

- If you have diabetes, watch your blood sugar closely to keep it under control. Consult your doctor for the latest in treatment.
- Have your blood pressure checked regularly. Talk with your doctor about the best medicine to keep your blood pressure under control.
- Avoid pain pills that may make your kidney disease worse. Check with your doctor before taking any medicine.

***Diet***

People with reduced kidney function need to be aware that some parts of a normal diet may speed their kidney failure.

***Protein***

Protein is important to your body. It helps your body repair muscles and fight disease. Protein comes mostly from meat. As discussed in an earlier section, healthy kidneys take wastes out of the blood but leave in protein. Impaired kidneys may fail to separate the protein from the wastes. Some doctors tell their kidney patients to limit the amount of protein they eat so that the kidneys have less work to do. But you cannot avoid protein entirely. You may need to work with a dietitian to find the right food plan.

***Cholesterol***

Another problem that may speed kidney failure is too much cholesterol (koh-LEStuh-rawl) in your blood. High levels of cholesterol may result from a high-fat diet. Cholesterol can build up on the inside walls of your blood vessels. The buildup makes pumping blood through the vessels harder for your heart. Although scientists do not know exactly why, patients with high cholesterol are more likely to have kidney problems. They also know that kidney patients who keep their cholesterol under control--either through diet or medicine--are more likely to preserve their remaining renal function.

***Sodium***

Sodium is a chemical found in salt and other foods. Sodium in your diet may raise your blood pressure, so you should limit foods that contain high levels of sodium. High-sodium foods include canned or processed foods like frozen dinners and hot dogs.

***Potassium***

Potassium is a mineral found naturally in many fruits and vegetables, like potatoes, bananas, dried fruits, dried beans and peas, and nuts. Healthy kidneys measure potassium in your blood and remove excess amounts. Diseased kidneys may fail to remove excess potassium, which can slow down the heart.

***Treating Anemia***

Anemia is a condition in which the blood does not contain enough red blood cells. These cells are important because they carry oxygen throughout the body. If you are anemic, you will feel tired and look pale. Healthy kidneys make the hormone EPO, which stimulates the bones to make red blood cells. Diseased kidneys may not make enough EPO. You may need to take injections of a manmade form of EPO. Other types of anemia may be treated with iron supplements or folic acid (a B vitamin) injections.

***Preparing for End-Stage Renal Disease***

As your kidney disease progresses, you will need to make several decisions. You will need to learn about your options for treating ESRD so that you can make an informed choice between hemodialysis, peritoneal dialysis, and transplantation.

**What Happens If My Kidneys Fail Completely?**

If your kidneys stop working completely, your body fills with extra water and waste products. This condition is called uremia. Your hands or feet may swell. You will feel tired and weak because your body needs clean blood to function properly. Untreated end-stage renal disease may lead to seizures or coma and will ultimately result in death. If your kidneys stop working completely, you will need to undergo dialysis or kidney transplant.

## ***Dialysis***

The two major forms of dialysis are hemodialysis and peritoneal dialysis. In hemodialysis, your blood is sent through a machine that filters away waste products. The clean blood is returned to your body. Hemodialysis is usually performed at a dialysis center three times per week for 3 or 4 hours. In peritoneal dialysis, a fluid is put into your abdomen. This fluid, called dialysate, captures the waste products from your blood. After a few hours, the dialysate containing your body's wastes is drained away. Then, a fresh bag of dialysate is dripped into the abdomen. Patients can learn to do this themselves without going to a doctor's office each time. Patients using continuous ambulatory peritoneal dialysis (CAPD), the most common form of peritoneal dialysis, change dialysate four times a day.

## ***Transplantation***

A donated kidney may come from an anonymous donor who has recently died or from a living person, usually a relative. The kidney that you receive must be a good match for your body. The more the new kidney is like you, the less likely your immune system is to reject it. Your immune system protects you from disease by attacking anything that is not recognized as a normal part of your body. So your immune system will attack a kidney that appears to be "foreign." Special drugs can help trick your immune system so it does not reject a transplanted kidney.

## **What Will the Future Bring?**

As our understanding of the causes of kidney failure increases, so will our ability to predict and prevent these diseases. Recent studies have shown that intensive control of diabetes and high blood pressure can prevent or delay the onset of kidney disease.

In the area of genetics, researchers have located two genes that cause the most common form of PKD and are narrowing in on a third gene that causes a less common form. This new knowledge will be used in the search for effective therapies to prevent or treat PKD.

In the area of transplantation, new drugs to help the body accept foreign tissue increase the likelihood that a transplanted kidney will survive and function normally. To combat the shortage of organs available for transplantation, scientists are exploring the possibility of using organs from animals. If this method is found to be medically feasible and ethically acceptable, the time a patient must wait for a usable kidney could be greatly reduced. In the distant future, scientists may develop an artificial kidney for implantation.

## **Points To Remember**

- Your kidneys are vital organs, keeping your blood clean and chemically balanced.
- The progression of kidney disease can be slowed, but it cannot be reversed.
- End-stage renal disease (ESRD) is the total loss of kidney function.
- Dialysis and transplantation can extend the lives of people with ESRD.
- Diabetes and high blood pressure are the two leading causes of kidney failure.
- You should see a nephrologist regularly if you have renal disease

If you are in the early stages of renal disease, you may be able to save your remaining renal function for many years by:

- Controlling your blood sugar.
- Controlling your blood pressure.
- Following a low-protein diet.
- Maintaining healthy levels of cholesterol in your blood.
- Taking an ACE inhibitor if you have diabetes.