The Kidneys and How They Work

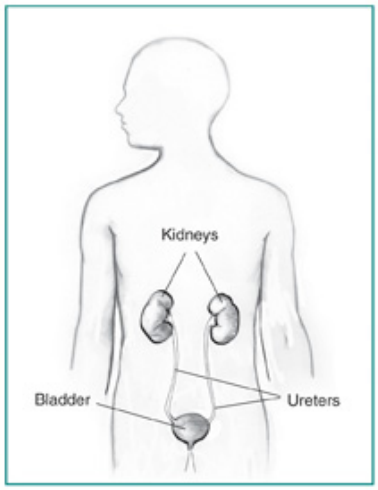
Updated in March 2012

http://kidney.niddk.nih.gov/KUDiseases/pubs/yourkidneys/index.aspx

The kidneys are a pair of vital organs that perform many functions to keep the blood clean and chemically balanced. Understanding how the kidneys work can help a person keep them healthy.

What do the kidneys do?

The kidneys are bean-shaped organs, each about the size of a fist. They are located near the middle of the back, just below the rib cage, one on each side of the spine. The kidneys are sophisticated reprocessing machines. Every day, a person's kidneys process about 200 quarts of blood to sift out about 2 quarts of waste products and extra water. The wastes and extra water become urine, which flows to the bladder through tubes called ureters. The bladder stores urine until releasing it through urination.



The kidneys remove wastes and water from the blood to form urine. Urine flows from the kidneys to the bladder through the ureters.

Wastes in the blood come from the normal breakdown of active tissues, such as muscles, and from food. The body uses food for energy and self-repairs. After the body has taken what it needs from food, wastes are sent to the blood. If the kidneys did not remove them, these wastes would build up in the blood and damage the body.

The actual removal of wastes occurs in tiny units inside the kidneys called nephrons. Each kidney has about a million nephrons. In the nephron, a glomerulus-which is a tiny blood vessel, or capillary-intertwines with a tiny urine-collecting tube called a tubule. The glomerulus acts as a filtering unit, or sieve, and keeps normal proteins and cells in the bloodstream, allowing extra fluid and wastes to pass through. A complicated chemical exchange takes place, as waste materials and water leave the blood and enter the urinary system.

Why do kidneys fail?

Most kidney diseases attack the nephrons, causing them to lose their filtering capacity. Damage to the nephrons can happen quickly, often as the result of injury or poisoning. But most kidney diseases destroy the nephrons slowly and silently. Only after years or even decades will the damage become apparent. Most kidney diseases attack both kidneys simultaneously.

The two most common causes of kidney disease are diabetes and high blood pressure. People with a family history of any kind of kidney problem are also at risk for kidney disease.

Diabetic Kidney Disease: Diabetes is a disease that keeps the body from using glucose, a form of sugar, as it should. If glucose stays in the blood instead of breaking down, it can act like a poison. Damage to the nephrons from unused glucose in the blood is called diabetic kidney disease. Keeping blood glucose levels down can delay or prevent diabetic kidney disease. Use of medications called angiotensin-converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) to treat high blood pressure can also slow or delay the progression of diabetic kidney disease.

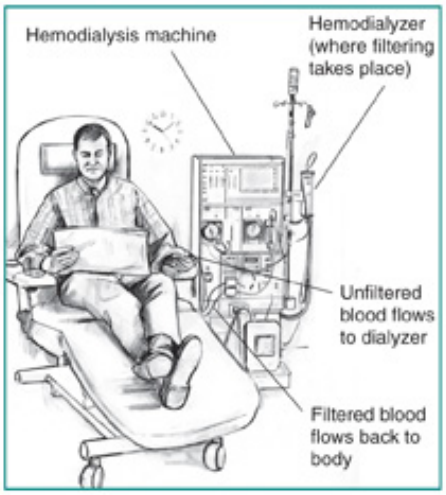
High Blood Pressure: High blood pressure can damage the small blood vessels in the kidneys. The damaged vessels cannot filter wastes from the blood as they are supposed to. A doctor may prescribe blood pressure medication. ACE inhibitors and ARBs have been found to protect the kidneys even more than other medicines that lower blood pressure to similar levels. The National Heart, Lung, and Blood Institute (NHLBI), one of the National Institutes of Health, recommends that people with diabetes or reduced kidney function keep their blood pressure below 130/80.

What happens if the kidneys fail completely?

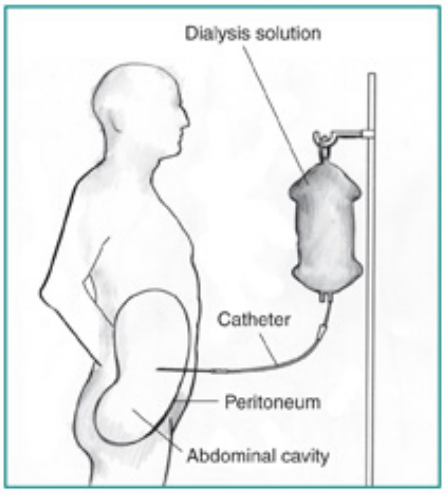
Total or nearly total and permanent kidney failure is called ESRD. If a person's kidneys stop working completely, the body fills with extra water and waste products. This condition is called uremia. Hands or feet may swell. A person will feel tired and weak because the body needs clean blood to function properly.

Untreated uremia may lead to seizures or coma and will ultimately result in death. A person whose kidneys stop working completely will need to undergo dialysis or kidney transplantation.

Dialysis: The two major forms of dialysis are hemodialysis and peritoneal dialysis. Hemodialysis uses a special filter called a dialyzer that functions as an artificial kidney to clean a person's blood. The dialyzer is a canister connected to the hemodialysis machine. During treatment, the blood travels through tubes into the dialyzer, which filters out wastes, extra salt, and extra water. Then the cleaned blood flows through another set of tubes back into the body. The hemodialysis machine monitors blood flow and removes wastes from the dialyzer. Hemodialysis is usually performed at a dialysis center three times per week for 3 to 4 hours. A small but growing number of clinics offer home hemodialysis in addition to standard in-clinic treatments. The patient first learns to do treatments at the clinic, working with a dialysis nurse. Daily home hemodialysis is done 5 to 7 days per week for 2 to 3 hours at a time. Nocturnal dialysis can be performed for 8 hours at night while a person sleeps. Research as to which is the best method for dialysis is under way, but preliminary data indicate that daily dialysis schedules such as short daily dialysis or nocturnal dialysis may be the best form of dialysis therapy.



Hemodialysis

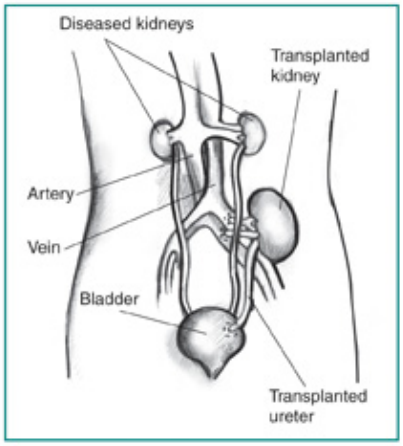


Peritoneal dialysis

In peritoneal dialysis, a fluid called dialysis solution is put into the abdomen. This fluid captures the waste products from a person's blood. After a few hours when the fluid is nearly saturated with wastes, the fluid is drained through a catheter. Then, a fresh bag of fluid is dripped into the abdomen to continue the cleansing process. Patients can perform peritoneal dialysis themselves. Patients using continuous ambulatory peritoneal dialysis (CAPD) change fluid four times a day. Another form of peritoneal dialysis, called continuous cycling peritoneal dialysis (CCPD), can be performed at night with a machine that drains and refills the abdomen automatically.

Transplantation:

A donated kidney may come from an anonymous donor who has recently died or from a living person, usually a relative. The kidney must be a good match for the patient's body. The more the new kidney is like the person receiving the kidney, the less likely the immune system is to reject it. The immune system protects a person from disease by attacking anything that is not recognized as a normal part of the body. So the immune system will attack a kidney that appears too "foreign." The patient will take special drugs to help trick the immune system so it does not reject the transplanted kidney. Unless they are causing infection or high blood pressure, the diseased kidneys are left in place. Kidneys from living, related donors appear to be the best match for success, but kidneys from unrelated people also have a long survival rate. Patients approaching kidney failure should ask their doctor early about starting the process to receive a kidney transplant.



Hope through Research

As understanding of the causes of kidney failure increases, so does the 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 transplantation, new drugs to help the body accept foreign tissue increase the likelihood that a transplanted kidney will survive and function properly. Scientists at the NIDDK are also developing new techniques to induce a person's tolerance for foreign tissue before receiving a transplanted organ. This technique will eliminate or reduce the need for immunosuppressive drugs and thereby reduce expense and complications. In the future, scientists may develop an artificial kidney for implantation.