Kidney Stones in Adults

National Kidney and Urologic Diseases Information Clearinghouse

U.S. Department of Health and Human Services

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NATIONAL INSTITUTE OF DIABETES AND DIGESTIVE AND KIDNEY DISEASES

ADULT PEDIATRIC UROLOGY & UROGYNECOLOGY

What is a kidney stone?

A kidney stone is a solid piece of material that forms in a kidney when substances that are normally found in the urine become highly concentrated. A stone may stay in the kidney or travel down the urinary tract. Kidney stones vary in size. A small stone may pass on its own, causing little or no pain. A larger stone may get stuck along the urinary tract and can block the flow of urine, causing severe pain or bleeding.

Kidney stones are one of the most common disorders of the urinary tract. Each year in the United States, people make more than a million visits to health care providers and more than 300,000 people go to emergency rooms for kidney stone problems.[1]

Urolithiasis is the medical term used to describe stones occurring in the urinary tract. Other frequently used terms are urinary tract stone disease and nephrolithiasis. Terms that describe the location of the stone in the urinary tract are sometimes used. For example, a ureteral stone—or ureterolithiasis—is a kidney stone found in the ureter.

What is the urinary tract?

The urinary tract is the body's drainage system for removing wastes and extra water. The urinary tract includes two kidneys, two ureters, a bladder, and a urethra. The kidneys are two 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. Every day, the two kidneys process about 200 quarts of blood to produce about 1 to 2 quarts of urine, composed of wastes and extra water. The urine flows from the kidneys to the bladder through tubes called ureters. The bladder stores urine until releasing it through urination. When the bladder empties, urine flows out of the body through a tube called the urethra at the bottom of the bladder.

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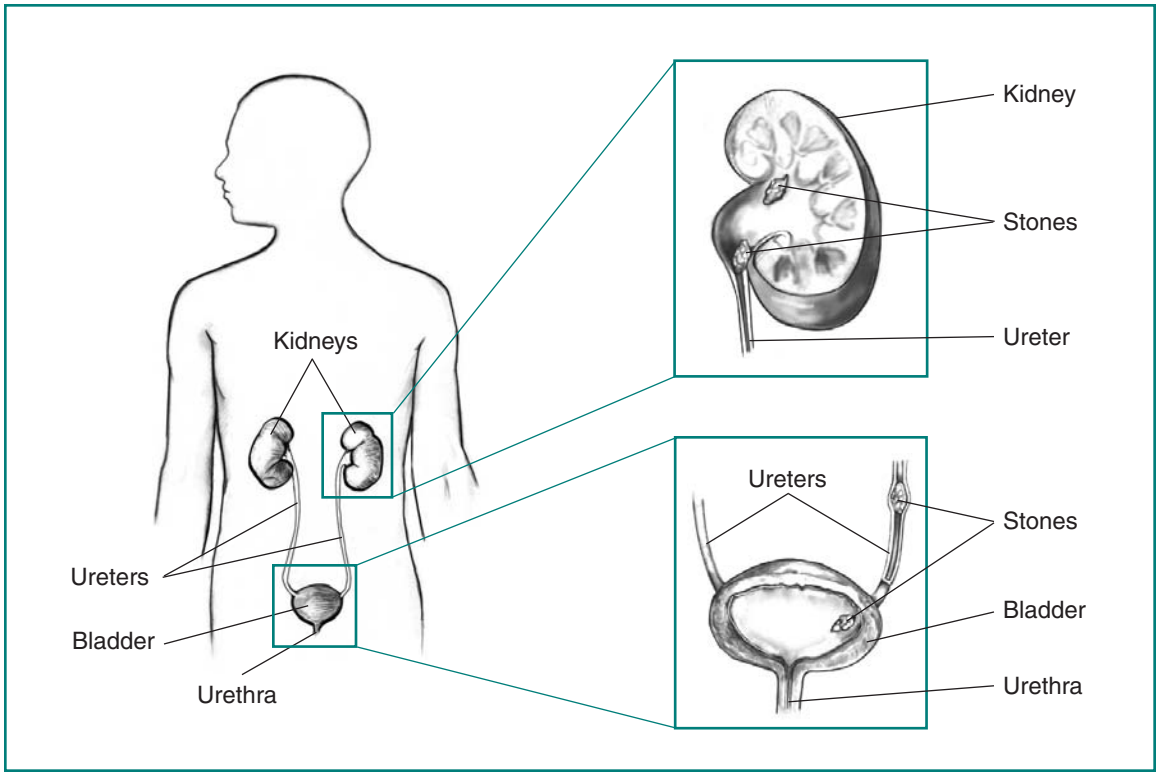
[1]Urinary tract stones. In: Litwin MD, Saigal CS, eds. *Urologic Diseases in America.* Department of Health and Human Services, Public Health Service, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases. Washington, D.C.: Government Printing Office; 2012. NIH publication 12–7865.



Kidney stones in the kidney and urinary tract

Who gets kidney stones?

Anyone can get a kidney stone, but some people are more likely to get one. Men are affected more often than women, and kidney stones are more common in non-Hispanic white people than in non-Hispanic black people and Mexican Americans. Overweight and obese people are more likely to get a kidney stone than people of normal weight. In the United States, 8.8 percent of the population, or one in 11 people, have had a kidney stone.[2]

What causes kidney stones?

Kidney stones can form when substances in the urine—such as calcium, oxalate, and phosphorus—become highly concentrated. Certain foods may promote stone formation in people who are susceptible, but scientists do not believe that eating any specific food causes stones to form in people who are not susceptible. People who do not drink enough fluids may also be at higher risk, as their urine is more concentrated.

[2]Scales CD, Smith AC, Hanley JM, Saigal CS. Prevalence of kidney stones in the United States. *European Urology.* 2012;62:160–165.

People who are at increased risk of kidney stones are those with

- hypercalciuria, a condition that runs in families in which urine contains unusually large amounts of calcium; this is the most common condition found in those who form calcium stones
- a family history of kidney stones
- cystic kidney diseases, which are disorders that cause fluid-filled sacs to form on the kidneys
- hyperparathyroidism, a condition in which the parathyroid glands, which are four pea-sized glands located in the neck, release too much hormone, causing extra calcium in the blood
- renal tubular acidosis, a disease that occurs when the kidneys fail to excrete acids into the urine, which causes a person's blood to remain too acidic
- cystinuria, a condition in which urine contains high levels of the amino acid cystine
- hyperoxaluria, a condition in which urine contains unusually large amounts of oxalate
- hyperuricosuria, a disorder of uric acid metabolism
- gout, a disorder that causes painful swelling of the joints
- blockage of the urinary tract
- chronic inflammation of the bowel
- a history of gastrointestinal (GI) tract surgery

Others at increased risk of kidney stones are people taking certain medications including

- diuretics—medications that help the kidneys remove fluid from the body
- calcium-based antacids
- the protease inhibitor indinavir (Crixivan), a medication used to treat HIV infection
- the anti-seizure medication topiramate (Topamax)

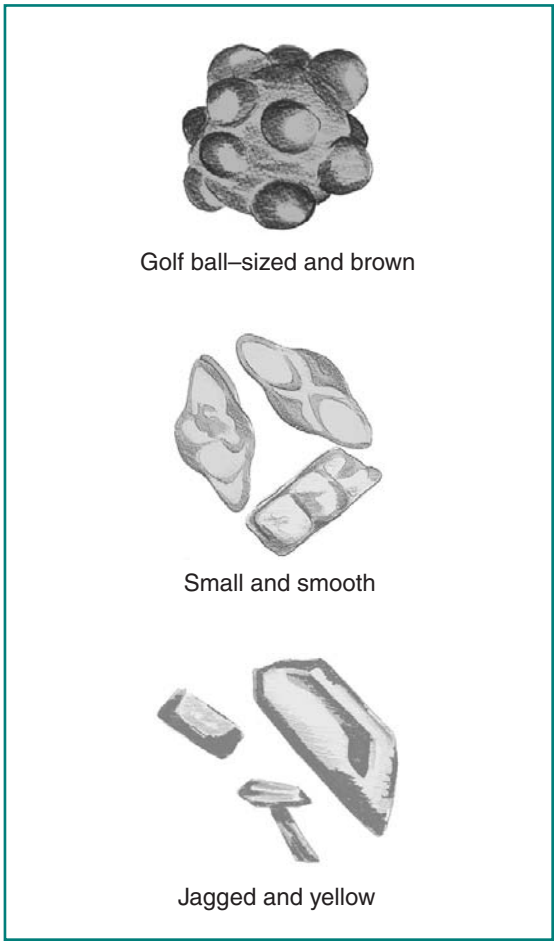
What are the types of kidney stones?

Four major types of kidney stones can form:

- **Calcium stones** are the most common type of kidney stone and occur in two major forms: calcium oxalate and calcium phosphate. Calcium oxalate stones are more common. Calcium oxalate stone formation may be caused by high calcium and high oxalate excretion. Calcium phosphate stones are caused by the combination of high urine calcium and alkaline urine, meaning the urine has a high pH.
- **Uric acid stones** form when the urine is persistently acidic. A diet rich in purines—substances found in animal protein such as meats, fish, and shellfish—may increase uric acid in urine. If uric acid becomes concentrated in the urine, it can settle and form a stone by itself or along with calcium.
- **Struvite stones** result from kidney infections. Eliminating infected stones from the urinary tract and staying infection-free can prevent more struvite stones.
- **Cystine stones** result from a genetic disorder that causes cystine to leak through the kidneys and into the urine, forming crystals that tend to accumulate into stones.

What do kidney stones look like?

Kidney stones vary in size and shape. Stones may be as small as a grain of sand or as large as a pearl. Some stones are even as big as golf balls. Stones may be smooth or jagged and are usually yellow or brown.



Kidney stones vary in size and shape. These stones are not actual size.

What are the symptoms of kidney stones?

People with kidney stones may have pain while urinating, see blood in the urine, or feel a sharp pain in the back or lower abdomen. The pain may last for a short or long time. People may experience nausea and vomiting with the pain. However, people who have small stones that pass easily through the urinary tract may not have symptoms at all.

How are kidney stones diagnosed?

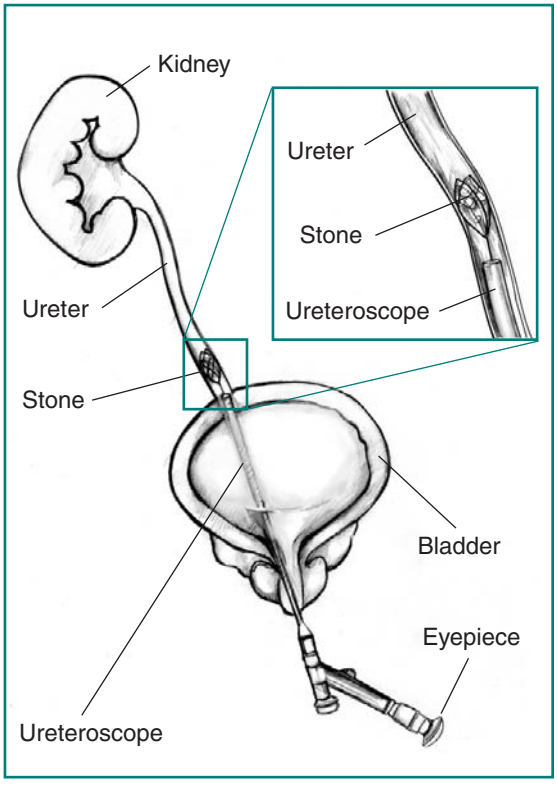
To diagnose kidney stones, the health care provider will perform a physical exam and take a medical history. The medical history may include questions about family history of kidney stones, diet, GI problems, and other diseases and disorders. The health care provider may perform urine, blood, and imaging tests, such as an x ray or computerized tomography (CT) scan to complete the diagnosis.

- **Urinalysis.** Urinalysis is testing of a urine sample. The urine sample is collected in a special container in a health care provider's office or commercial facility and can be tested in the same location or sent to a lab for analysis. Urinalysis can show whether the person has an infection or the urine contains substances that form stones.
- **Blood test.** A blood test involves drawing blood at a health care provider's office or commercial facility and sending the sample to a lab for analysis. The blood test can show biochemical problems that can lead to kidney stones.
- **Abdominal x ray.** An abdominal x ray is a picture created using radiation and recorded on film or on a computer. The amount of radiation used is small. An x ray is performed at a hospital or outpatient center by an x-ray technician, and the images are interpreted by a radiologist—a doctor who specializes in medical imaging. Anesthesia is not needed. The person will lie on a table or stand during the x ray. The x-ray machine is positioned over the abdominal area. The person will hold his or her breath as the picture is taken so that the picture will not be blurry. The person may be asked to change position for additional pictures. The x rays can show the location of stones in the kidney or urinary tract.
- **CT scans.** CT scans use a combination of x rays and computer technology to create three-dimensional (3-D) images. A CT scan may include the injection of a special dye, called contrast medium. CT scans require the person to lie on a table that slides into a tunnel-shaped device where the x rays are taken. The procedure is performed in an outpatient center or hospital by an x-ray technician, and the images are interpreted by a radiologist. Anesthesia is not needed. CT scans can show stone locations and conditions that may have caused the stone to form.

How are kidney stones treated?

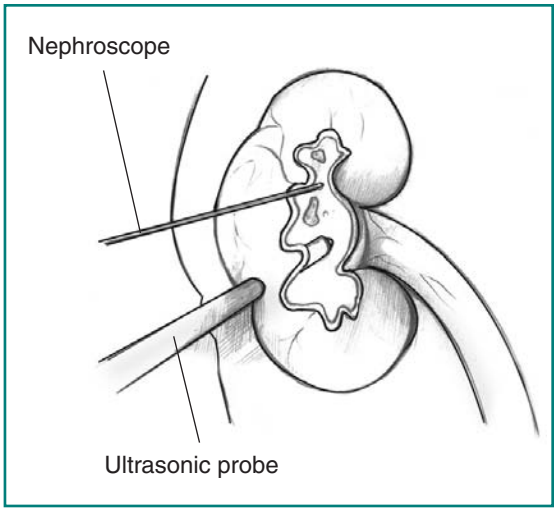
Treatment for kidney stones usually depends on their size and what they are made of, as well as whether they are causing pain or obstructing the urinary tract. Kidney stones may be treated by a general practitioner or by a urologist—a doctor who specializes in the urinary tract. Small stones usually pass through the urinary tract without treatment. Still, the person may need pain medication and should drink lots of fluids to help move the stone along. Pain control may consist of oral or intravenous (IV) medication, depending on the duration and severity of the pain. IV fluids may be needed if the person becomes dehydrated from vomiting or an inability to drink. A person with a larger stone, or one that blocks urine flow and causes great pain, may need more urgent treatment, such as

- **Shock wave lithotripsy.** A machine called a lithotripter is used to crush the kidney stone. The procedure is performed by a urologist on an outpatient basis and anesthesia is used. In shock wave lithotripsy, the person lies on a table or, less commonly, in a tub of water above the lithotripter. The lithotripter generates shock waves that pass through the person's body to break the kidney stone into smaller pieces to pass more readily through the urinary tract.
- **Ureteroscopy.** A ureteroscope—a long, tubelike instrument with an eyepiece—is used to find and retrieve the stone with a small basket or to break the stone up with laser energy. The procedure is performed by a urologist in a hospital with anesthesia. The urologist inserts the ureteroscope into the person's urethra and slides the scope through the bladder and into the ureter. The urologist removes the stone or, if the stone is large, uses a flexible fiber attached to a laser generator to break the stone into smaller pieces that can pass out of the body in the urine. The person usually goes home the same day.

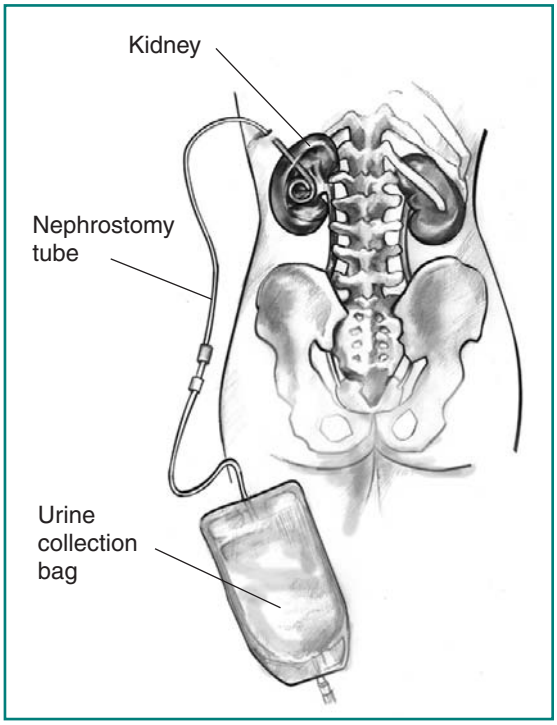


Ureteroscopic stone removal

- **Percutaneous nephrolithotomy.** In this procedure, a wire-thin viewing instrument called a nephroscope is used to locate and remove the stone. The procedure is performed by a urologist in a hospital with anesthesia. During the procedure, a tube is inserted directly into the kidney through a small incision in the person's back. For large stones, an ultrasonic probe that acts as a lithotripter may be needed to deliver shock waves that break the stone into small pieces that can be removed more easily. The person may have to stay in the hospital for several days after the procedure and may have a small tube called a nephrostomy tube inserted through the skin into the kidney. The nephrostomy tube drains urine and any residual stone fragments from the kidney into a urine collection bag. The tube is usually left in the kidney for 2 or 3 days while the person remains in the hospital.



Percutaneous nephrolithotomy



Nephrostomy tube

How are kidney stones prevented?

The first step in preventing kidney stones is to understand what is causing the stones to form. The health care provider may ask the person to try to catch the kidney stone as it passes, so it can be sent to a lab for analysis. Stones that are retrieved surgically can also be sent to a lab for analysis.

The health care provider may ask the person to collect urine for 24 hours after a stone has passed or been removed to measure daily urine volume and mineral levels. Producing too little urine or having a mineral abnormality can make a person more likely to form stones. Kidney stones may be prevented through changes in eating, diet, and nutrition and medications.

Eating, Diet, and Nutrition

People can help prevent kidney stones by making changes in their fluid intake. Depending on the type of kidney stone a person has, changes in the amounts of sodium, animal protein, calcium, and oxalate consumed can also help.

Drinking enough fluids each day is the best way to help prevent most types of kidney stones. Health care providers recommend that a person drink 2 to 3 liters of fluid a day. People with cystine stones may need to drink even more. Though water is best, other fluids may also help prevent kidney stones, such as citrus drinks.

Recommendations based on the specific type of kidney stone include the following:

Calcium Oxalate Stones

- reducing sodium
- reducing animal protein, such as meat, eggs, and fish
- getting enough calcium from food or taking calcium supplements with food
- avoiding foods high in oxalate, such as spinach, rhubarb, nuts, and wheat bran

Calcium Phosphate Stones

- reducing sodium
- reducing animal protein
- getting enough calcium from food or taking calcium supplements with food

Uric Acid Stones

- limiting animal protein

More information about how changes in diet affect kidney stone formation can be found in the National Kidney and Urologic Diseases Information Clearinghouse fact sheet *Diet for Kidney Stone Prevention* at *www.kidney.niddk.nih.gov.*

Medications

The health care provider may prescribe certain medications to help prevent kidney stones based on the type of stone formed or conditions that make a person more prone to form stones:

- hyperuricosuria—allopurinol (Zyloprim), which decreases uric acid in the blood and urine
- hypercalciuria—diuretics, such as hydrochlorothiazide
- hyperoxaluria—potassium citrate to raise the citrate and pH of urine
- uric acid stones—allopurinol and potassium citrate
- cystine stones—mercaptopropionyl glycine, which decreases cystine in the urine, and potassium citrate
- struvite stones—antibiotics, which are bacteria-fighting medications, when needed to treat infections, or acetohydroxamic acid with long-term antibiotic medications to prevent infection

People with hyperparathyroidism sometimes develop calcium stones. Treatment in these cases is usually surgery to remove the parathyroid glands. In most cases, only one of the glands is enlarged. Removing the glands cures hyperparathyroidism and prevents kidney stones.

Points to Remember

- A kidney stone is a solid piece of material that forms in a kidney when substances that are normally found in the urine become highly concentrated.
- Kidney stones are one of the most common disorders of the urinary tract.
- Certain foods may promote stone formation in people who are susceptible, but scientists do not believe that eating any specific food causes stones to form in people who are not susceptible.
- People with kidney stones may have pain while urinating, see blood in the urine, or feel a sharp pain in the back or lower abdomen. However, people who have small stones that pass easily through the urinary tract may not have symptoms at all.
- To diagnose kidney stones, the health care provider will perform a physical exam and take a medical history. The health care provider may perform urine, blood, and imaging tests to complete the diagnosis.
- Treatment for kidney stones usually depends on their size and what they are made of, as well as whether they are causing pain or obstructing the urinary tract. Treatments may include shock wave lithotripsy, ureteroscopy, or percutaneous nephrolithotomy.
- Kidney stones may be prevented through changes in eating, diet, and nutrition and medications.

Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) funds research on the causes, treatments, and prevention of kidney stones. The International Registry for Hereditary Kidney Stone Diseases, funded under National Institutes of Health (NIH) clinical trial number NCT00588562, collects medical information from a large number of patients with kidney stones to create a registry that will help researchers compare similarities and differences in patients and their symptoms.

The Study of the Biological and Physical Manifestations of Spontaneous Uric Acid Kidney Stone Disease, funded under NIH clinical trial number NCT00904046, aims to determine how much fat accumulates within cells and how it affects the kidneys by correlating kidney fat content with urine test results. A second aim is to evaluate the effect of the medication thiazolidinedione on excess fatty acid accumulation in kidney tissue and its correlation with uric acid stone formation.

Tamsulosin for Urolithiasis in the Emergency Department, funded under NIH clinical trial number NCT00382265, studies the effectiveness and safety of tamsulosin in treatment of kidney stones. Other areas of focus include reduction in time to pain-free recovery, decrease in narcotic medication for pain, less need for follow-up, decrease in the need for surgery, and cost savings.

Clinical trials are research studies involving people. Clinical trials look at safe and effective new ways to prevent, detect, or treat disease. Researchers also use clinical trials to look at other aspects of care, such as improving the quality of life for people with chronic illnesses. To learn more about clinical trials, why they matter, and how to participate, visit the NIH Clinical Research Trials and You website at *www.nih.gov/health/clinicaltrials.* For information about current studies, visit *www.ClinicalTrials.gov.*

For More Information

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More information about hyperparathyroidism can be found in the National Endocrine and Metabolic Diseases Information Service (NEMDIS) fact sheet *Hyperparathyroidism* at *www.endocrine.niddk.nih.gov.* The NEMDIS can be contacted at

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You may also find additional information about this topic by visiting MedlinePlus at *www.medlineplus.gov.*

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This publication is available at *www.kidney.niddk.nih.gov.*

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