

# Kidney Stones

BASIC FACTS EVERYONE SHOULD KNOW



Kidney stones are among the most common—and painful—disorders of the urinary tract. Each year, thousands of Americans are diagnosed with kidney (renal) stone disease, a condition that develops when the urine becomes overly saturated with certain microscopic substances. They form crystals that eventually bind into hardened mineral deposits, known as calculi or stones.

About 10 percent of all Americans will suffer kidney stone disease during their lifetime. These episodes occur most frequently in men, but women are also at risk. For reasons not fully understood, both genders have experienced an increase in stone disease over the past 30 years. Recent statistics suggest urinary tract stones account for more than two million

## test your knowledge about

1. Kidney stones usually develop because:
  - a. a person ate too much hard-to-digest food
  - b. the balance of fluids in the urine breaks down, and crystals form in the urine
  - c. no one knows
2. The typical person who gets kidney stones is:
  - a. a woman over 60 years old
  - b. a man or woman under 20 years old
  - c. a man or woman between 20 and 60 years old
3. Stones may develop due to:
  - a. very hot weather, heavy sweating, and not drinking enough liquids
  - b. living in colder areas of the United States
  - c. exercising moderately and drinking plenty of liquids
4. The percent of kidney stones thought to pass by themselves in the urine is:
  - a. less than 10%
  - b. about 50%
  - c. between 70% and 80%

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visits to the doctor and more than 600,000 visits to hospital emergency rooms each year.

Despite the numbers, kidney stones are hardly a modern day phenomenon. Scientists recorded the first evidence of these deposits in an Egyptian mummy, circa 7,000 years old.

Luckily, doctors today know much more about diagnosing and treating kidney stones than the healers back then. Advances in the last several decades alone have revolutionized the medical management of this disease. In years past, many people lost significant kidney function—and even had to undergo dialysis—due to the large, infected stones they developed and the complex open surgical procedures used to remove them. But lithotripsy,

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5. Stones that do not pass out the of body on their own usually are eliminated by:
  - a. lithotripsy
  - b. surgery
  - c. waiting for them to dissolve
6. People who have had a kidney stone are:
  - a. not likely to ever have another
  - b. prone to develop another
  - c. neither more nor less likely than anyone else to develop another
7. One of the most important things to do to keep from developing another stone is:
  - a. talk to your doctor about changing your diet
  - b. drink a lot of fluids — mainly water
  - c. both a. and b.

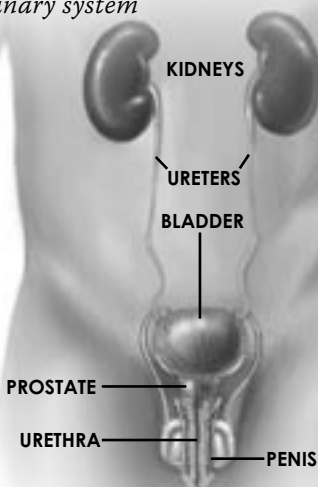
Answers on page 21.

There also is a glossary of terms you may not be familiar with at the end of this booklet.

which uses shockwaves to crush stones, and endoscopy, where fiberoptic instruments are used to spot and remove stones, have significantly reduced the trauma of treatment. With better diagnostic and therapeutic options, patients now can look forward to speedier recoveries and even fewer recurrent stones.

The purpose of this booklet is to help you understand kidney stones. What causes them, who gets them and how they can be addressed.

*Front view,  
interior of male  
urinary system*



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## WHAT IS THE URINARY SYSTEM AND HOW DOES IT WORK?

The urinary system is the body's filtering center. It contains several different parts, including the kidneys, ureters, bladder and urethra.

Each day, the kidneys cleanse hundreds of gallons of blood. They remove waste products, salts and water left after the body has metabolized or processed what it needs. Bean-shaped and fist-sized, these twin organs are located below the ribs toward the lower middle back. Together they contain nearly 40 miles of tiny tubes instrumental in processing waste into urine. Once converted, the urine flows through two narrow conduits, the ureters, to the bladder, a balloon-like pouch in the lower abdomen that stretches temporarily to store the liquid. At urination, the urine exits the body via the urethra.

As the urinary system filters your blood, it regulates water levels and the balance of fluids in your body. Your kidneys also perform several other functions. They regulate electrolytes, control acids, and produce hormones essential to several activities, such as blood pressure.

## WHAT CAUSES KIDNEY STONES?

Kidney stones are hardened clumps of microscopic crystals that can develop anywhere in the urinary tract. They form because the balance between fluid and certain wastes in your urine is disturbed, creating a high concentration primarily of stone-forming mineral salts (e.g. calcium oxalate, calcium phosphate, and struvite) that will not dissolve.

If they remain tiny, these particles can travel through the urinary tract and pass out of the body without notice or intervention. But they can also settle on the inner surface of the kidney where they build, layer by layer, into hardened masses. Stones also form when there is an acid imbalance in the urine or an insufficient amount of certain chemicals—citrate, magnesium, and pyrophosphate—necessary to break down the wastes.

The medical term for stones that develop in the kidney is nephrolithiasis. Urolithiasis describes those that occur elsewhere in the urinary tract.

Kidney stones may grow over months and even years before causing problems.

## **WHAT DOES A KIDNEY STONE LOOK LIKE?**

Kidney stones come in various sizes, shapes and colors. They can be as small as a spec of sand or as large as a golf ball. While many resemble smooth, spherical pebbles, others have rough edges, often created by tiny spokes or even bigger jagged structures called staghorns. Each stone's color depends on its chemical composition. Most are yellow or brown but they can also be tan, gold or black.

Since identifying specific characteristics is important in treatment and prevention, your doctor will want to learn as much as possible about your stone.

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## WHO GETS KIDNEY STONES? ---

Anyone can develop kidney stones; some people are just more prone to them than others. Stones tend to occur most frequently in men, between the ages of 20 and 70 with a personal and family history of such formations. Women, however, can suffer from stones also. White Americans are more susceptible than African Americans. People who develop one stone are likely to develop others.

Doctors do not always know what causes kidney stones, but chronic dehydration—a dangerous lack of water in the body—is frequently associated with them. If you sweat heavily, particularly in hot weather, and do not take in enough replenishing fluids, you increase your risk. You are also vulnerable if you have recurring urinary infections, suffer from certain metabolic disorders or experience bowel disease. In those cases, chronic diarrhea or vomiting may deplete your fluids.

While some foods may promote stone formation in people who are susceptible to them, scientists do not believe that eating specific dietary items will cause deposits in adults who are not predisposed. But obesity and overweight increases the potential for anyone. In fact, many physicians think that a protein-rich American diet promotes stone development. Experts cite the increasing incidence of kidney stones in Japan, which has tripled since World War II at the same time that the Japanese diet has become like our own.

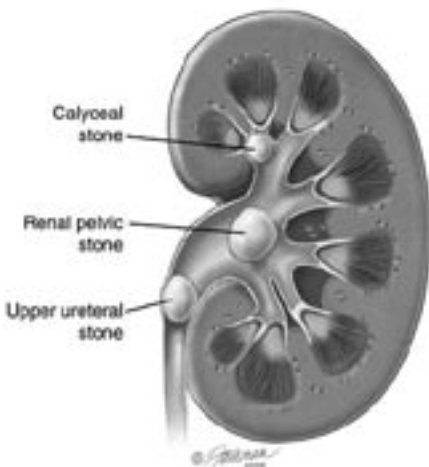
## ARE ALL KIDNEY STONES ALIKE?

No, kidney stones are defined by their chemical make-up and underlying cause.

### CALCIUM OXALATE AND CALCIUM PHOSPHATE STONES

The majority—about 75 percent—of all urinary tract calculi are composed of calcium, chemically mixed with oxalate (to form calcium oxalate stones) or phosphate (to form calcium phosphate stones). Of these two hard crystalline compounds, calcium oxalate stones appear most frequently, even though the two types may be mixed.

Calcium plays an essential role throughout the body. Key to the formation of teeth and bones, it's involved in transporting nerve impulses, contracting muscles and supporting other life-sustaining activities. Most individuals get their daily calcium requirements from a healthy diet, abundant with dairy products, eggs, fish, fruits and green vegetables.



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Not all of the calcium is needed by the body, however. After a sufficient amount is absorbed, any excess is normally excreted by the kidneys and flushed out with urine. But in some patients, abnormally high levels collect in the urinary tract, triggering high calcium (hypercalciuria), the most common cause of calcium oxalate stones.

There are many reasons for these elevated levels. In almost 40 percent of calcium oxalate stone sufferers, an inherited metabolic disorder is causing the build-up. In others, the elevated level is associated with certain drugs, such as calcium containing antacids and steroids. In still others, a calcium overload can be triggered by a diet high in vitamin A, D or purine, the digestive end-product of proteins, such as those in red meat. Elevated levels can also be brought on by an overactive parathyroid gland.

You also may develop calcium stones under other circumstances. For instance, if your diet has too little calcium or your body produces too much oxalate, you are at risk. Large doses of vitamin C (more than 1,000 mg. per day) increase oxalate levels in your urine. Hypocitraturia, or low levels of urinary citrate, also can result in calcium stones. Citrate normally prevents calcium salts from crystallizing. But with certain medications and conditions (e.g., chronic diarrhea, kidney disease, strenuous exercise) the citrate supply is reduced. Low citrate levels are unable to effectively stop the formation of these stones.

## STRUVITE STONES

Between 10 and 15 percent of all kidney stones are associated with chronic urinary tract infections. Struvite stones form because invading bacteria release chemicals that neutralize urinary acid, thus enabling them to grow. Struvite stones are often defined by their large size and staghorn edges. Since women are most susceptible to urinary tract infections, they are also at greatest risk for these types of kidney stones. Because of the link to urinary bacteria, treatment is two-fold: remove all the stone but also prevent recurrence of the infection. If you suffer from a struvite stone your urine may be tested regularly to ensure that it is bacteria-free.

## URIC ACID STONES

About 10 percent of kidney stones contain uric acid, a waste product created by normal metabolism in the body. Ordinarily, uric acid dissolves in the blood, passing through the kidneys into the urine where it is eliminated. But when the body produces too much of it, or the kidneys are unable to eliminate it, the acid accumulates, eventually crystallizing into deposits. There are many reasons for this build-up: genetics, certain gastrointestinal conditions, some medications, obesity, and a diet rich in foods such as organ meats. Men are more susceptible than women, particularly if they have gout, a painful form of arthritis also linked to elevated uric acid in the blood.

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## CYSTINE STONES

An amino acid found in proteins, cystine is a building block for muscles, nerves and other parts of the body. But in some people who inherit a rare, metabolic condition, called cystinuria, it is also the source of the least common of all kidney calculi, cystine stones. Cystine stones occur because the kidneys do not reabsorb cystine properly. Instead, the cystine collects in the urine, forming crystals. While cystine stones account for only one percent of all kidney calculi, they are difficult to treat and require life-long therapy.

## WHAT ARE THE WARNING SIGNS OF A KIDNEY STONE?

Kidney stones often do not cause any warning signs. When they do, however, the earliest symptom is usually a sharp cramping pain in the back and side (or flank) of the body, sometimes radiating into the abdomen or groin. The ache often begins suddenly as the stone moves into the urinary tract, causing irritation or blockage. The discomfort becomes constant while your system attempts to get rid of the stone.

Other symptoms may occur too. Once the stone grows or moves down the ureter closer to the bladder, you may feel a frequent urge to urinate, a burning sensation during urination or experience blood in your urine (hematuria). There can be nausea and vomiting. Your lower abdomen and flank also may be painful to the touch. You could even develop fever and chills if you have an accompanying urinary tract infection.

## **CAN KIDNEY STONES DAMAGE THE KIDNEY?**

If left unchecked, kidney stones can cause kidney damage. Two factors—the location of the stone and the presence of an underlying urinary infection—determine whether or not your kidney will be injured and to what extent. To avoid or minimize such damage, it is important to eliminate those stones that have already formed and to prevent others from developing. Your family doctor may refer you to a urologist, someone with specific expertise in diagnosing, treating conditions of the urinary tract.

## **HOW ARE KIDNEY STONES FOUND?**

Kidney stone sufferers usually seek medical help when they first experience back pain or blood in their urine (hematuria). If your physician suspects a stone, he or she will want to find out its location, composition and size. The information will help in choosing proper treatment.

You will be asked questions about your personal and family medical histories. Knowing, for instance, that you have previously had kidney stones, will help focus your physician on the real possibility that they are occurring again. After undergoing a physical examination, you may be asked for a blood test and urine sample. The results will reveal if you have an underlying urinary tract infection or high levels of uric acid or the salts (e.g., calcium, oxalate, phosphate, cystine) known to cause stones. The results will also help your physician decide if you are dehydrated or if your kidneys are functioning well.

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Since kidney stones can become lodged in any part of the urinary system, doctors often order special diagnostic tests to locate and assess them. “Silent” stones, those that do not cause symptoms, are frequently spotted on X-rays taken for other reasons. But more often, they are found with special imaging tests—an ultrasound (sonogram), intravenous pyelogram (IVP) or computed axial tomography (CT)—ordered when a person complains of pain or blood in the urine.

Ultrasound scanning is a fast and painless way to obtain images of the urinary system. Based on Navy sonar, this technology uses a special device, called a transducer, to beam high-frequency sound waves through the body. As they hit the stones, the waves create echoes that turn into real-time images processed by a computer. Ultrasound can detect when the upper urinary tract and kidneys are dilated or stretched by a stone lodged in the ureter.

Your doctor may choose to scan your urinary system with an intravenous pyelogram, a special X-ray that reveals the urinary tract’s structure and function. The technician injects an iodine-based dye into a vein before snapping a series of X-rays. The dye collects in the urinary system, producing white contrast where a stone is present. Because the agent yields high-definition images, most kidney stones can be located precisely using IVP. But since the dye also causes an allergic reaction, your doctor may rely on other tests.

Today, most patients undergo a painless, non-invasive imaging technique—computed tomography or “spiral” CT scanning—to locate, size and assess stones. CT produces detailed images by directing a series of X-ray pulses through the body as the scanner rotates. Each pulse yields cross-sectional “slices” or pictures interpreted by a computer. Because of its resolution, CT scanning is useful in identifying hard-to-see stones.

Since treatment and prevention depend on your stone, it is important that you retrieve and save any particles for laboratory analysis. Between 70 and 80 percent of kidney stones pass on their own through urine, usually within 48 hours of your first symptoms. Some stones, however, may take from four to six weeks to pass. To catch the pieces, you will have to urinate into a strainer or cup with mesh lining. Your doctor may not need more than one fragment for analysis, since most people develop just one type of kidney stone. But you still should turn over every particle for a thorough analysis.

## **HOW ARE KIDNEY STONES TREATED?**

Fortunately, most stones will pass through the urinary system on their own, but you need to drink sufficient fluids (two to three quarts-a-day) to move them along. You may be given a pain medication, but you should experience relief in a reasonable period of time.

Your doctor will recommend additional measures if your stone is too large to pass; growing larger;

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blocking urine flow; causing a urinary tract infection; or threatening to damage your kidneys.

In the past, people with stubborn stones usually underwent painful surgical procedures requiring lengthy recoveries. But doctors today can offer patients greatly improved alternatives. Most of the 20 to 30 percent of urinary tract calculi that do not pass naturally can be eliminated without major surgery.

**Lithotripsy.** Derived from the Greek word meaning “stone crushing”—is an effective tool for eliminating urinary tract stones. It uses high-energy shock or sound waves to crush dense calculi into sand-like granules that then pass naturally with urine. Urologists have various ways to pulverize those stones, but they commonly rely on shockwave lithotripsy (SWL). With this procedure, high-energy impulses from an outside machine, called a lithotripter, are focused on your ureters, kidney or bladder through a water bath or soft gel cushion. The sound waves are guided by X-ray or ultrasound.

Because there is some discomfort with this procedure, you will likely undergo local or general anesthesia. If the stone is not completely shattered in one treatment, which takes about an hour, additional sessions may be necessary. Complications with SWL are uncommon, but you can experience blood in the urine and mild bruising or tenderness post-procedure. Recovery is still brief. Most people resume normal activities within a few days.

While SWL is effective, it is not for every patient. Depending on the size, composition and location of a stone, your doctor may suggest other ways to destroy or treat it. Among them:

- **Ureteroscopy.** Relies on a special telescopic instrument, called a ureteroscope, to pinpoint stones in the mid- and lower- portion of the ureter. Inserted through the urethra and bladder, this narrow fiberoptic tube provides the urologist with a clear view up the ureters to locate and retrieve any stone. If the stone is small, your doctor will use a tiny wire basket to retrieve it. If it is large, the stone will be fragmented, so the pieces can pass naturally. While uteroscopy requires general anesthesia, most patients go home the same day. A small scaffold, called a stent, may be left in the ureter to promote healing. The stent is removed on a follow-up office visit.
- **Percutaneous Nephrolithotomy (PCN).** Performed by making a tiny skin incision to create a narrow tunnel directly into the back of the kidney. After threading a telescopic instrument, called a nephroscope, through the opening, your doctor will insert small tools to dislodge the calculus. The scope is also used to transmit high-frequency sound waves when a stone fragmented before suctioned. PCN is an effective option for very large stones or located in an area inaccessible by SWL. Also, because the stone is removed directly, you don't have to wait for it to pass naturally. While patients are hospitalized for two to three days, they

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can resume normal activity within one to two weeks.

- **Open surgery.** This is rarely used today, given the other available treatment options. For complicated cases, however, it may be the best—and even the only—option. The stone is extracted through incisions in the back and the ureter or kidney. Most patients require prolonged hospitalization. Recovery takes several weeks.

## CAN I PREVENT FUTURE KIDNEY STONES?

Yes, there are steps you can take to reduce your risk. Since a second episode is likely, you will want to focus on prevention. It is essential.

For many health reasons, including the well-being of your urinary tract, the most important daily habit you can establish is to drink lots of liquids, particularly water. Fluids prevent your urine from becoming so concentrated that crystals will form. A high fluid intake also reduces the risk of a urinary tract infection.

A rule-of-thumb is to spread your fluid intake evenly throughout the day. Your goal should be to consume 100 ounces of liquid in 10 to 12 glasses. Even though you can supplement with fruit juices, water should make up at least half of that amount. Also, while you can drink coffee, tea and cola, you should limit your consumption to two cups per-day. Caffeine in these products may contribute to fluid loss. Since your goal is

to produce at least two quarts of urine every 24 hours, you will need to add fluids in very hot weather to make up for what is lost in sweat.

You can judge whether you are drinking enough fluids by simply watching your urine. While the color will be darker in the morning because it is concentrated, urine should be pale, almost watery, during the rest of the day. If your urine is dark and yellow, you need to consume more fluids.

Since prevention also depends on your stone type, you may be asked to collect your urine for 24 hours after you return to your normal routine.

Patients with calcium oxalate stones, for instance, are usually told to reduce meat products, table salt, and other foods high in oxalate (e.g., green leafy vegetables, chocolate, nuts). Also, while there is a common belief that eliminating dairy products is helpful, recent studies suggest that decreasing sources of calcium and Vitamin D only increases the risk of stones. So you can still make two servings of dairy products (an eight-ounce glass of milk counts as one) a part of your daily eating plan.

As to other foods, talk to your doctor before eliminating anything from your diet. Chances are good that you will be able to continue eating your favorite foods, even if in moderation. You may want to work with a dietitian, to create a plan just for you.

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## CAN I TAKE MEDICATIONS TO PREVENT FUTURE STONES?

Yes, there are drugs that help certain patients. Your doctor may prescribe a diuretic to control the elevated levels of urinary calcium implicated in calcium oxalate and phosphate stones. Medications such as hydrochlorothiazide (HydroDiuril®) and chlorthalidone (Hygroton®) decrease calcium released into the urine while increasing urinary output.

Other medications control acid or alkali in your urine, key factors in the formation of various stones. Potassium citrate (Urocit-K® or Polytetra-K®), for instance, helps inhibit high calcium or uric acid levels, which helps block kidney stones. Medications such as allopurinol (Zyloprim®) reduce levels of uric acid, thus decreasing the risk of calcium oxalate and uric acid stones.

As for other medications, penicillamine (Cuprimine®) or tiopronin (Thiola®) are often recommended if drinking more fluids does not control cystine formations. Both hinder the development of these stones by helping dissolve the amino acid that causes them.

Your doctor may prescribe other medications, depending on your specific problem. No matter what drugs you are taking, be aware: You need to drink at least 10, 10-ounce glasses of fluid daily to make up for any fluid loss tied to the drugs.

Kidney stones can be painful but with today's diagnostic and therapeutic advances—plus new

information about prevention—you can find relief. Just know the symptoms and talk to your doctor when they occur.

## GLOSSARY

**allopurinol:** a medication used to reduce urinary levels of uric acid.

**anesthesia:** induced loss of sensitivity to pain in all or a part of the body for medical reasons.

**bladder:** the balloon-shaped pouch of thin, flexible muscle in which urine is temporarily stored before being discharged through the urethra.

**calcium oxalate stone:** most common kidney stone, made up of a hard crystalline compound, often mixed with calcium phosphate.

**catheter:** a thin tube that is inserted through the urethra into the bladder to allow urine to drain or for performance of a procedure or test, such as insertion of a substance during a bladder X-ray.

**CT scan (or CAT scan or computerized axial tomography):** diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce cross-sectional images of the body to show detailed images.

**cystine stone:** a rare form of kidney stone consisting of the amino acid cystine.

**dehydration:** dangerous lack of water in the body resulting from inadequate intake of fluids or excessive loss through sweating, vomiting or diarrhea.

**dialysis:** process of cleansing the blood when the kidneys can't function by passing it through a special machine outside the body.

**electrolytes:** Positively and negatively charged particles (ions) essential to your health and survival. When in balance, they facilitate important functions, such as muscle coordination, heart and nerve function, fluid absorption and excretion.

## KIDNEY STONE CHECKLIST

	Yes	No
I have a relative who has had kidney stones.	<input type="checkbox"/>	<input type="checkbox"/>
I have had kidney stones in the past five years.	<input type="checkbox"/>	<input type="checkbox"/>
I have had serious back/side pain recently.	<input type="checkbox"/>	<input type="checkbox"/>
My voiding habits have changed significantly recently.	<input type="checkbox"/>	<input type="checkbox"/>
I have noticed blood in my urine.	<input type="checkbox"/>	<input type="checkbox"/>

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Answers to quiz

1) b, 2) c, 3) c, 4) false, 5) false

**endoscope:** lighted medical telescope, used for diagnostic examinations and surgical procedures, consisting of a long tube inserted into the body, usually through a small incision.

**gout:** a metabolic disorder in which uric acid levels in blood and urine are too high.

**hematuria:** blood in the urine, which can be a sign of a kidney stone or other urinary problem.

**hydrochlorothiazide:** used as a diuretic.

**hypercalciuria:** abnormally large amounts of calcium in the urine.

**hormones:** chemical substances produced by the body to control or regulate cell and organ activity.

**intravenous pyelogram (IVP):** a succession of X-ray films of the urinary tract following the injection into a vein of a contrast medium. An IVP tests kidney function and reveals the presence of stones, tumors, or obstruction in the urinary tract.

**kidneys:** two bean-shaped organs located near the middle of the back that filter wastes from the blood and discharges these waste products in urine.

**kidney stone:** a stone that develops from crystals that form in urine and build up on the inner surfaces of the kidney, in the renal pelvis or in the ureter.

**lithotripsy:** a method of breaking up kidney stones using shock waves or other means.

**metabolic disorder:** an inherited problem in how the body breaks down and uses certain substances.

**metabolism:** biochemical processes that occur in the body; commonly refers to breakdown of food into energy.

**parathyroid glands:** glands, located next to the thyroid in the neck, that secrete a hormone which regulates the metabolism of calcium and phosphorous in the body.

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**penicillamine:** medication used to aid in the treatment of cystine stones.

**purine:** an organic compound containing uric acid; primarily found in animal protein.

**sedative:** a medicine that calms and relaxes.

**shock wave lithotripsy (SWL):** non-surgical procedure using shock waves to break up kidney stones.

**struvite stones:** a kind of kidney stone caused by infection.

**ultrasound (sonogram):** a technique that bounces painless sound waves off organs to create an image of their structure to detect abnormalities.

**ureters:** two tubes that carry urine from the kidneys to the bladder.

**urethra:** in males, this narrow tube carries urine from the bladder to the outside of the body and also serves as the channel through which semen is ejaculated. Extends from the bladder to the tip of the penis. In females, this short, narrow tube carries urine from the bladder to the outside of the body.

**uric acid stone:** a kidney stone that may result from high acid levels in the urine.

**urologist:** a doctor who specializes in diseases of the male and female urinary systems and the male reproductive system.

The American Urological Association Foundation was established to support and promote research, patient/public education and advocacy to improve the prevention, detection, treatment and cure of urologic disease.

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