

# KIDNEY STONES (NEPHROLITHIASIS)

## BASICS

### OVERVIEW

- “Nephrolithiasis” is the medical term for the presence of stones in the kidneys; “nephrolith” is the medical term for a kidney stone; “urolith” is the general term for urinary tract stones (that is, stones located anywhere in the urinary tract)
- The kidney is composed of thousands of “nephrons” (the functional units of the kidney, each consisting of the “glomerulus” [a tuft of blood capillaries—the “blood filter”] and a series of tubes, through which the filtered fluid flows, as urine is produced; the tubes drain into “collecting ducts” through which urine flows; the collecting ducts join together and eventually enter the renal pelvis; the “renal pelvis” is a funnel-shaped structure through which urine flows into the ureter (the tube between the kidney and bladder)
- Kidney stones (nephroliths) are either aggregates of crystals or stones located in the renal pelvis or collecting diverticula of the kidney
- The most common minerals found in the stones of the urinary tract (uroliths) are used to name the particular stone, such as “calcium oxalate uroliths,” “struvite uroliths,” and “urate uroliths”
- Kidney stones (nephroliths) or fragments of kidney stones may pass into the ureters; the “ureters” are the tubes from the kidneys to the bladder
- Kidney stones (nephroliths) that are not infected, not causing blockage or obstruction of urine flow or clinical signs, and not progressively enlarging are called “inactive kidney stones”

### SIGNALMENT/DESCRIPTION of ANIMAL

#### Species

- Dogs and cats

#### Breed Predispositions

##### Canine

- Kidney stones containing calcium and oxalate or oxalic acid (known as “calcium oxalate nephroliths”)—miniature schnauzer, Lhasa apso, Yorkshire terrier, miniature poodle, and shih tzu
- Kidney stones containing magnesium ammonium phosphate (known as “struvite;” stones are known as “struvite nephroliths”)—miniature schnauzer, bichon frise, shih tzu, Yorkshire terrier, Lhasa apso, cocker spaniel, and miniature poodle
- Kidney stones containing uric acid or urate (known as “urate nephroliths”)—Dalmatian, Yorkshire terrier, and English bulldog
- Kidney stones containing cystine (known as “cystine nephroliths”)—Newfoundland

##### Feline

- Breeds reported to have kidney stones (nephroliths) include the following: domestic shorthair (33%), domestic longhair (17%), Persian (8%), Siamese (6%)

#### Mean Age and Range

- Dogs—mean age of affected animals, 9 years (range, 4 months to 14 years of age)
- Cats—mean age of affected animals, 8 years (range, 2 months to 18 years of age)

#### Predominant Sex

- Overall, kidney stones (nephroliths) in dogs are slightly more common in females than in males; females are more likely than males to develop struvite kidney stones; males are more likely than females to develop calcium oxalate, cystine, and urate kidney stones
- In cats, kidney stones (nephroliths) are slightly more common in females than in males

### SIGNS/OBSERVED CHANGES in the ANIMAL

- Many patients have no clinical signs, and the kidney stones (nephroliths) are found during the diagnostic workup of other medical problems
- Blood in the urine (known as “hematuria”), vomiting, and recurrent urinary tract infection; difficulty or painful urination (known as “dysuria”) and frequent voiding of small volumes (known as “pollakiuria”) in animals with urinary tract infection
- Signs attributable to excess levels of urea and other nitrogenous waste products in the blood (known as “uremia” or “azotemia”) in animals with blockage of urine flow involving both ureters or kidneys or kidney failure; possible signs include lack of appetite (known as “anorexia”), sluggishness (lethargy), vomiting, and ulcers in the mouth
- Signs referable to stones (uroliths) in the lower urinary tract (the bladder and urethra; the “urethra” is the tube from the bladder to the outside, through which urine flows out of the body), if stones are present in the upper urinary tract (kidneys and ureters) and the lower urinary tract; possible signs include difficulty or painful urination (dysuria), frequent voiding of small volumes (pollakiuria), straining to urinate (known as “stranguria”), and reduced or absent flow of urine
- So-called “renal colic” with sudden (acute) abdominal/ lumbar pain and vomiting is uncommon

### CAUSES

- Over saturation of the urine with stone-forming minerals may contribute to development of urinary tract stones (uroliths)

- Urinary tract stones containing calcium and oxalate or oxalic acid (calcium oxalate uroliths)—increased levels of calcium in the urine (known as “hypercalciuria”), increased levels of calcium in the blood (known as “hypercalcemia”), low levels of citrate in the urine (known as “hypocitraturia”), increased levels of oxalate or oxalic acid in the urine (known as “hyperoxaluria”), abnormality in calcium and phosphorus regulation in the body (known as “hyperparathyroidism”), excessive calcium intake in the diet
- Urinary tract stones containing calcium and phosphate (known as “calcium phosphate uroliths”)—long-term (chronic) bleeding in the kidneys (cats), increased levels of calcium in the blood (hypercalcemia), abnormality in calcium and phosphorus regulation in the body (hyperparathyroidism), excessive calcium and phosphorus in the diet
- Urinary tract stones containing magnesium ammonium phosphate or struvite (struvite uroliths)—urinary tract infection, diets that produce high (alkaline) urine pH
- Urinary tract stones containing uric acid or urate (urate uroliths)—inherited disorder (Dalmatians), portosystemic shunt (condition in which blood vessels allow blood to flow abnormally between the portal vein [vein that normally carries blood from the digestive organs to the liver] and the body circulation without first going through the liver)
- Urinary tract stones containing xanthine (known as “xanthine uroliths”)—allopurinol (a medication used to reduce uric acid) administration and high dietary purine intake in dogs susceptible to developing urinary tract stones containing uric acid or urate (urate uroliths)
- Urinary tract stones containing cystine (cystine uroliths)—increased levels of cystine in the urine (known as “cystinuria”)

### RISK FACTORS

- Alkaline urine (urine with high pH)—struvite and calcium phosphate uroliths
- Acid urine (urine with low pH)—calcium oxalate, cystine, urate, and xanthine uroliths
- Urine retention and formation of highly concentrated urine
- Lower urinary tract infection—infection may move up from the lower urinary tract to the kidneys and result in bacterial infection/inflammation of the kidney (known as “pyelonephritis”)
- Conditions that increase the likelihood of developing urinary tract infection (such as surgical removal of the penis with creation of a new opening into the urethra [known as “perineal urethrostomy”]; abnormalities during development of the urinary tract in which the ureters [tubes from the kidneys to the bladder] may not attach to the bladder properly or may attach to reproductive organs—when this occurs, they are called “ectopic ureters” and one or both can terminate in the distal urethra, uterus, or vagina; increased levels of steroids produced by the adrenal glands [known as “hyperadrenocorticism” or “Cushing’s disease”]; reflux of urine from the bladder back into the ureter(s); and administration of steroid-containing medications

## TREATMENT

### HEALTH CARE

- Manage patients with inactive kidney stones (nephroliths) as outpatients
- Medical protocols to dissolve stones can be administered to outpatients
- Removal of kidney stones (nephroliths) by surgery or extracorporeal shock wave lithotripsy requires hospitalization; extracorporeal shock wave lithotripsy is a medical procedure in which the stone is broken up within the urinary tract using some type of energy or sound wave

### ACTIVITY

- Unlimited

### DIET

- Medical protocols to dissolve kidney stones (nephroliths) requires a diet appropriate to the specific chemical make-up of the stone

### SURGERY

- Indications for removal of kidney stones (nephroliths)—blockage or obstruction of urine flow; recurrent infection; kidney stones are causing signs of disease (known as “symptomatic nephroliths”); progressive enlargement of the kidney stone; and a nonfunctional kidney on the opposite side of the kidney containing a stone
- Treatment options for kidney stones (nephroliths)—dissolve the stone through medical treatment, surgery, and extracorporeal shock wave lithotripsy, a medical procedure in which the stone is broken up within the urinary tract using some type of energy or sound wave
- Stones in the ureters (known as “ureteroliths”) or in the kidney (nephroliths) causing complete blockage or obstruction of urine flow are not responsive to being dissolved through medical treatment, thus surgery is necessary
- Extracorporeal shock wave lithotripsy—safe and effective method of treating canine kidney stones (nephroliths) and stones in the ureters (ureteroliths); stone fragments pass down the ureter into the bladder and are voided in the urine
- Extracorporeal shock wave lithotripsy—not as effective for treatment of kidney stones (nephroliths) and stones in the ureters (ureteroliths) in cats compared with effectiveness in dogs

## MEDICATIONS

Medications presented in this section are intended to provide general information about possible treatment. The treatment for a particular condition may evolve as medical advances are made; therefore, the medications should not be considered as all inclusive.

- Antibiotics selected on the basis of urine bacterial culture and sensitivity testing, as necessary
- Antibiotics are recommended at the time of the procedure when infected kidney stones (nephroliths) are treated by extracorporeal shock wave lithotripsy, a medical procedure in which the stone is broken up within the urinary tract using some type of energy or sound wave or are removed surgically
- Medical protocols to dissolve stones are limited to struvite, urate, and cystine stones (uroliths)
- Medical protocols to dissolve *struvite* kidney stones (nephroliths) include a diet to dissolve the stones (Hill's Prescription Diet® s/d®) and appropriate antibiotic therapy (if patient has a urinary tract infection) for the duration of treatment
- Medical protocols to dissolve canine *urate* kidney stones (nephroliths) can be attempted by a protein- and purine-restricted, alkalinizing diet (Hill's Prescription Diet® Canine u/d®), allopurinol, and supplemental potassium citrate, as needed to maintain urine pH at approximately 7.0
- Medical protocols to dissolve canine *cystine* kidney stones (nephroliths) can be attempted using a protein-restricted, alkalinizing diet (Hill's Prescription Diet® Canine u/d®), N-(2-mercaptopyrionyl) glycine (2-MPG or THIOLA®), and supplemental potassium citrate, as needed to maintain urine pH at approximately 7.5
- Kidney stones containing calcium and oxalate or oxalic acid (calcium oxalate nephroliths), the most common mineral composition in dogs and cats, are not responsive to being dissolved through medical treatment

## FOLLOW-UP CARE

### PATIENT MONITORING

- Abdominal X-rays or ultrasound examinations, urinalysis, and urine culture every 3 to 6 months to detect recurrence of kidney stones (nephroliths)
- Dogs treated with extracorporeal shock wave lithotripsy, a medical procedure in which the stone is broken up within the urinary tract using some type of energy or sound wave—check every 2 to 4 weeks by X-rays and ultrasound examination until fragments of the kidney stone have passed through the lower urinary tract (bladder and urethra)

### PREVENTIONS AND AVOIDANCE

- Eliminate factors that increase the likelihood of developing a particular type of urinary tract stone, increase urine volume (thus decreasing the concentration of stone-causing minerals), and correct factors contributing to urine retention

### POSSIBLE COMPLICATIONS

- Blockage or obstruction of urine flow
- Dilation of the funnel-shaped structure (renal pelvis) through which urine flows into the ureter due to blockage of urine flow (known as “hydronephrosis”)
- Kidney failure
- Recurrent urinary tract infection
- Bacterial infection/inflammation of the kidney (pyelonephritis)

### EXPECTED COURSE AND PROGNOSIS

- Highly variable; depends on type, location, and size of the kidney stone, and the presence of secondary complications (such as blockage or obstruction of urine flow, kidney failure, urinary tract infection)
- Inactive nephroliths may remain inactive for years, resulting in an excellent prognosis
- Extracorporeal shock wave lithotripsy (a medical procedure in which the stone is broken up within the urinary tract using some type of energy or sound wave) to treat dogs with kidney stones (nephroliths)—return to normal health and excellent prognosis
- Prognosis for patients with kidney failure caused by the presence of stones in the kidney (nephrolithiasis) depends on the severity and rate of progression of kidney failure

## KEY POINTS

- Inactive kidney stones (nephroliths)—may not require removal, but should be monitored periodically by urinalysis, urine culture, and X-rays; potentially can cause blockage or obstruction of urine flow at any time, which can result in dilation of the funnel-shaped structure (renal pelvis) through which urine flows into the ureter due to blockage of urine flow (hydronephrosis) without clinical signs, so conservative management and monitoring carries a slight risk of undetected and potentially irreversible kidney damage, which must be weighed against the potential kidney damage from kidney surgery to remove the stone
- Kidney stones (nephroliths) tend to recur after removal; monitor the patient every 3 to 6 months