Feline Lower Urinary Tract Disease – Idiopathic Cystitis & Struvite/Calcium Oxalate Urolithiasis

Joseph W. Bartges, DVM, PhD, DACVIM, DACVN

Definition

Feline lower urinary tract disease (FLUTD) is often associated with ***urolithiasis*** (formation of struvite or calcium oxalate uroliths in the urine) or ***idiopathic cystitis***. In cats less than 10 years of age, idiopathic cystitis is the most common type of nonobstructive lower urinary tract disease, with urolithiasis (usually sterile struvite) the next most common type. In cats older than 10 years of age, bacterial ***urinary tract infection*** (UTI) is the most common cause of nonobstructive lower urinary tract disease, with urolithiasis (usually calcium oxalate) the next most common type. If the UTI is caused by a urease-producing bacterial organism, infection-induced struvite uroliths may form. **Obstructive uropathy** may be due to urolithiasis or to matrix-crystalline ***urethral plugs*** (found only in male cats); struvite is the most common mineral observed to occur in plugs.

Key Diagnostic Tools and Measures

Diagnosis begins with urinalysis to determine urine pH and presence and type of crystalluria. Urine culture can rule out or confirm infection; less than 1% of cats under 10 years of age with lower urinary tract signs have a bacterial UTI, whereas approximately 45% of cats over 10 years of age with lower urinary tract signs have a bacterial UTI. In these cases, the infection is often associated with a predisposing factor (e.g., renal failure, diabetes mellitus, feline leukemia virus [FeLV] infection). Abdominal radiography is helpful in determining if uroliths are present because struvite and calcium oxalate, which account for over 90% of uroliths in cats, are typically radiodense. Serum calcium concentration determination is important in cats with calcium oxalate uroliths because 20% to 35% of cats with calcium oxalate uroliths are hypercalcemic. Ionized calcium (iCa) and parathyroid hormone (PTH) concentrations should be determined if hypercalcemia is present. Idiopathic hypercalcemia, characterized by increased total calcium, increased iCa, and low PTH concentrations, is the most common cause of hypercalcemia in cats. If a urolith or plug is retrieved, it should be analyzed. Advanced imaging such as cystoscopy, ultrasonography, or contrast urethrocystography may help to identify uroliths or rule out causes of FLUTD. Thickened urinary bladder wall and glomerulations may be observed by cystoscopy with idiopathic cystitis.

Pathophysiology

Many diseases result in signs of lower urinary tract disease; idiopathic cystitis and urolithiasis occur most commonly, especially in cats less than 10 years of age. Uroliths form when urine is oversaturated with minerals that precipitate to form the uroliths. **Struvite** is magnesium ammonium phosphate hexahydrate, and thus struvite solubility is dependent on concentrations of magnesium, ammonium, and phosphate, and urine pH. Struvite solubility decreases as urine pH exceeds approximately 6.8. Two forms of struvite occur: 1) **Infection-induced struvite uroliths** form secondary to a UTI with a urease-producing bacterial organism, typically *Staphylococcus* spp. Bacterial urease activity results in alkaluria, increased urinary ammonium concentrations, and change in ionization state of phosphate promoting struvite formation. 2) **Sterile struvite uroliths** form without a bacterial infection and occur with oversaturation of urine with struvite calculogenic minerals and alkaluria. Alkaluria occurs secondary to postprandial alkaline tide or to persistent renal excretion of base. Sterile struvite uroliths occur more commonly in cats than infection-induced struvite; however, cats do form infection-induced struvite uroliths if they develop a UTI with a urease-producing bacterial organism.

Calcium oxalate uroliths may occur as the monohydrate or dihydrate forms or a combination of both; dihydrate form occurs most commonly. Calcium oxalate uroliths form when urine is oversaturated with calcium or oxalate or both, and form with aciduria. Approximately 20% to 35% of cats with calcium oxalate uroliths have hypercalcemia, most commonly idiopathic, which promotes hypercalciuria and urolith formation. The mechanism(s) for calcium oxalate urolith formation in cats that are normocalcemic is unknown; however, urinary oversaturation with calcium oxalate occurs.

Idiopathic cystitis may occur as a nonobstructive form that may or may not be associated with crystalluria or as an obstructive form due to a matrix-crystalline urethral plug in male cats. Idiopathic cystitis refers to clinical signs of FLUTD including hematuria, but without an identifiable cause. Viral infection and neurogenic inflammation are theorized causes. Matrix-crystalline urethral plug formation in male cats may represent an intermediate phase between urinary inflammation (e.g., idiopathic cystitis, bacterial cystitis) and urolithiasis.

Signalment

FLUTD occurs more commonly in cats between 4 and 10 years of age. Idiopathic cystitis and struvite urolithiasis occurs typically in cats less than 10 years of age; there is no gender or breed predisposition. Matrix-crystalline urethral plugs typically occur in male cats less than 10 years of age. Calcium oxalate urolithiasis typically occurs in cats older than 8 years of age; long-haired cats have a breed-associated predisposition, but there is no gender predisposition.

Key Nutrient Modifications

For cats with **struvite urolithiasis** and **matrix-crystalline urethral plugs**, increasing water intake will help to decrease concentration of calculogenic minerals in urine. For dissolution, dietary protein restriction decreases urinary ammonia concentration; for prevention, dietary protein should be moderated. Phosphorous and magnesium should be restricted. With regard to dietary fat, increasing energy density results in decreased amount of food intake and, therefore, overall mineral intake; however, obesity increases the risk of FLUTD and should be avoided. With regard to urinary acidification, struvite is more soluble (that is, likelihood of precipitation is increased) when urine pH is <6.5–6.8; therefore, avoid alkalinizing foods and induce an aciduria.

For **calcium oxalate urolithiasis**, increasing water intake will help to decrease the concentration of calculogenic minerals in urine. Excessive dietary protein intake should be avoided. Increasing energy density results in decreased amount of food intake and, therefore, overall mineral intake; however, obesity increases the risk of FLUTD and should be avoided. Calcium intake should be moderately restricted (see, for example, the diet fed in reference 6). Avoid dietary restriction of phosphorous and magnesium. Avoid excessive intake of vitamins C and D. With regard to urinary alkalinization, calcium oxalate is more soluble when urine pH is >6.8;[11] therefore, avoid acidifying diets and induce a neutral to alkaline urine pH. Increasing fiber intake may benefit cats with idiopathic hypercalcemia and calcium oxalate uroliths.

For **idiopathic cystitis**, increasing water intake may help to decrease recurrence of clinical signs.

See **Algorithm – Nutritional Management of Feline Lower Urinary Tract Disease** on page 94.

Recommended Ranges of Key Nutrients

Nutrient	% DM	g/100 kcal	% DM	g/100 kcal
	Recommended dietary level		Minimum dietary requirement*	
For cats with struvite urolithiasis:				
Protein	30–48	8–13	26	6.5
Fat	14–28	3.5–6.5	9	2.3
Phosphorus	0.6–1.1	0.1–0.3	0.5	0.13
Magnesium	0.05–0.08	0.01–0.025	0.04	0.01
For cats with calcium oxalate urolithiasis:				
Protein	30–48	8–13	26	6.5
Fat	14–28	3.5–.65	9	2.3
Calcium	0.6–1.1	0.1–0.3	0.6	0.15
Phosphorus	0.6–1.1	0.1–0.3	0.5	0.13
Magnesium	0.05–0.08	0.01–0.025	0.04	0.01
Fiber#	5–16	2–4	n/a	n/a

Modified intake of these nutrients may help address metabolic alterations induced by disease states. The recommended dietary composition is shown as percent of dietary dry matter (DM) and as g or mg per 100 kcal metabolizable energy. All other essential nutrients should meet normal requirements adjusted for life stage, lifestyle, and energy intake. Increased water intake should be encouraged. Use of canned, high moisture diets or sodium-supplemented diets may help increase water intake.

*Nutrient requirement for adult animals as determined by the Association of American Feed Control Officials

#For hypercalcemic cats, select a high-fiber diet along with the listed modifications

Therapeutic Feeding Principles

For dissolution or prevention of struvite urolithiasis and matrix-crystalline urethral plugs, induce aciduria and restrict dietary magnesium, protein, and phosphorous to induce urinary undersaturation and dissolution of uroliths or crystals. For calcium oxalate urolithiasis, induce neutral to alkaline urinary pH, restrict dietary calcium, and increase urine volume. For idiopathic cystitis, increase urine volume.

■ **Treats** – For cats with struvite urolithiasis and matrix-crystalline urethral plugs, avoid alkalinizing treats and medications. For cats with calcium oxalate urolithiasis, avoid acidifying treats, such as those containing acidifiers or high protein content, and avoid excessive calcium and vitamins D and C intake. For cats with idiopathic cystitis, avoid alkalinizing treats as they may induce struvite crystalluria.

■ **Tips for Increasing Palatability** – Warming food to near, but not over, body temperature increases palatability. Flavoring agents, such as gravy or broth, can also be used.

■ **Diet Recommendations** – Commercial diets formulated to decrease the risk of struvite and calcium oxalate formation as well as a struvite dissolution diet are available for cats with struvite urolithiasis, matrix-crystalline urethral plugs, and calcium oxalate urolithiasis. Canned diets are recommended for cats with idiopathic cystitis.

Client Education Points

- Struvite uroliths usually occur without a bacterial UTI in cats, but can form secondary to an infection. Dietary modification is important to decrease crystalluria and potential for recurrence of uroliths and plugs.
- Approximately one in three to five cats with calcium oxalate stones has high blood calcium concentrations. Dietary modifications to decrease calcium in urine and increase urine pH help to decrease recurrence.
- The cause(s) of idiopathic cystitis is/are not known. From a diet perspective, increasing urine volume helps to decrease recurrence in many cats.

Common Comorbidities

Struvite uroliths can form secondary to UTIs with urease-producing bacteria (infection-induced struvite); however, in cats, they usually form without an infection. Idiopathic hypercalcemia occurs in 20% to 35% of cats with calcium oxalate uroliths. Stress and inappropriate behavior are part of the pathogenesis of idiopathic cystitis. Obesity is associated with increased incidence of struvite urolithiasis and matrix-crystalline urethral plugs, calcium oxalate urolithiasis, and idiopathic cystitis.

Interacting Medical Management Strategies

If dietary acidification is ineffective in cats with struvite urolithiasis and matrix-crystalline urethral plugs, urinary acidifiers can be used. For calcium oxalate urolithiasis, potassium citrate induces neutral to alkaline urine pH and citrate is an inhibitor of calcium oxalate formation. It should be administered to cats with idiopathic hypercalcemia that are fed a moderate- to high-fiber diet. Thiazide diuretics decrease renal excretion of calcium; however, data does not exist in cats concerning safety and efficacy

No treatment has been shown to be completely effective for idiopathic cystitis. Analgesics aid in keeping the cat comfortable until clinical signs spontaneously resolve. Amitriptylline may help some cats with recurrent or persistent idiopathic cystitis. Pentosan polysulfate sodium is used in women with interstitial cystitis and may help some cats with recurrent or persistent idiopathic cystitis. Pharmacological modification of stress may benefit some cats.

Monitoring

For cats monitored for **dissolution of struvite uroliths**, sterile struvite uroliths typically dissolve in 2 to 4 weeks when feeding a struvite dissolution diet. Infection-induced struvite uroliths typically dissolve in 8 to 10 weeks when feeding a struvite dissolution diet and administering an appropriate antimicrobial agent. Urinalysis and lateral abdominal radiographs should be monitored monthly until urolith dissolution. Urinalysis should indicate aciduria, dilute urine, no crystalluria, resolution of hematuria, and no inflammation. For **prevention of struvite urolithiasis**, urinalysis and lateral abdominal radiography should be performed 1 to 2 months after medical dissolution or surgical removal. Urinalysis should indicate aciduria, dilute urine, no crystalluria, resolution of hematuria, and no inflammation. Consider urinalysis every 4 to 6 months and abdominal radiography if clinical signs of FLUTD occur.

For cats with **struvite matrix-crystalline urethral plugs**, urinalysis should be performed 1 to 2 months after beginning dietary modification. Check for aciduria, dilute urine, no crystalluria, resolution of hematuria, and no inflammation. Consider urinalysis every 4 to 6 months, and abdominal radiography if clinical signs of FLUTD occur.

For cats with **calcium oxalate urolithiasis**, urinalysis and lateral abdominal radiography should be performed 1 to 2 months after surgical removal. Look for neutral to alkaline urinary pH, dilute urine, no crystalluria, resolution of hematuria, and no inflammation. Consider urinalysis every 4 to 6 months. In cats with idiopathic hypercalcemia, monitor total serum calcium 1 to 2 months after dietary modification is begun and then every 4 to 6 months; abdominal radiographs are needed if clinical signs of FLUTD occur.

For cats with **idiopathic cystitis**, urinalysis should be performed 1 to 2 months after beginning dietary modification; look for aciduria, dilute urine, no crystalluria, resolution of hematuria, and no inflammation. Consider urinalysis every 4 to 6 months, and abdominal radiography if clinical signs of FLUTD occur.