

Management of Feline Lower Urinary Tract Disease

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FELINE IDIOPATHIC CYSTITIS

Feline idiopathic cystitis (FIC) is characterized by relapses of lower urinary tract signs (hematuria, pollakiuria, periuria, etc) that often resolve spontaneously within 4 to 7 days regardless of treatment. Although our understanding of the pathogenesis of this condition has changed over the past decade, the underlying causes remain unknown. Therefore, the goals of managing cats with FIC are to decrease severity of clinical signs and increase the interval between episodes of lower urinary tract disease.¹ Over the past 40 years, many different treatments have been recommended to control clinical signs in cats with FIC, yet only a few (prednisolone, chloramphenicol, propantheline, amitriptyline, glucosamine, feline facial pheromone, and feeding moist food) have been evaluated in clinical trials of cats with FIC.²⁻⁸

Nutritional Management

Moist Food

To date, of all treatments evaluated in a controlled clinical study, the only one that has been associated with a statistically significant difference in recurrence of clinical signs in cats with FIC is feeding moist food (> 60% moisture). During a 1-year study of cats with FIC, clinical signs recurred less often in cats fed moist food (11%) compared with cats fed the dry formulation (39%) of the same food.⁸

In a 6-month study evaluating glucosamine versus placebo in cats with FIC, cats in both groups improved significantly compared with their condition at the beginning of the study.³ All owners were given client education hand-

KEY POINTS

- The only treatment that has been associated with statistically significant improvement in a controlled study of cats with feline idiopathic cystitis is feeding moist food.
- Struvite uroliths can be dissolved by feeding a dissolution food for approximately one month.
- Treatment of calcium oxalate uroliths includes urolith removal followed by feeding a moist therapeutic food to help prevent recurrence.
- Feeding moist food is indicated for all cats with feline idiopathic cystitis, struvite uroliths or urethral plugs, and calcium oxalate uroliths.

TABLE 1: Water Intake/Urine Volume in Cats Fed Dry or Moist Food

Volume (ml/day)	Moist Food	Dry Food
Water (in food)	246	6
Water (in addition to food)	32	221
Total water intake	278	227
Fecal water	27	44
Urine	166	79

outs describing recommendations for cats with FIC, including moist food. At the beginning of this study, 95% of cats were fed either dry food exclusively or at least half of their daily food was dry. After starting the trial, however, 36 owners (90%) increased the amount of moist food given to their cats daily to at least 50%. In 33 cats (82.5%), owners began feeding moist food exclusively. Mean urine specific gravity at the

Methods to increase water consumption in cats include:

- feeding moist food
- increasing frequency of feeding
- adding broth to food
- placing ice cubes in the water
- using unique water bowls
- providing water fountains

associated with an increase in daily water intake and urine volume in cats compared with feeding dry food (Table 1).^{9,10} It has been stated that the goal of increased water intake is to decrease urine specific gravity below 1.030.¹⁰ However, beneficial effects have been observed in cats with FIC when urine specific gravity decreased from values around 1.050 to values ranging from 1.032 to 1.041.^{3,8} Most cats can be switched to a moist food if the change is made gradually; the transition in some cats may take several weeks. Failure to make a gradual

beginning of the study was 1.050 and it was significantly lower (1.036) when reassessed one month later ($p < 0.01$). It is likely that increased consumption of moist food caused urine dilution, which in turn was associated with improvement in cats with FIC. However, it is possible that other factors associated with feeding moist food (eg, texture, taste, or owner/cat interactions associated with delivery of canned meals) played a role.

Increasing daily water intake and/or switching to moist food should be part of the initial management of cats with FIC. Feeding moist food has been

change may result in refusal to eat the moist food or increased stress, which may cause recurrence of clinical signs. Therefore, moist food should initially be offered as an additional option in a second dish next to the usual food. If the cat will consume the moist food, the dry food can be gradually reduced.

Frequency of Feeding

Increasing frequency of feeding (ie, dividing the daily amount of food into several meals) also may help increase daily water intake. In a study of healthy cats, feeding 2 to 3 meals per day was associated with a significant increase in total water intake compared with feeding a single meal.¹¹ This has not been evaluated in cats with FIC; however, it would appear to be a reasonable method to increase water consumption. Additional methods for increasing water intake such as adding broth to foods, placing ice cubes in the cat's water, using unique water bowls, and providing water fountains also may help in some cases.¹

Increasing Dietary Salt

Increasing salt (eg, sodium chloride) content of food is another method of increasing water intake and causing subsequent urine dilution in cats.¹² Short-term feeding of high-salt foods for 14 days was associated with increased water intake and decreased urine specific gravity without increasing systolic blood pressure in a study of young healthy cats (mean age of 2.5 years).¹³ In order to stimulate sufficient water intake to cause production of dilute urine, the food must contain more than 1% sodium on a dry matter basis (DMB).¹⁴ The minimum requirement of sodium for adult cats is 0.2% of the food (DMB). According to the most recent information published by the National Research Council (NRC), it is difficult to suggest a safe upper limit of sodium for healthy adult cats.¹⁵ The NRC has concluded that as long as unlimited amounts of water are available, it is likely that cats can tolerate reasonably high concentrations of dietary sodium; the safe upper limit of sodium for healthy adult cats has been defined as 1.5% sodium (DMB).¹⁵ The safe upper limit of sodium for cats with chronic kidney disease, lower urinary tract disease, and other conditions is unknown. Many foods formulated for cats with lower urinary tract disease (LUTD) contain between 0.25% and 0.50% sodium, whereas some contain 1% to 1.4% sodium (Table 2).

Despite the benefits of urine dilution associated with

increased salt intake, there is potential for adverse effects. To date, hypertension has not been associated with feeding high salt foods to healthy cats or those with kidney disease (naturally occurring and experimentally induced).^{13,14,16} However, these studies were designed to evaluate cats for periods ranging from 7 days to 3 months and effects beyond this duration are unknown. At present, there are differing opinions regarding the role of sodium in cats with kidney disease.^{14,16-18} An epidemiologic study of 38 cats evaluated from 1994 to 1995 showed an association between increased dietary sodium and decreased odds of kidney disease.¹⁹ In a study of cats with experimentally induced kidney disease that were fed different levels of sodium for 7 days, cats fed the lowest amount of sodium chloride had the lowest values for glomerular filtration rate. The authors concluded that low sodium intake might contribute to progressive renal injury in cats.¹⁶ In contrast, cats with naturally occurring kidney disease lived significantly longer and had no uremic episodes when fed a renal therapeutic food (with a similar amount of sodium used in the previous study) versus a control food with higher sodium for 2 years.²⁰ Finally, effects of high salt (1.2% sodium, DMB) intake for 3 months were evaluated in cats with mild azotemia due to naturally occurring chronic kidney disease.¹⁴ These cats had progressive increases in BUN, serum creatinine, and serum phosphorus compared to cats consuming food with 0.4% sodium (DMB). Based on all findings to date, it appears that further study is needed to better determine the role of sodium in healthy cats fed long-term, as well as cats with hypertension and chronic kidney disease. Pending further studies, high-salt foods should not be fed to cats with chronic kidney disease. In addition, kidney function should be monitored when high-salt foods are fed to cats with no apparent kidney disease.

Fatty Acids and Antioxidants

Recently, a new food (Hill's® Prescription Diet® c/d® Multi-care Feline) has become available for managing cats that have FIC as well as struvite and calcium oxalate uroliths. In addition to controlled amounts of magnesium, phosphorus, calcium, and oxalate, this food contains increased omega-3 fatty acids from fish oil (eicosapentanoic acid [EPA] and docosahexanoic acid [DHA]). After ingestion, fatty acids are incorporated in all cell membranes of the body where they exert their antiinflammatory effects (eg, arthritis, dermatitis, cystitis). Antioxidants (vitamin E and β -carotene) are also included to decrease oxidative stress, which is associated with inflammation, and create an environment less favorable for

development of uroliths. For more information about using fatty acids and antioxidants for managing cats with LUTD, see the article entitled Dietary Management of the Three Most Common Lower Urinary Tract Diseases in Cats (page 53).

Environmental Enrichment and Stress Reduction

In addition to nutritional management, the currently recommended treatment for cats with FIC includes environmental enrichment, stress reduction, and appropriate litter box maintenance.¹ Recently, a prospective study evaluating the effects of multimodal environmental modification was reported in 46 client-owned cats with FIC.²¹ There were significant reductions in lower urinary tract signs, fearfulness, and nervousness after treatment for 10 months. For cats with FIC, stressful situations (eg, conflict with other cats in the home) should be avoided or minimized.⁷ Environmental enrichment includes providing opportunities for play/resting such as horizontal and vertical surfaces for scratching, hiding places, and climbing platforms. Food and water bowls should be clean and kept in safe places (eg, not next to noisy appliances). Litter boxes also should be clean and kept in locations that do not increase stress. There should be an adequate number of litter boxes (one more than the number of cats in the home). More detailed information on environmental enrichment and litter box management is available.^{1,22,23}

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Amitriptyline

Amitriptyline (Elavil,® AstraZeneca Pharmaceuticals) is a tri-cycle antidepressant with anticholinergic, antihistaminic, sympatholytic, analgesic, and antiinflammatory properties that has been used in humans with interstitial cystitis and cats with FIC. In an uncontrolled study of cats with severe, recurrent, idiopathic cystitis that failed to respond to other treatments, administration of amitriptyline for 12 months was associated with decreased clinical signs in 9 of 15 cats (60%) during the last 6 months of treatment.²⁴ A randomized, controlled clinical trial of amitriptyline treatment for 7 days revealed no significant difference in rate of recovery from pollakiuria or hematuria; overall, clinical signs recurred sig-

TABLE 2: Nutrient Information for Commercially Available Foods for Cats with Lower Urinary Tract Disease*

Company	Food	Form	Indications [†]	Kcal/kg As Fed	Na	Ca	Mg	P	n-3	Target Urine pH
Hill's	Prescription Diet [®] c/d [®] Multicare with Chicken Feline	Moist	SP, C, FIC	1,044	0.32	0.72	0.052	0.68	0.96	6.2-6.4
Hill's	Prescription Diet [®] c/d [®] Multicare with Chicken Feline	Dry	SP, C, FIC	3,858	0.33	0.76	0.061	0.65	0.64	6.2-6.4
Hill's	Prescription Diet [®] s/d [®] Feline	Moist	SD	1,381	0.41	0.62	0.062	0.48	0.34	5.9-6.1
Hill's	Prescription Diet [®] s/d [®] Feline	Dry	SD	4,292	0.40	1.05	0.059	0.77	0.26	5.9-6.1
Hill's	Prescription Diet [®] x/d [®] with Chicken Feline	Moist	C/FIC	1,197	0.37	0.69	0.082	0.53	0.15	6.6-6.8
Hill's	Prescription Diet [®] x/d [®] Feline	Dry	C	3,794	0.36	0.76	0.076	0.66	0.16	6.6-6.8
Hill's	Prescription Diet [®] w/d [®] Feline	Moist	SP/C/FIC	934	0.33	0.74	0.063	0.59	0.15	6.2-6.4
Hill's	Prescription Diet [®] w/d [®] Feline	Dry	SP/C	3,227	0.30	0.99	0.059	0.77	0.25	6.2-6.4
Iams	Low pH/S [™] /Feline Formula	Moist	SP/FIC	1,159	0.46	1.27	0.1	1.00	NA	5.9-6.3
Iams	Low pH/S [™] /Feline Formula	Dry	SP	4,286	0.52	1.10	0.084	0.96	0.4	5.9-6.3
Iams	Moderate pH/O [™] /Feline Formula	Moist	C/FIC	1,159	0.48	1.23	0.104	0.90	NA	6.3-6.9
Iams	Moderate pH/O [™] /Feline Formula	Dry	C	4,235	0.48	1.11	0.088	0.96	NA	6.3-6.9
Purina	ONE [®] Special Care Urinary Tract Health Formula	Dry	SP	4,313	0.2	1.09	0.07	0.99	NA	< 6.3
Purina	Pro Plan [®] Urinary Tract Health Formula Extra Care	Dry	SP	4,271	0.26	1.05	0.070	1.01	NA	6.2-6.4
Purina	UR URinary [®] St/Ox Feline Formula	Moist	SD/SP/C/FIC	1,057	0.62	0.96	0.07	0.97	NA	6.0-6.4
Purina	UR URinary [®] St/Ox Feline Formula	Dry	SD/SP/C	3,441	1.17	1.10	0.07	1.08	NA	6.0-6.4
Royal Canin	Medi-Cal [®] Preventive Formula	Moist	SP/FIC	1,005	0.3	1.10	0.06	1.00	NA	NA
Royal Canin	Medi-Cal [®] Preventive Formula	Dry	SP	4,150	0.4	1.00	0.07	0.80	NA	NA
Royal Canin	Medi-Cal [®] Dissolution Formula	Moist	SD	847	1.27	1.08	NA	1.06	NA	NA
Royal Canin	Medi-Cal [®] Dissolution Formula	Dry	SD	4,010	0.37	0.97	NA	0.97	NA	NA
Royal Canin	Veterinary Diet [™] feline Urinary SO [™] in Gel	Moist	SD/SP/C/FIC	1,211	1.02	1.02	0.097	1.36	NA	6.0-6.3
Royal Canin	Veterinary Diet [™] feline Urinary SO 30 [™]	Dry	SD/SP/C	3,971	1.40	1.08	0.075	0.86	NA	6.0-6.3

*Unless indicated, all nutrients expressed on dry matter basis; NA = not available, Na = sodium, Ca = calcium, Mg = magnesium, P = phosphorus, n-3 = omega-3 fatty acids

[†] C = calcium oxalate prevention, FIC = feline idiopathic cystitis, SD = struvite dissolution, SP = struvite prevention

nificantly faster and more frequently in cats treated with amitriptyline compared to control cats.²⁵ In a similar study, amitriptyline combined with amoxicillin was no more effective than placebo and amoxicillin when given for 7 days to cats with FIC.²⁶ Based on current information, amitriptyline does not appear to be beneficial for short-term management of cats with FIC. It is possible that longer use (several months) may be helpful, but this has not been demonstrated in a controlled, long-term, clinical study.

Antiinflammatory Agents and Analgesics

These agents may be helpful for managing patient discomfort during acute episodes of FIC. Drugs that have been used for 3 to 4 days include butorphanol (4 mg/kg PO Q 8 H) and meloxicam (0.1 mg/kg PO Q 24 H). Other analgesics and anti-inflammatory agents may be appropriate. Selection is often based on clinician preference or experience. There have been no clinical trials evaluating opioid analgesics (butorphanol, buprenorphine) or nonsteroidal antiinflammatory drugs in cats

with FIC. Prednisolone (1 mg/kg PO Q 12 H for 10 days) was evaluated in a randomized, controlled, clinical trial of cats with FIC and found to be no more effective than placebo for reducing severity or duration of clinical signs in affected cats.⁵

Feline Facial Pheromone

Synthetic feline facial pheromone therapy has been recommended to decrease signs of stress in cats with FIC. In a double-blind, placebo-controlled, clinical study of 20 hospitalized cats (13 with lower urinary tract disease and 7 apparently healthy), exposure to feline facial pheromone (Feliway® Ceva Santé Animale) was associated with significant increases in grooming, interest in food, and food intake. These results suggested that feline facial pheromone had an anxiolytic effect in some cats.²⁷ Another study evaluated effects of feline facial pheromone in a study of 12 cats with FIC.⁴ While there was no significant difference between treatment of the environment with placebo and feline facial pheromone for 2 months, there was a trend for cats exposed to facial pheromone to show fewer days with clinical signs of cystitis, fewer episodes, and fewer negative behavioral traits (less aggression and fear). Further study is needed; however, it seems reasonable to consider treatment with feline facial pheromones in cats with signs of stress or when clinical signs persist after implementing environmental enrichment and methods to increase water intake.

Glycosaminoglycans

Treatment with glycosaminoglycans (GAGs) such as pentosan polysulfate, glucosamine, and chondroitin sulfate has been suggested in cats with FIC because defects in the GAG layer covering the urinary bladder epithelium may play a role in the pathogenesis of the disease. Anecdotally, these agents have been mentioned as helpful in cats with FIC, although only one has been critically evaluated. In a randomized, controlled clinical trial, cats that received 125 mg glucosamine (Cystease®, Ceva Animal Health) by mouth once daily did not show any difference in clinical signs as compared to cats that received placebo.³ If signs of FIC persist despite other treatments, GAGs such as pentosan polysulfate (8 mg/kg PO Q 12 H) or a combination of glucosamine and chondroitin sulfate (1 mg/100 mg per 4.5-kg cat PO Q 24 H) may be attempted.

STRUVITE UROLITHIASIS/URETHRAL PLUGS

Treatment options for cats with struvite uroliths include physical removal of uroliths (ie, cystotomy, voiding urohydropropulsion, laser lithotripsy) or dissolution via nutritional management. No studies have compared these methods. Choice of treatment depends on clinician experience/expert-

ise, availability of necessary equipment, patient factors, and client preferences. In human patients, every effort is made to treat uroliths by the least invasive method possible.

Several therapeutic foods marketed for dissolution of struvite uroliths are formulated to avoid excessive magnesium and phosphorus and maintain acidic urine pH, which decreases precursors available to form uroliths. Some foods contain relatively high amounts of salt (eg, sodium chloride), which results in production of more dilute urine and decreased saturation of struvite in urine (**Table 2**). Only two foods have been evaluated in cats with struvite uroliths: Hill's® Prescription Diet® s/d® Feline and Medi-Cal® Dissolution Formula, Veterinary Medical Diets. The mean time required for dissolution of sterile struvite uroliths using these foods was approximately 1 month.^{28,29} The relative supersaturation (RSS) and activity product ratio (APR) of the urine in healthy cats fed various preventive and maintenance foods can estimate the risk for crystalluria and urolith formation.³⁰⁻³³ These values have not been correlated with recurrence in cats with struvite urolithiasis. Treatment options for cats with struvite uroliths include physical removal of uroliths (eg, cystotomy, voiding urohydropropulsion, laser lithotripsy) or dissolution via nutritional management.

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For cats with suspected struvite uroliths (usually < 7 years old, alkaline urine pH, struvite crystalluria, and/or radiopaque uroliths), it is appropriate to transition to feeding a canned calculolytic food such as Hill's® Prescription Diet® s/d® Feline over a 7-day period. Cats should be reevaluated every 2 to 4 weeks by performing urinalysis and abdominal radiography. Urine pH should remain acidic and specific gravity should be less than 1.040 if the cat is given canned food exclusively. Nutritional management is continued for 1 month beyond radiographic resolution of the urolith(s). If uroliths do not dissolve completely or decrease in size within 2 months, different treatment should be considered.

After dissolution or removal of struvite uroliths or urethral plugs, nutritional management is indicated to prevent recurrence. Several commercial foods are available for struvite prevention; however, only one (Hill's® Prescription Diet® s/d® Feline) has been evaluated in cats with struvite disease. In a randomized, prospective study of cats with urethral plugs, the calculolytic food was compared with perineal urethrostomy alone

and perineal urethrostomy plus the calculolytic food to prevent recurrence of urethral obstruction.³⁴ During the 1-year study, urethral obstruction was not observed in any group. The study did not include an untreated control group; however, recurrence rate for urethral obstruction in a previous study was 35%.³⁵ Bacterial UTI occurred in 40% to 50% of cats that had perineal urethrostomies but was not observed in cats managed by calculolytic food alone. Several other foods formulated for struvite prevention have been evaluated in healthy cats by measuring values for RSS and APR.³⁶⁻³⁸ After dissolution or removal of struvite uroliths, cats should be gradually transitioned to a food formulated to prevent struvite crystalluria. A dissolution (calculolytic) food is appropriate for initial management (1 to 3 months) after relieving urethral obstruction. This should be followed by a struvite preventive food (eg, Hill's® Prescription Diet® c/d® Multicare Feline) indefinitely (**Table 2**).

CALCIUM OXALATE UROLITHIASIS

The treatment of choice for calcium oxalate urolithiasis is urolith removal, followed by management strategies to prevent recurrence. At present, the standard of care for preventing calcium oxalate urolith recurrence is to feed moist therapeutic food and encourage water intake.^{10,39} Other suggested treatments include dietary supplementation with potassium citrate and vitamin B₆ and treatment with thiazide diuretics. If hypercalcemia exists, the underlying

In cats with hypercalcemia and calcium oxalate uroliths, feeding increased amounts of fiber and administering potassium citrate have been recommended.

cause should be treated; however, many cats have idiopathic hypercalcemia, which makes specific treatment challenging.⁴⁰⁻⁴² Although much information is available regarding risk factors for calcium oxalate uroliths, the causes remain largely unknown, making ideal preventive recommendations challenging.^{43,44} All

cats should be monitored for recurrence, including urinalysis every 3 months to detect calcium oxalate crystalluria and diagnostic imaging every 6 months to detect uroliths. If uroliths recur and are small, less-invasive procedures such as voiding urohydropropulsion are more likely to be effective.

Nutritional Management

Several commercial therapeutic foods are available for prevention of calcium oxalate uroliths in cats (**Table 2**). Of these, only one food (Hill's® Prescription Diet® x/d® Feline) has been evaluated in cats with naturally occurring calcium oxalate uroliths (the technology of x/d® Feline is currently

available in c/d® Multicare Feline).⁴⁵ In a study of 10 cats with confirmed calcium oxalate uroliths, urinary APR values for calcium oxalate were measured prior to the study and after a feeding trial. Using a crossover design, half the cats were randomly assigned to continue their regular food and half were fed the therapeutic food. After 8 weeks, the foods were switched for another 8 weeks. Urinary APR values were determined and compared between groups (regular food versus therapeutic food). Results revealed that hypercalciuria was a consistent abnormality in urolith-forming cats and calcium oxalate APR values were significantly lower in cats fed the therapeutic food compared with regular food.

In cats with hypercalcemia and calcium oxalate uroliths, feeding increased amounts of fiber and administering potassium citrate have been recommended.³⁹ In a report of 5 cats with calcium oxalate uroliths, hypercalcemia resolved and urolith recurrence was not observed after discontinuing an acidifying food (or urinary acidifier) and changing to a higher fiber food (Hill's® Prescription Diet® w/d® Feline) or adding a fiber supplement.⁴² It was suggested that increased fiber may have lowered serum calcium by binding intestinal calcium, preventing its absorption, and/or decreasing transit time through the small intestine, where most calcium is absorbed.

The effect of some high-salt foods (> 1% sodium, DMB) on urinary calcium oxalate saturation (RSS values) in healthy cats has been assessed (**Table 2**).^{12,36,38,46} Studies have shown that increased salt intake is associated with increased water consumption and urine dilution in healthy cats, which could help prevent urolith recurrence.^{13,46} Although concerns have been expressed about increasing risk for calcium oxalate uroliths due to increased urine calcium excretion associated with salt-induced diuresis, urine calcium concentration and calcium oxalate saturation were not increased in normal cats when fed a high-salt food, even though there was a significant increase in 24-hour urine calcium excretion.⁴⁶ In contrast, increased urinary concentration and increased fractional excretion of calcium were identified in cats with mild, naturally occurring, chronic kidney disease consuming high-salt food.¹⁴ The effects of these foods in cats with kidney disease need additional study because renoliths and ureteroliths, most of which are calcium oxalate, are being diagnosed more frequently in cats with chronic kidney disease.^{14,47} In healthy cats, increased dietary salt has been associated with decreased values for urinary calcium oxalate RSS.¹² Interestingly, urinary RSS for calcium oxalate was not significantly decreased when feeding high-salt foods compared with lower-salt foods to healthy cats in three studies.^{36,38,46} Although RSS values may be used to predict risk of developing crystalluria, they have not been criti-

cally evaluated in cats that have calcium oxalate uroliths.

Increased water intake is associated with decreased concentrations of urolith-forming minerals in urine and has been recommended to help prevent urolith recurrence. One epidemiologic study showed that cats fed high-moisture foods were less likely to develop calcium oxalate uroliths than cats fed dry foods.⁴⁸ In addition to using moist food, it may be helpful to feed several meals per day, add additional water or broth to dry or moist food, and use water fountains or novel water bowls.

Potassium Citrate

Potassium citrate is a urinary alkalinizer that has been recommended to prevent calcium oxalate uroliths. Increased urinary citrate may form soluble complexes with calcium, making it unavailable to form calcium oxalate uroliths. Effects of potassium citrate alone on urinary calcium oxalate saturation or urolith recurrence have not been evaluated in healthy cats or cats with calcium oxalate uroliths. Potassium citrate is found in one therapeutic food (Hill's® Prescription Diet® x/d® Feline, now available as c/d® Multicare Feline) that has been evaluated in cats with calcium oxalate uroliths.⁴⁵ Potassium citrate (50–75 mg/kg PO Q 12 H with food) should be considered in cats that have recurrent calcium oxalate uroliths despite using a therapeutic food.

Vitamin B₆ (Pyridoxine)

Increases in urinary oxalic acid excretion have been observed in kittens fed pyridoxine-deficient foods, but the effects of vitamin B₆ in cats with calcium oxalate uroliths have not been evaluated.^{49,50} Because most commercially available pet foods are well supplemented with vitamin B₆, it seems unlikely that additional supplementation would be helpful. However, if a cat with calcium oxalate uroliths is given a homemade food, it would be appropriate to supplement with vitamin B₆ (2–4 mg/kg PO Q 24 H).

Thiazide Diuretics

Thiazide diuretics are known to cause renal tubular reabsorption of calcium, resulting in decreased urine calcium excretion, which may decrease likelihood of urolith recurrence. In a blinded, crossover, controlled study of healthy cats, administration of

hydrochlorothiazide suspension (1 mg/kg PO Q 12 H) was associated with significantly decreased urinary saturation of calcium oxalate compared with placebo.⁵¹ No studies of thiazide diuretics in cats with calcium oxalate uroliths have been reported, however. For cats with recurrent uroliths despite using previously described measures, thiazide diuretics may be attempted. Thiazides should not be used in cats with hypercalcemia and patients should be monitored carefully for dehydration.

SUMMARY

Many treatments have been recommended for managing cats with lower urinary tract disease. Feeding moist food and using other methods to increase water intake are indicated for cats with FIC, urethral plugs, and urolithiasis. In addition, environmental enrichment and stress reduction are indicated in cats with FIC. Feeding therapeutic foods for 1 to 2 months may be used as the sole treatment to dissolve struvite uroliths in cats. Foods formulated to prevent struvite urolith or urethral plug recurrence are indicated after urolith dissolution or removal of urethral plugs. The treatment of choice for calcium oxalate uroliths is urolith removal followed by feeding a therapeutic food formulated to prevent urolith recurrence. Cats with a history of uroliths or urethral plugs should be monitored periodically by performing urinalyses and diagnostic imaging to detect recurrent disease and make changes in the therapeutic regimen as needed.

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