Advances in Lower Urinary Tract Diseases

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- urolithiasis
- struvite
- calcium oxalate
- idiopathic and interstitial cystitis
- behavior disorder
- amitryptiline
- glycosaminoglycan
- cystoscopy

Dysuria, stranguria, pollakiuria, macroscopic hematuria, and periuria, that is, inappropriate urination (urinating in places other than the litter box), are nonspecific signs that, individually or in some combination, cause clients to bring their cats to a veterinarian. None of these signs is diagnostic for any particular disease. In our experience, owners most often present their cat for care because it urinated in an inappropriate place.[1] It is important to recognize that many cats exhibiting inappropriate urination as the sole owner complaint actually have idiopathic cystitis rather than a behavior disorder. Approximately two thirds of cats with nonobstructive lower urinary tract (LUT) disorders have idiopathic cystitis, a percentage that has not changed in the past four decades.[1–4] Although idiopathic cystitis is the most common diagnosis in young cats with LUT signs, only 5% of cats more than 10 years of age with such signs have idiopathic cystitis. Bacterial urinary tract infection (UTI) was encountered in more than half of these older cats.[5]

Diagnosis of the causes of lower urinary tract disease (LUTD) requires integration of findings from history, physical examination, urinalysis, urine culture, and some combination of abdominal radiography, ultrasound of the bladder and proximal urethra, urethrography, cystography, or urethrocystoscopy (Figure 1). Endoscopy of the urethra and bladder is now routinely possible using a flexible fiberoptic scope in male cats and a rigid human pediatric cystoscope in female cats.[6,7] Urethroscopy and cystoscopy allow detailed evaluation of the mucosal surfaces of the urethra and bladder. Cystoscopic evaluation of female cats with the rigid scope is considerably easier and provides greater optical detail than that obtained in males using the fiberoptic scope. Urethroscopy allows documentation of urethral plugs in males, urethral stones, and urethritis. Cystoscopy allows documentation of cystitis, evaluation of the region of the urachus, and detection of small urinary stones. Small bladder stones that are not visible by radiography or ultrasonography are usually easily detected during cystoscopy. The degree of vascularity, edema, and submucosal petechiations ("glomerulations") in the bladder can help assess the severity of cystitis.

UROLITHIASIS

The two most common types of stones in cats are struvite and calcium oxalate. Prior to the late 1980s, sterile struvite was the most common urolith found in cats. The proportion of struvite urolithiasis declined in subsequent years after changes in commercial cat food formulations. Unfortunately, this decline appears to have come at the expense of an increase in the proportion of calcium oxalate uroliths.[8–10] The proportion of stones analyzed at the University of Minnesota Urolithiasis Center has shifted from approximately 65% struvite and 2% calcium oxalate in 1984 to 48% struvite and 40% calcium oxalate in 1995.[11,12]

Struvite Urolithiasis

Struvite crystalluria is not synonymous with struvite urolithiasis; struvite urolithiasis can occur with or without struvite crystalluria, and struvite crystalluria can occur in apparently normal cats. Unlike dogs, the vast majority of cats form struvite uroliths in sterile urine. Struvite (magnesium ammonium phosphate) urolithiasis and urethral obstruction have been induced experimentally in healthy cats by feeding diets containing 3 to 10 times the amount of magnesium found in commercial cat foods. These studies led to the conclusion that magnesium was a primary cause of naturally occurring struvite urolithiasis in cats. It subsequently was learned that when the urine pH was reduced to approximately 6, struvite stones dissolved in the bladder of healthy cats fed large quantities of magnesium. These results suggested that magnesium's

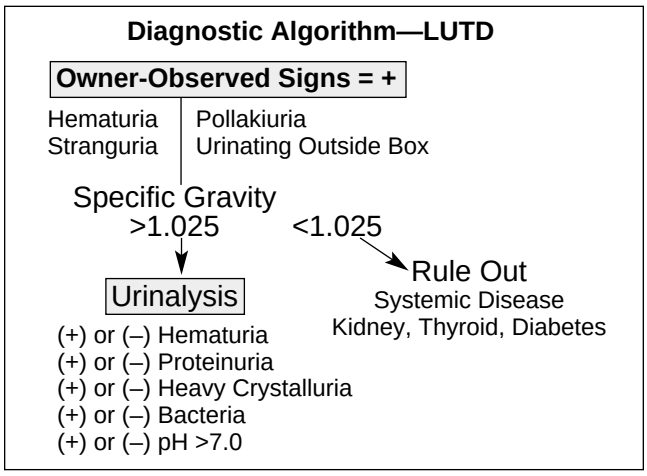

Figure 1A

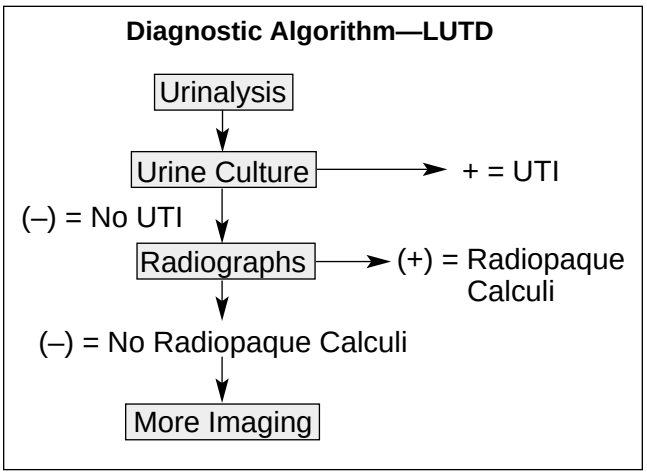

Figure 1B

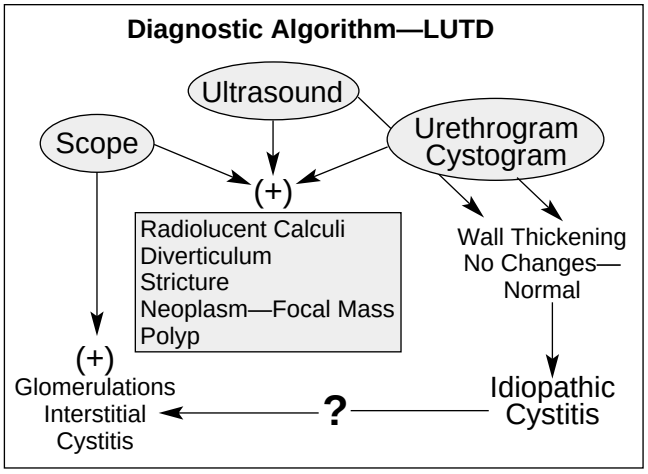

Figure 1C

Figure 1. (**A**) It is important to rule out dilute urine as a cause for increased urine production resulting in inappropriate urination. Cats consuming dry food usually have a urine specific gravity in excess of 1.030, while cats eating canned foods may have a specific gravity near 1.025. Although hematuria and proteinuria are often present during active states of inflammatory LUTDs of cats, the severity of hematuria and proteinuria can wax and wane (false-negative finding). False-positive findings for hematuria and proteinuria can occur when urine samples are obtained by cystocentesis or urinary catheter. Heavy crystalluria is an uncommon occurrence in urine from cats in the 1990s in the United States. It is important to ensure that the finding of crystalluria is not overinterpreted, because crystals by themselves do not create disease. Crystalluria can be an artifact of urine that has cooled and sat for prolonged periods—this is especially true for refrigerated samples. The finding of "bacteria" should be viewed with caution, as many artifacts in feline urine resemble bacteria. Bacteria in the presence of hematuria and pyuria more likely do reflect bacterial infection, although this is uncommon in young cats with signs of LUTD. Alkaline urine by itself is not a disease and is not a common finding in cats fed acidifying diets common in the 1990s. (**B**) Urine should be submitted for culture if there is evidence of pyuria, dilute urine (<1.030), previous urethral catheterization, or perineal urethrostomy. Plain radiographs may show radiopaque calculi due to calcium oxalate or struvite, but good technique and cleansing enemas are needed to visualize small stones. (**C**) Contrast radiography is indicated in cats with recurrent or persistent clinical signs in which no abnormalities are seen on plain radiographs. Small stones, anatomic abnormalities (urethral stricture in males, urachal diverticulum), and masslike lesions may be disclosed, although neoplasia of the cat bladder is very uncommon. Ultrasonography may show radiolucent cystic calculi and is useful for the assessment of bladder wall thickness if the bladder is at least moderately distended with urine. Ultrasonography is not useful for evaluation of the urethra, however. Urethrocystoscopy is useful for excluding small urinary calculi and evaluating the bladder and urethra for anatomic abnormalities. Additionally, cystoscopy provides the most information about mucosal detail—this method is more likely to detect mucosal abnormalities than are other imaging modalities. At present, "glomerulations" following bladder distention to 80 cm H_20 must be seen to make the diagnosis of interstitial cystitis. Interstitial cystitis is a subcategory of idiopathic cystitis. The question mark at the bottom of the figure between idiopathic and interstitial cystitis indicates that it is not known how many cats with a diagnosis of idiopathic cystitis would have a diagnosis of interstitial cystitis if evaluated with a cystoscope.

effect on struvite formation depended on the urine pH. This idea was supported when it was found that the form of magnesium used in previous studies increased urine pH. The research implicating magnesium as a potential cause of urinary stone disease in cats seems to have led cat food manufacturers to restrict the magnesium contents of diets and to add ingredients to promote a more acidic urine in an attempt to minimize the struvite-promoting potential of their products. In retrospect, it appears that few client-owned cats formed struvite urolithiasis despite consumption of commercial foods that were alkalinizing and magnesium replete, suggesting that these diets revealed cats intrinsically susceptible to struvite stone formation rather than having directly caused stone formation.

The presence or absence of struvite crystalluria on a random urinalysis does not predict which cat will form a stone for the first time, although the persistence of struvite crystalluria is a risk factor for recurrence of struvite urolithiasis. We have observed the formation of naturally occurring struvite urolithiasis in cats consuming dry diets designed to inhibit struvite formation. This observation emphasizes the significance of that most important nutrient, water, in the treatment of cats with all types of urolithiasis.

Medical dissolution of struvite urolithiasis using dietary methods has been reported.[13] In an uncontrolled study, consumption of a *canned*, magnesium-restricted, urine acidifying, salt-supplemented diet dissolved naturally occurring struvite calculi in cats over several weeks. Although magnesium-restricted acidifying diets are commonly used to prevent recurrence of sterile struvite urolithiasis in cats, no data exist to prove their effectiveness in doing so. Because so many commercial American diets for cats have been modified to restrict the formation of struvite, clinicians should recognize that acidifying agents such as ammonium chloride or d,l-methionine no longer are needed to maintain acidic urine in cats consuming these foods. Acidifying agents should not be routinely prescribed for cats with struvite urolithiasis because they impose an additional source of acid that may contribute to the development of metabolic acidosis.

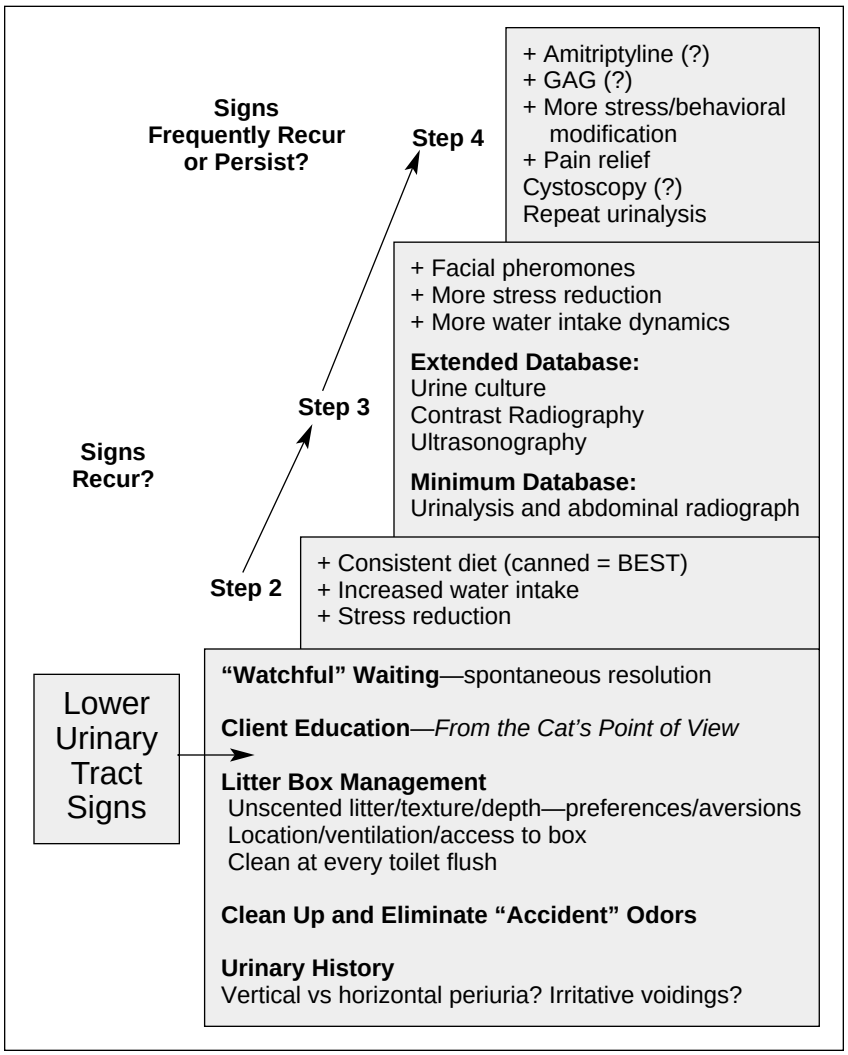

Figure 2. Stepwise approach to treatment of cats with idiopathic LUT signs. To ensure that the diagnosis is really idiopathic LUTD, more diagnostics should be performed when initial LUT signs do not resolve and when signs recur. Properly controlled clinical trials may provide better approaches to treatment in the future, but these steps can be undertaken in the interim.

Calcium Oxalate Urolithiasis

Calcium oxalate crystalluria is not synonymous with calcium oxalate urolithiasis; oxalate crystalluria occurs in some apparently normal cats, and oxalate urolithiasis can form with or without oxalate crystalluria seen on urinalysis. In one report, only about half the cats with calcium oxalate uroliths had calcium oxalate crystalluria at the time of diagnosis, and 9% had struvite crystalluria.[14]

In contrast to struvite stone formation, induction of calcium oxalate stone formation in healthy cats through experimental diet manipulations has not been reported. Acidifying diets increase both urine concentration and fractional excretion of calcium, and magnesium restriction reduces the urine content of magnesium.[15] These circumstances appear to increase the risk of calcium oxalate formation. Previous commercial feline diets that did not restrict magnesium or reduce urine pH may have obscured this susceptibility by causing formation of urine in which calcium oxalate stones were unlikely to form. When cat food manufacturers added acid-forming ingredients and reduced the magnesium content of foods to prevent struvite formation, the diets may no longer have protected cats prone to calcium oxalate formation. Cats susceptible to calcium oxalate formation were now consuming a "provocative" diet. The diet modifications made by cat food manufacturers may not have "caused" an increase in calcium oxalate urolithiasis but may have simply exposed a population of cats already genetically predisposed to calcium oxalate formation (diet sensitive rather than diet induced). This hypothesis is compelling in cats, because the overall occurrence of calcium oxalate urolithiasis in the United States appears to be no greater in cats than it is in humans, despite the fact that much of the cat population consumes similarly formulated diets.

Two studies of epidemiologic factors associated with the development of calcium oxalate urolithiasis in cats recently have been published. In a study comparing 91 cats with calcium oxalate urolithiasis to 258 age- and sex-matched controls, increased risk was associated with increased age (bimodal peaks at 5 and 12 years), Persian and Himalayan breeds, indoor

housing, and consumption of urine-acidifying diets.[16] The other study reviewed the records of 3,498 urolith accessions between 1982 and 1992.[17] This study too found that risk increased in older cats and in Persian and Himalayan (and Burmese) breeds and that stones removed from the kidneys were more likely to be calcium oxalate than struvite. Males and females appear to be at equal risk (male dogs are at greater risk than are females for calcium oxalate urolithiasis). Both studies were based on samples of convenience, however, so these results may not represent the general population of cats.

Hypercalcemia and calcium oxalate stone formation occasionally occur in cats with primary hyperparathyroidism. Veterinary urologists from the University of Minnesota Urolithiasis Center recently reported idiopathic hypercalcemia to be present in approximately one third of cats from which calcium oxalate stones had been removed and submitted for analysis.[14] Similar findings also were reported from the University of Georgia.[18]

No medical regimen has been shown to successfully dissolve calcium oxalate uroliths; surgery or voiding urohydropropulsion is recommended for these patients. To prevent urolith recurrence, some stone-specific alterations may be useful in addition to dilution of the urine. Although a decreased risk of recurrence of oxalate stones related to diet change has never been documented in cats, changing to a diet that is less acidifying and that has not been magnesium restricted seems reasonable, as long as the resulting urine specific gravity is ~1.020. Acidifying agents are contraindicated in cats with calcium oxalate urolithiasis. Some veterinary food manufacturers offer diets designed to reduce the probability of calcium oxalate stone formation. These diets have been tested in healthy cats, and it is hoped that they will prove effective in cats with naturally occurring stone disease. The frequency of recurrent calcium oxalate stone formation in cats is not known, so the safety, efficacy, and cost effectiveness of these diets cannot yet be determined.

Treatment of Urolithiasis—General

The frequency of urolithiasis does not appear to be greater in cats than in either dogs or human beings, so no modification of the diet is necessary prior to formation of the first stone. Treatment of sporadic calcium oxalate or struvite crystalluria is not necessary in cats that have never formed a stone previously; neither oxalate nor struvite crystalluria (without stone formation) is known to damage the urothelium.[19] Therapy of cats with a stone includes acute treatment to remove or dissolve the stone and chronic therapy to reduce the risk of recurrence. Stone-specific treatment recommendations can be based on quantitative stone analysis when stone material from spontaneous voiding, catheter aspiration, voiding urohydroexpulsion, or surgery can be obtained for analysis. When the stone type is unknown, the choice of empiric medical or surgical therapy is offered to the client after the risks and benefits have been explained.

Postoperative abdominal radiographs should be taken to ensure that all calculi were removed; otherwise, "pseudorecurrence" of urolithiasis may take place. Failure to remove all stones at the time of cystotomy is common (20% of cats in one study[20]) and seems to be more likely with calcium oxalate uroliths. Flushing of stones from the bladder to the urethra and dragging stones distally during urinary catheter withdrawal are procedures suspected to account for this.

All cats that have formed a stone are at increased risk for recurrence. Urolithiasis seems to be a diet-sensitive disease in which an intrinsic susceptibility in the patient is exposed by provocative nutrients. Water may be the most important nutrient to prevent recurrence of stone formation. Increased water intake is the cornerstone of therapy for urolithiasis in both human[21] and veterinary medicine.[22] Increasing water intake to dilute urine and increasing frequency of urination are important parts of treatment. Decreasing the concentration of potential stone-forming minerals in the urine and increasing the voiding frequency are primary therapies for reducing the risk of new stone formation. When a urolith is diagnosed, the patient should be switched to a canned diet, or water (one cup per cup of dry food) should be added to the dry food before it is presented to the cat. Additional water can be added to the food to reduce the urine specific gravity until food intake declines; the goal of a urinary specific gravity near 1.020 is recommended. A food appropriate for the stone type should be chosen, if possible. Salting the food or water is not recommended for cats with calcium oxalates, as the extra sodium may increase calciuria.

In those cats with a history of both struvite and calcium oxalate urolithiasis, prevention regimens should be biased toward calcium oxalate because we can successfully dissolve the struvite but not the oxalate stone with medical dissolution protocols, if needed.

Some manufacturers recently have reported that their veterinary foods for patients with stone disease reduce the relative supersaturation (RSS) of the urine with respect to struvite and/or calcium oxalate. In humans with calcium oxalate nephrolithiasis, the 5-year stone recurrence rate decreased from 27% to 12.1%

when the urine RSS was reduced from 10.1 to 2.6 by supplementation with water. Pending similar studies in cats with naturally occurring stone disease, these results suggest that reduction of RSS may help predict the therapeutic usefulness of such diets.[23]

IDIOPATHIC AND INTERSTITIAL CYSTITIS

Terminology referring to disorders of the feline LUT has been confusing. Widespread use of the term *feline urologic syndrome (FUS)* often was used indiscriminately to describe cats with signs of irritative voidings, regardless of the underlying cause. The term *feline lower urinary tract diseases (FLUTDs)* was subsequently coined to shift focus to the fact that many diagnosable LUTDs exist in cats. The term *idiopathic lower urinary tract disease* is appropriate if no cause of irritative voiding signs is found following a complete exclusionary diagnostic workup that includes urinalysis, urine culture, and urinary imaging with some combination of radiographs, contrast cystography, contrast urethrography, and ultrasonography of the bladder. Use of the term *feline interstitial cystitis (FIC)* as an umbrella term for all cats with idiopathic LUTD is not appropriate. We reserve use of the term *feline interstitial cystitis* for those cats that have frequent recurrences or chronic persistence of clinical signs. Idiopathic cystitis can be acute or chronic, but interstitial cystitis is by definition a chronic process. Furthermore, the use of this term should be restricted to those cases in which cystoscopic evaluation of the bladder and urethra has been performed following exclusionary diagnostic workup. We apply the term *interstitial cystitis* to cats that display characteristic findings of glomerulations during cystoscopy following bladder distention to 80 cm H_2O. This was the de facto standard in human medicine, but the necessity of this finding to establish the diagnosis has recently been challenged. Interstitial cystitis in human medicine is a chronic disorder characterized by waxing and waning. Accordingly, we do not apply the term *interstitial cystitis* to cats with an acute episode of idiopathic cystitis/urethritis that completely resolves. We prefer to add the term "feline" in front of idiopathic or interstitial cystitis; differences from interstitial cystitis in humans may exist. Similar conditions of idiopathic cystitis exist in other species (dogs, llamas, and horses, in the authors' experience), although not nearly as commonly as in the cat. Use of the term *interstitial cystitis* does not imply that the cause or causes are known.

Cats usually are not subjected to extensive diagnostic testing after an initial episode of LUT signs. Consequently, most of our data on idiopathic or interstitial cystitis have been collected from cats with recurrent disease. It is not clear how many cats experiencing their first episode of idiopathic cystitis will experience another episode within the subsequent year, although a recurrence rate of 30% to 50% has been reported. Data are especially lacking from primary care veterinary practices, as most epidemiologic studies have been conducted at referral centers.

Idiopathic Cystitis

We define idiopathic cystitis as a disease of irritative voiding signs (dysuria, pollakiuria, hematuria, periuria), sterile and cytologically negative urine, and failure to find a more objective cause for this clinical picture after appropriate LUT diagnostic procedures, including plain and contrast radiography or ultrasonography. The diagnosis of idiopathic cystitis is a diagnosis of exclusion. Idiopathic cystitis is classified as a noninfectious inflammatory LUTD.

Periuria, or inappropriate urination, was the most common owner-reported clinical sign in our series of cats with idiopathic cystitis, occurring in nearly 98% of females and 87% of males. Episodes of inappropriate urination occurred more than six times per week in 70% and three to six times per week in 13% of both males and females. Increased frequency of urination was the next most commonly observed clinical sign, occurring in nearly 80% of both females and males. Stranguria was noted in 65% of females and 75% of males. Macroscopic hematuria was reported least frequently, occurring in 58% of females and 67% of males; frequent episodes of hematuria were reported in about 50%.[1]

Most cats with nonobstructive idiopathic cystitis spontaneously resolve their clinical signs within 5 to 7 days regardless of treatment, although signs recur in about 50% of cases. A small group of cats affected with idiopathic cystitis continue to display signs of inflammation either continuously or intermittently. Urethral obstruction secondary to the inflammatory process within the bladder and urethra develops in some males. Whether this is a self-limiting disease or a chronic disorder with acute attacks remains to be determined. Some affected cats have a striking increase in severity of clinical signs that appears to be associated with stress—episodes that are referred to as "flares." Some cats display waxing and waning of clinical signs without known change in stress.

Interstitial Cystitis

Some cats with idiopathic cystitis qualify for a narrower diagnosis of interstitial cystitis if characteristic submucosal hemorrhages ("glomerulations") are ob-

served during cystoscopy following bladder distention to 80 cm H_2O in the absence of other diagnoses. We estimate that 40% of the cats with an initial diagnosis of idiopathic cystitis studied with cystoscopy display such glomerulations; the remaining cats display other lesions supportive of cystitis, including increased vascularity, edema, and exaggerated mucosal friability.

Treatment of Idiopathic and Interstitial Cystitis

Because the underlying cause or causes of this disorder are unknown, treatment recommendations are necessarily tentative. A combination of recommendations are usually offered, including a discussion of litter box management, suggestions for cleaning soiled areas, and a discussion of normal cat behaviors and activities that might benefit the cat. Changes in diet, increase in water intake, provision of pain relief, and drug therapy are also considered. Patients with interstitial cystitis are unusually susceptible to changes in their environment, one of which may be abrupt diet changes. Increasing water intake to dilute urine and increasing frequency of urination are important parts of treatment. One mechanism for this benefit may be the dilution of the noxious components of urine that gain access to the bladder wall as a result of increased bladder permeability.

Dietary Treatment

Some diet modifications may reduce the risk of recurrence of LUT signs in cats with idiopathic cystitis. Because struvite crystals do not seem to damage normal urothelium, dietary efforts to reduce struvite crystalluria are not warranted in idiopathic or interstitial cystitis. Efforts to acidify the urine have no known value in the treatment of cats suffering from idiopathic cystitis. There is experimental evidence that highly acid urine increases sensory nerve fiber transmissions that increase pain perception; consequently, cats with idiopathic cystitis should not be blindly placed on acidifying diets.

Pending improvements in understanding of the pathophysiology/etiology, dietary treatment recommendations for cats with idiopathic cystitis include consideration of the constancy, the consistency, and the composition of the diet.

Constancy. Our clinical experience suggests that diet change can result in recurrence of signs of idiopathic/interstitial cystitis in some patients. Moreover, with the advent of many similarly formulated veterinary and commercial foods marketed for use in cats with LUT signs, signs sometimes recur when cats are switched from any of these foods to another one. These observations suggest that diet change may result in recurrence of signs. This hypothesis is strengthened by the observation that some cats with LUT signs appear to be sensitive to a variety of environmental stimuli.[24] Pending further study to test this hypothesis, limiting the frequency of diet changes in this group of patients may be prudent.

Consistency. Compared with results from U.S. household surveys, cats with idiopathic cystitis were significantly more likely to eat dry food exclusively.[1] We recently reported that LUT signs recurred in only 11% of cats with idiopathic cystitis during a year of feeding the canned formulation of a veterinary food designed to cause production of acidic urine.[25] Recurrence occurred in 39% of cats fed the dry form of the food, suggesting that both constancy and consistency (increased water intake) may be important, although the reasons for this effect remain to be determined. Both diets contained a similar potential renal solute load and resulted in a similar degree of urinary acidification. Interestingly, the urine specific gravity of cats fed the dry form was usually greater than 1.050 (mean = 1.050), whereas that of cats fed the canned diet usually was less than 1.040 (mean = 1.030). It appears that the canned form protected nearly 90% of cats against recurrence of LUT signs for up to 1 year, constancy of diet protected about 60%, and 10% were offered no protection from recurrence by the diet.

Composition. In addition to water, diet-related decreases in urine magnesium and/or increases in urine calcium, potassium, and/or hydrogen ion concentrations all could influence activity of sensory nerve fibers in the urothelium.[26] Unfortunately, most of these effects have been studied using in vitro experimental systems. The effects of urine electrolyte content on LUT signs have not been adequately studied but may be important in treatment of some patients.

Cats suffering idiopathic cystitis seem to benefit from provision of a single canned diet, if such a feeding plan is not too stressful to the cat or the owner. The issues surrounding stress, diet change, and disease currently are controversial, and further investigation of these relationships is needed.

Amitriptyline

In severe recurrent cases, administration of the tricyclic antidepressant amitriptyline may be considered. We recently reported the results of amitriptyline treatment in 15 cats with severe recurrent interstitial cystitis.[27] Failure during this study was defined as the recurrence of any LUT sign during the next 12 months. Amitriptyline successfully eliminated clinical signs of interstitial cystitis in 73% of the cats for the first 6

months and in 60% of cats studied for the entire 12 months. Despite clinical remission, cystoscopic abnormalities persisted in all cats at the 6- and 12-month evaluations. Weight gain, somnolence, decreased grooming, and transient cystic calculi were observed in some cats.

The answer to whether amitriptyline should be used in some cats with idiopathic or interstitial cystitis in the absence of alternative treatment is a qualified yes. We consider the use of amitriptyline only for treatment of chronic idiopathic cystitis in which other "standard" therapies have failed (client education about feeding, litter box management, stress, and methods for increasing water intake is the standard in our hospital). There is not a good argument to use amitriptyline in acute cystitis because spontaneous resolution of clinical signs often occurs within a few days and complete resolution within 5 to 10 days; it may take weeks to months for amitriptyline to exert a maximal effect. Further studies of amitriptyline for safety and efficacy during treatment of idiopathic LUTD are needed, although amitriptyline has been used in cats with apparent safety by animal behaviorists for many years. Complete blood counts and serum biochemical panels in our series remained normal throughout 1 year. Given the success of our nonplacebo-controlled study, double-blinded placebo-controlled studies using amitriptyline treatment for cats with chronic idiopathic LUTD are warranted. Although amitriptyline has its place in the control of the signs of LUTD associated with interstitial cystitis in cats, it is not an ideal drug, because the lesions of cystitis are still apparent cystoscopically during treatment, and undesirable side effects occur in some cats. Lower doses of amitriptyline may possibly be effective when given in combination with other drugs.

Glycosaminoglycan

Glycosaminoglycan (GAG) replacement therapy, used with some success in humans with interstitial cystitis,[28,29] currently is being investigated because of the abnormalities observed in GAG excretion and bladder permeability in affected cats. The assumption for use of this treatment is that administered GAG attaches to the defective urothelium, thereby decreasing bladder permeability, although differences in the relative efficacy among the various GAGs may produce this effect.[30] GAGs also can exert analgesic and anti-inflammatory effects that might prove useful.[31] A double-blinded placebo-controlled multicenter study of a specific GAG treatment for cats with interstitial cystitis has recently been concluded in the United States; we await results.

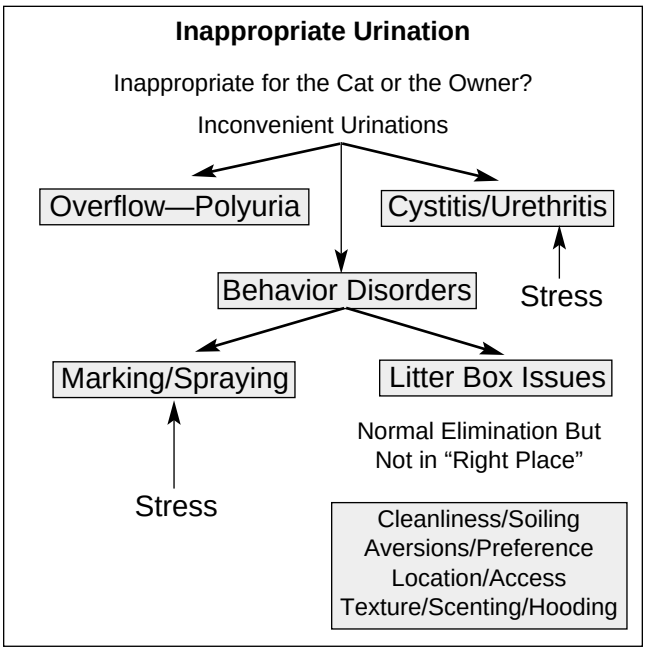

Figure 3. Inappropriate urinations may be the sole complaint of the owner of a cat affected with overflow from dilute urine and polyuria (renal failure, hyperthyroidism, diabetes mellitus), cystitis/urethritis (idiopathic, mechanic due to stones, bacterial infection), or a behavior disorder. Behavior disorders should further be characterized into those related to marking or spraying, as contrasted to those with normal eliminations that do not occur in the litter box. Stress can activate episodes of marking or spraying as well as idiopathic cystitis.

BEHAVIOR PROBLEM

Cats with a true urinary behavior disorder have a history of inappropriate urination without evidence of irritative voiding (no pollakiuria, gross hematuria, vocalizing during urination, dysuria, or stranguria). Abnormal locations of urination may be on either horizontal or vertical surfaces.[32] Urinalysis should not exhibit excess blood or protein, and no opaque calculi are seen on survey radiographs. Radiographic contrast procedures (i.e., cystography and urethrography) are normal, as is the ultrasonographic evaluation of the bladder. Cystoscopic evaluation of the bladder also should be normal. Fourteen of the 70 cats with idiopathic cystitis in our series would have been diagnosed as having a behavior disorder if they had not been examined using contrast radiography or cystoscopy. Unfortunately, in the absence of access to cystoscopic evaluation, cats with a normal diagnostic workup including contrast radiography will be diagnosed with a behavior disorder when in reality nearly half actually have evidence of bladder inflammation when evaluated by cystoscopy. When we examined cats with a cystoscope, we found that 16 of 24 cats with the single owner complaint of inappropriate urination actually had interstitial cystitis rather than a pure behavior disorder. It is interesting to note that

nearly 40% of cats being treated for a urinary behavior disorder also had a previous history of cystitis.[33] There appears to be a crossover between urinary behavior and inflammatory disorders of the LUT. One common connection is the ability of stress to incite or perpetuate either condition.

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