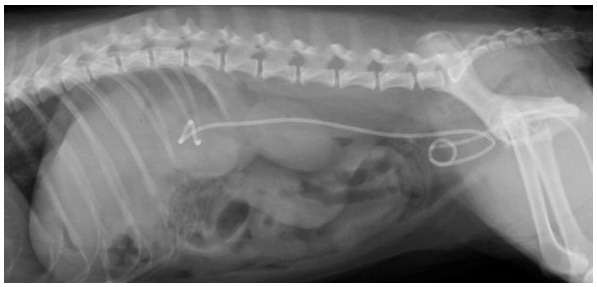
Hotter Topics in Feline Medicine - Challenging Cases for Advanced Practitioners Mini Series

Session 3: Feline lower urinary tract disease

Professor Danièlle A. Gunn-Moore BSc(Hon), BVM&S, PhD, FHEA, MANZCVS, MRCVS,
RCVS Specialist in Feline Medicine,
Professor in Feline Medicine



CLINICAL SIGNS OF FLUTD

The term cystitis means inflammation of the urinary bladder. Cats with cystitis or feline lower urinary tract disease (FLUTD), usually present with signs of dysuria (difficult urination), pollakiuria (increased frequency of urination), haematuria, agitation or vocalisation (crying or howling) when trying to urinate, urethral obstruction, and/or periuria (inappropriate urination). In some cases the owner is unaware of an underlying urinary tract problem, and they present the cat for investigation into behavioural change, loss of house-training, aggression and/or suspected constipation. Some cats will over-groom and remove hair from their ventral abdomen and/or perineal area (presumably in response to local pain) and these may be referred as behavioural, rather than medical cases.

INCIDENCE AND CAUSES OF FLUTD

The annual incidence of FLUTD in cats from Britain and US is believed to be up to 8%, with a similar incidence likely in other European countries. It can be caused by a number of different conditions that can affect the bladder and/or urethra. Unfortunately, since the urinary tract can respond to insult in only a limited numbers of ways, the clinical signs are rarely indicative of a particular disease. Overall, FLUTD is seen far more commonly in young to middle-aged cats (Figure 1), and while there are many conditions that can result in signs of FLUTD the conditions that are most likely to occur vary considerably with age. In younger cats the vast majority of cases (55-69%) are idiopathic (Figure 2). In contrast, idiopathic FLUTD is rarely seen in older cats (unless the cat first developed the condition earlier in life). Older cats are far more likely to develop bacterial cystitis, urolithiasis (bladder stones) or neoplasia.

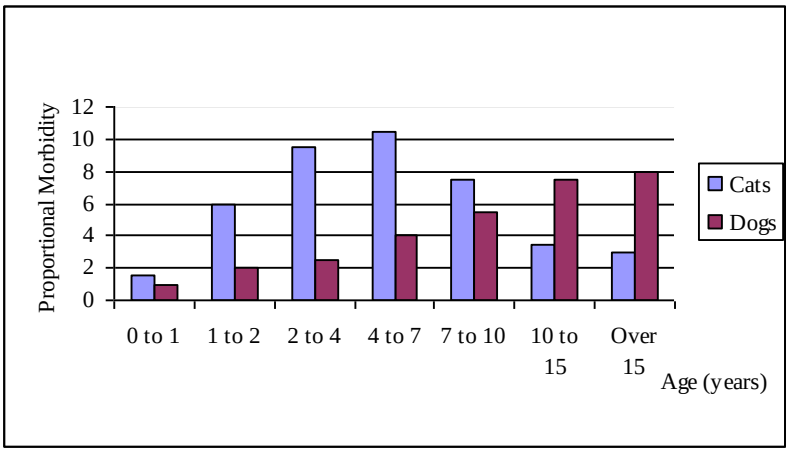


Figure 1. Prevalence of lower urinary tract disease in dogs (1980-1995) and cats (1980-1995) in the USA. (Bartges JW What's New in Feline LUTD? Proceedings of ECVIM 2002).

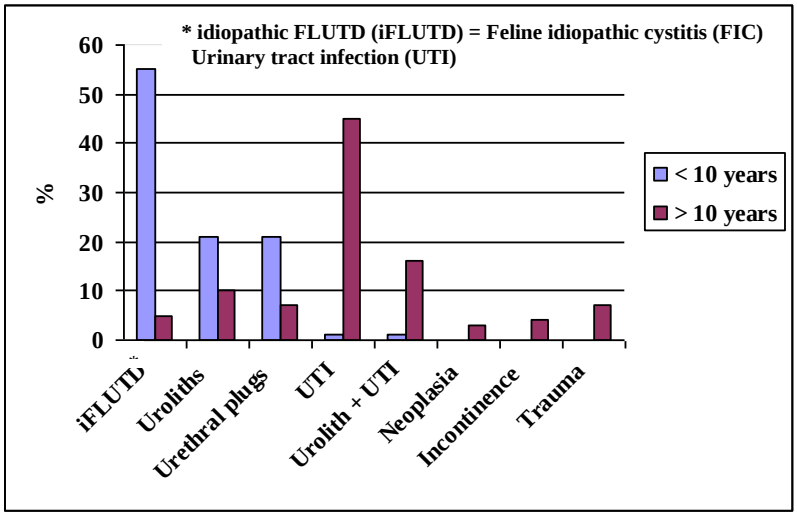


Figure 2. Most common diagnoses in cats with signs of FLUTD, presented according to age (data from USA). (Bartges JW What's New in Feline LUTD? Proceedings of ECVIM 2002).

Since FLUTD describes a collection of conditions, rather than a single condition, we need to consider the aetiology of each of the conditions in turn. Our understanding of the prevalence and pathophysiology of the many causes of FLUTD has changed significantly in the last few years. Hence, while historically more interest was placed on the role of bladder stones (urolithiasis) and urinary crystals, recent evidence has shown that idiopathic cystitis is by far the most common cause of FLUTD in cats (Figure 2).

Feline idiopathic cystitis (FIC)

In the majority of cases of FLUTD no underlying cause can be found. Clinical signs are seen most commonly in young to middle-aged, over weight cats, that take little exercise, use an indoor litter box, have restricted access outside, eat a dry diet and, typically, live in a multi-animal household (where there is often antipathy between the affected cat and other members of the household). Persian and black and white domestic short haired cats appear to be predisposed (and the condition is rarely seen in Siamese cats). While disease occurs equally in male and female cats neutered cats are more susceptible, and the risk of urinary tract obstruction is greatest in males. Clinical signs are often seasonal, being worse from autumn to early spring. Most non-obstructive cases are self-limiting; usually resolving within 5-10 days, although occasional cases do show prolonged episodes of disease. Most affected cats have episodes of clinical signs, which recur with variable frequency, but generally tend to decrease in frequency and severity over time.

Current research supports the hypothesis that FIC is seen when a 'susceptible cat is placed in a provocative environment'. The changes in the bladder epithelium are believed to occur as an 'end stage' result of alterations in the cat's nervous and endocrine systems, leading to exaggerated arousal and an inability to cope with environmental stress. The primary cause of the condition is unknown but is likely to be either genetic and/or developmental (the latter possibly related to pre-natal exposure to maternal stress). The end result is altered processing within the brain, changes in the nature of the adrenocortical response as a result of exposure to external events, and alterations in the interaction between the neuronal supply to and from the brain and the bladder. Subsequent changes in the integrity of bladder epithelium are exacerbated by compounds within the urine and altered interactions with the protective glycosaminoglycan (GAG) layer that lines the bladder (Figure 3).

Stress is believed to play an important role in triggering and/or exacerbating FIC, with suggested stressors including living in a multiple animal household (particularly when there is inter-cat conflict), moving house, and separation anxiety in indoor-only single-cat households. It is chronic rather than acute stress that appears to be most detrimental and other potential stressors include stress associated

with urination (unsuitable litter box availability, access, position, type, content, hygiene); abrupt changes in diet, weather or access outside; the addition of new pets or family members (including new babies); undertaking building work in the house; changes to the owners' work schedule; and owner stress. It has therefore been suggested that reducing stress, particularly triggers of chronic stress, may help to reduce the recurrence and/or severity of FIC.

Support for the importance of stress, and for exaggerated arousal, in the induction and/or maintenance of FIC comes from a number of studies that have shown that affected cats respond to stress very differently from normal cats. Normal cats, when exposed to stressful situations, may show signs of fear, aggression, hiding, anorexia, and weight change. Physiologically, this stress results in activation of the hypothalamic-pituitary-adrenal axis. This is seen as increased activity in the hypothalamus, which produces corticotrophin-releasing factor (CRF) which acts on i) the anterior pituitary to cause release of adreonocorticotropic hormone (ACTH) which stimulates the adrenal glands to produce glucocorticoids from the adrenal cortex (i.e. cortisol) and ii) the brainstem nuclei and locus coeruleus (an area of the brain that deals with vigilance and autonomic activity), resulting in increased plasma catecholamine concentrations (causing enhanced adrenal sensitivity to ACTH) and activation of the sympathetic nervous system. The role of glucocorticoids and other alpha-2 adrenoceptor agonists are very complex. However, one of their essential functions is to provide negative feedback to control the stress response, which they do by inhibiting further transmission of noxious signals to the brain, i.e. cortisol acts to dampen down the response by having an inhibitory action on the hypothalamus, anterior pituitary, brainstem nuclei and locus coeruleus. In contrast, cats with FIC, when stressed, display more displacement activity than normal cats. This is seen as increased eating, drinking, grooming and urinating. Interestingly, while they do produce CRF and ACTH, they also develop marked increases in activity in their locus coeruleus and sympathetic nervous system, but do not have increased plasma cortisol concentrations. The lack of cortisol results in a lack of inhibition within the brain and the peripheral sympathetic nervous system (Figure 3). This uncoupling of the hypothalamic-pituitary-adrenal axis is also seen in some chronic pain syndromes in humans and is believed to result from desensitization or down-regulation of the alpha-2 adrenoceptor agonists receptors secondary to chronic stimulation.

Much of our understanding of the peripheral aspects of FIC has come from studying the histopathology of bladder wall biopsies taken from affected cats. They usually reveal a relatively normal epithelium and muscularis, but have submucosal oedema and vasodilation, without obvious inflammatory infiltrate, although large numbers of mast cells are frequently present. Biopsies often reveal increased numbers of unmyelinated pain fibers (C-fibers) and pain receptors (substance P receptors). These sensory neurones within the bladder wall are located in the submucosa; when stimulated these nerves transmit the perception of pain to the brain, and local axon reflexes lead to release of substance P, and other neurotransmitters), which can in turn result in more pain, plus vasodilatation of the intramural blood vessels, increased vascular and bladder-wall permeability, oedema of the submucosa, smooth muscle contraction (resulting in a bladder and/or urethral spasm), and mast cell de-granulation. Mast cell de-granulation results in the release of a variety of inflammatory mediators (including histamine, heparin, serotonin, cytokines, and prostaglandins) which can further exacerbate the effects of the C-fibres. Stimulation of C-fibres and the resulting neurogenic inflammation can therefore explain many of the changes recorded in FIC. The nerve endings can be stimulated in response to central triggers (such as "stress"), or via compounds within the urine (e.g. acid pH, potassium, magnesium, and calcium ions). This in turn may result in further recruitment of C-fibres, and intensification of disease.

The exact role of the thin layer of mucus, which is composed of GAG and covers the bladder epithelium, is still unclear. It is known that it helps to prevent microbes and crystals from sticking to the bladder lining. In addition, it has been shown that some cats with FIC have altered urine concentrations of GAG and increased urinary bladder permeability. This increased permeability may allow noxious substances within the urine to pass through the urothelium and cause inflammation.

While it appears that neurogenic inflammation may play an important role in the development of the clinical signs of FLUTD, it is unclear whether or not it is as a primary factor, or a secondary event, perhaps triggered by an, as yet, unidentified infectious agent.

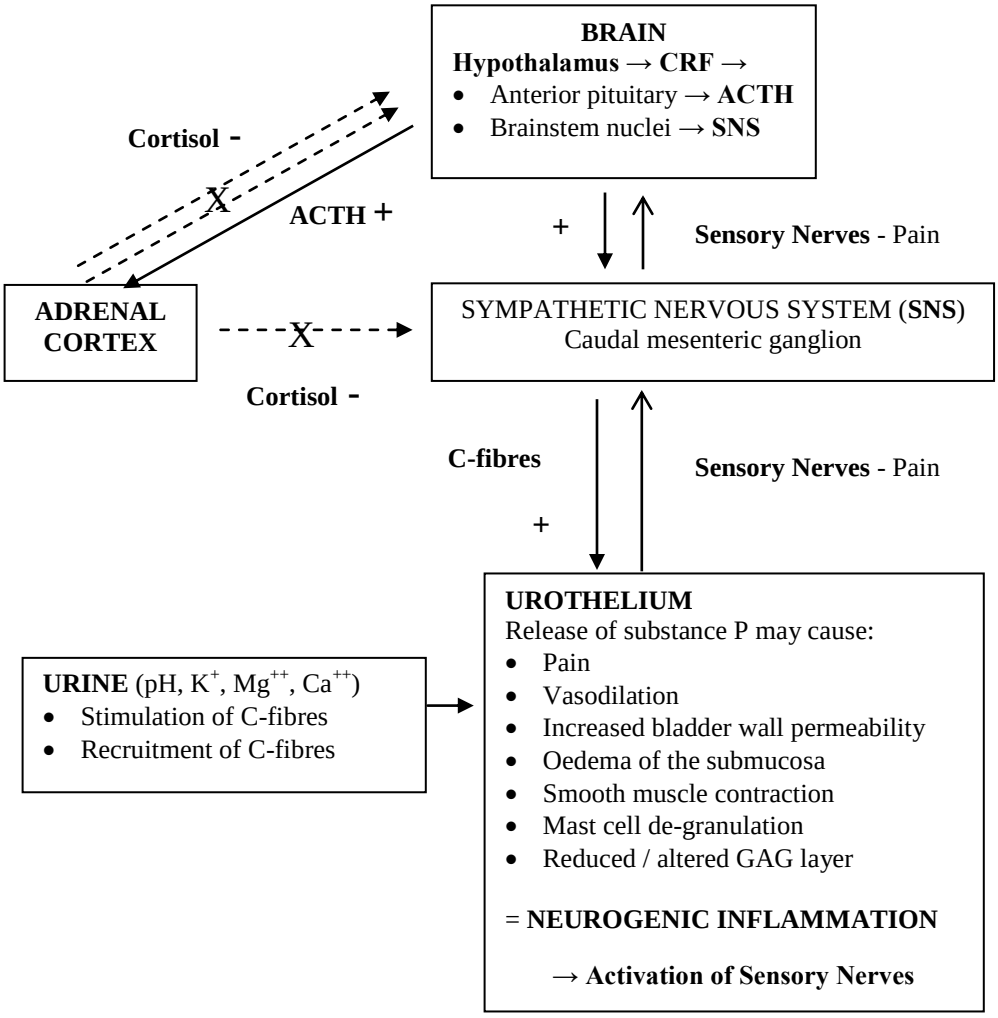


Figure 3. Current hypothesis for the pathogenesis of FIC. Chronic activation of stress pathways leads to suppression of adrenal cortex function (X represents a lack of cortisol production). This lack of cortisol means there is a lack of feedback inhibition to the anterior pituitary and hypothalamus, resulting in further increases in corticotrophin-releasing factor (CRF) and ACTH. Inadequate suppression of the sympathetic nervous system results in activation of the C-fibes in the bladder causing neurogenic inflammation and leading to secondary activation of afferent sensory nerves. (Adapted from Westropp and Buffington, 2004).

Urolithiasis

Urolithiasis is defined as the formation of calculi (uroliths or stones) within the urinary tract. Uroliths can vary in their mineral composition, with struvite (magnesium ammonium phosphate) and calcium oxalate forms being seen most commonly in cats. Over the last few years the feeding of diets designed to reduce the risk of struvite stone formation has resulted in an increased incidence of oxalate urolithiasis. The risk of oxalate uroliths is also increased in certain breeds of cats (e.g. Persian and Ragdoll cats), in cats with hypercalcaemia (~1/3 of cats with calcium oxalate uroliths are hypercalcaemic, most of which have idiopathic hypercalcaemia), and in older cats (because their urine pH tends to be lower, particularly if they have renal insufficiency). Most stones found in the kidneys or ureters are made of calcium oxalate.

Urethral plugs
Urethral plugs occur with approximately the same frequency as uroliths. They are of particular importance because they are associated with urethral obstruction. They are composed of varying combinations of a protein-colloid matrix (mucoproteins, albumin, globulin, cells, blood clots, etc.) and crystalline material (most typically struvite). The colloid matrix leaks from the bladder wall as a result of inflammation. In most cases this inflammation is neurogenic in nature (associated with FIC), although it may also arise secondary to infection, neoplasia or uroliths. Neurogenic or pain-associated urethral spasm may exacerbate things further. Thick colloid may cause urethral obstruction without evidence of crystalluria. However, where crystalluria is also present, the crystals may become trapped within the matrix, and add to the obstruction. It is therefore usually the colloid that is of primary importance, rather than the presence of crystals *per se.* While very severe crystalluria may result in urethral obstruction in the absence of colloid matrix, in most cats crystalluria is clinically silent. In fact, most normal cats develop crystalluria when they are fed many dry cat diets. Since the majority of cases of urethral plugs are caused by neurogenic bladder and/or urethral inflammation, plus or minus neurogenic urethral spasm, these cases should really be considered as variations of FIC, making FIC responsible for ~75% for all cases of FLUTD.

Infectious causes
So far, no bacterial, fungal or viral organisms have been consistently shown to induce FIC. However, it is still possible that a very fastidious organism could be involved, and the role of viruses is still being investigated.

Bacterial infection is typically a rare cause of FLUTD, except in older cats, or in younger cats following urethral catheterisation. The age-related risk of bacterial cystitis usually relates to the presence of concurrent disease: Two thirds of the cases in older cats are found to have chronic kidney disease (or other conditions that result in dilute urine, e.g. hyperthyroidism, or following the administration of corticosteroids, etc.). (It is easy to grow bacteria in dilute cat urine [specific gravity <1.025], but very difficult to grow bacteria in more concentrated cat urine [specific gravity >1.035]). Many of the other cases have diabetes mellitus, and so have an increased risk of infection because of glycosuria plus reduced urine specific gravity. Bacterial cystitis may also be iatrogenic (typically following catheterization), or secondary to urolithiasis, neoplasia or an anatomical defect of the urinary tract. Affected cats are typically prone to recurrent infections, and ascension of these infections can result in the initiation or exacerbation of kidney disease. The most commonly cultured bacteria are *Escherichia coli* (~ 40-70% of isolates - most commonly found in dilute urine), with *Enterococcus* spp. (25-30%: mainly *E. faecalis*), *Staphlococcus* spp. (including *S. felis*, which may account for up to 20% of isolates), *Proteus* spp., *Streptococcus* spp., *Klebsiella* spp., *Enterobacter* spp., *Pseudomonas* spp., and *Pasteurella* spp. being seen less commonly. Occasional cases of *Corynebacterium* spp. have also been seen (typically following previous catheterization). Infection following catheterization may persist in the face of concentrated urine as bacteria within thickened bladder walls are protected from the otherwise potentially damaging effects of the urine (this is more commonly associated with *Staphlococcus felis*, *Pseudomonas* spp. and even *Corynebacterium* spp.).

Fungal infections (e.g. *Candida albicans*) are rare. When they are seen they are usually associated with significant immuno-suppression, e.g. diabetes mellitus, or hyperadrenocorticism.

Neoplasia
Transitional cell carcinomas (TCC), adenocarcinoma, leiomyoma, and a number of other tumours may occur in cat bladders. However, TCC are seen most frequently; either as isolated tumours, or arising secondary to chronic inflammation. In the latter case they may be seen as pre-cancer prior to full transformation.

Unifying hypothesis
The different causes of FLUTD may occur individually, or in various interacting combinations (Figure 4). For example, the formation of urethral plugs may result from concurrent, but not necessarily related, disorders, for example, the simultaneous occurrence of urinary tract inflammation and crystalluria. While obstruction most typically results from the formation of urethral plugs, it may also be caused by

the passage of small uroliths (typically made of calcium oxalate as these often form with numerous sharp surface spikes), or from neurogenic, pain or inflammation-induced urethral spasm. Although inflammation without crystalluria can result in obstruction with colloid matrix, it more typically causes haematuria and dysuria. While crystalluria is often clinically silent, if severe and persistent, it may predispose to the development of uroliths, and these, in turn can lead to urethral obstruction, and bladder inflammation.

SUMMARY of CAUSES

Over the past few years our understanding of the pathophysiology of many causes of FLUTD has improved and the significance of the different conditions has changed. With further study we will hopefully be better able to understand the different mechanisms involved, particularly in the development of FIC.

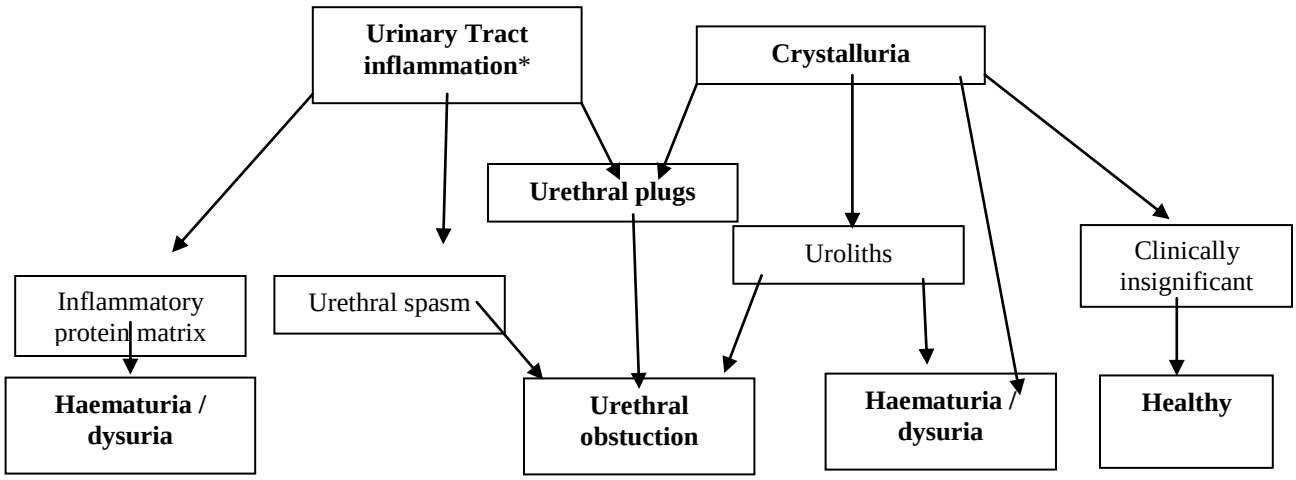


Figure 4. Flow diagram illustrating how the interaction between urinary tract inflammation and crystalluria can lead to different clinical presentations. (Initial hypothesis from Osborne *et al.,* 1992).
* Urinary tract inflammation may be neurogenic, idiopathic or secondary to infection, neoplasia or uroliths.

INVESTIGATION

The diagnostic plan aims to detect specific causes of FLUTD (urolithiasis, urethral plugs, anatomical defects, neoplasia, or bacterial infection) and to differentiate these cases from those cases in which no underlying cause can be found i.e. FIC. A practical, step-by-step approach is detailed below and in Figure 5. The extent of the investigation may appear daunting; however, it is not necessary in all cases. While it is strongly recommended that all severe and, particularly, recurrent cases should be investigated as fully as possible, this is rarely warranted for initial cases, or for cats that only have very mild or occasional clinical signs. For milder cases an abbreviated investigation may be more appropriate; consisting of full urinalysis, with culture and sensitivity, followed by survey and contrast radiography or, possibly, ultrasonography. Cytological or histopathological examination of aspirates or biopsies is rarely required. In many cases, the lack of pathological findings on diagnostic imaging leads to a presumptive diagnosis of FIC.

1. Patient's age, sex, breed, and history

The first step in any diagnostic investigation involves determining the patient's age, sex and breed, and gaining a complete history. While cats of any age, sex and breed can develop FLUTD, FIC is seen most frequently in overweight male cats, often of a nervous predisposition, that live in multi-cat households, and are fed dry cat food. Also, male cats are considerately more likely to become obstructed; older cats are more likely to develop bladder neoplasia; and Persian cats are predisposed to both FIC and oxalate urolithiasis.

The relevance of living in a multi-cat household means it is necessary to take a specific history relating to the interaction between the cats in the home. This should focus on establishing the number of social groups within the cats, rather than the numbers of cats *per se*. In order to determine this it is helpful for owners to make a record of friendly (affiliative) behaviours, such as cats rubbing themselves on and/or grooming other cats. Cats within the same social group tend to show these behaviours to each other. Some cats show no affiliative behaviour (and appear to resent all other cats) so they can be said to be in a social group of their own. Each of the social groups will need to be provided with free and immediate access to the five important resources of food, water, resting places, latrines (e.g. litter boxes), and entry and exit points into the territory. Cats do not comfortably share these resources with other social groups so resource distribution is a vital factor in the treatment and management of FIC. The link with obesity and FIC is likely to be related to the effects of chronic stress on levels of physical activity as well as effects on feeding behaviour; therefore, behavioural modification and environmental manipulation will be as important in the control of obesity as diet. In single cat households potential sources of social stress relate to other cats in the neighbourhood or to people or other animals living within the home environment.

In depth history taking is needed to identify sources of chronic stress and it may be appropriate to consider referral to a veterinary behaviourist in order to complete a behavioural investigation to complement the medical workup in cases of FIC.

The history and pattern of clinical signs can be very helpful. While FIC and urolithiasis can cause clinical signs all year round, episodes of FIC occur most frequently in the autumn and winter, or after a period of stress, e.g. moving house or a stay in a cattery. Bladder neoplasia should be considered when an older cat presents with severe FLUTD, particularly if it has not had previous signs of cystitis.

The pattern of inappropriate urination may also be helpful. Cats with behavioural problems are more likely to repeatedly urinate in one or two inappropriate places and display location and/or substrate preference (i.e. prefer to urinate in a particular place and/or on a particular type of surface). Cats with physical disease are more likely to urinate in more random locations. That said, physical disease can lead to behavioural disease through a negative association between pain and the litter box, so the distinction can be difficult to make. The complex interaction between physical and behavioural causes of inappropriate urination is supported by the finding that most cats that are referred for apparent behavioural problems has shown evidence of haematuria at some point in the past.

2. Physical examination

The main aim of the physical examination is to determine whether or not the bladder is large or small and, therefore, whether or not there is an indication of urethral obstruction. In all cases, the caudal abdomen is likely to be painful and, in male cats, the prepuce and/or penis are often swollen. In cases of unobstructed FIC the bladder is typically small, thickened and painful. In contrast, obstruction causes a large, full, often hard, painful bladder. In the case of urethral obstruction, cardiac irregularity and bradycardia may indicate severe hyperkalaemia. Where available, running an ECG will assess the significance of the hyperkalaemia. Prompt intervention is essential if the bladder is obstructed. (For the method of unblocking the urethra see later [Appendix A] and refer to reference texts for the treatment of acute renal failure secondary to post-renal obstruction). The physical examination should also highlight any concurrent conditions. Presence of physical injury due to inter-cat aggression should be identified (but remember that passive reactions to social stress are far more common than overt aggression and the lack of evidence of physical confrontation should not be taken as evidence of harmony between the cats). Once under anesthesia (whether for unblocking the urethra and/or performing radiographic contrast studies) a rectal examination should be performed, looking for evidence of urethral stones, swelling or damage.

3. Serum biochemistry and haematology

Unless they have concurrent systemic disease, or urethral obstruction, cats with FLUTD typically have unremarkable serum biochemistry and haematology. However, it is essential to assess these parameters in obstructed cats, especially the serum potassium, urea and creatinine concentrations. It is

also important to assess them in older cats which are very likely to have underlying systemic disease. Some cases of severe and chronic haematuria may develop blood-loss anaemia, and some cats with oxalate uroliths have idiopathic hypercalcaemia.

4. Urinalysis

Urine samples can be collected by various methods:

- *From the litter box* – This can be done by placing clean non-absorbent litter into the litter box (e.g. aquarium gravel or a commercial non-absorbent cat litter). While urine samples collected by this method can be used for routine biochemical analysis, they tend to contain too much debris for reliable assessment of sediment, and are unsuitable for bacterial culture.
- *Free flow* – It is usually difficult to collect urine by this method from cats. Samples can be used for routine biochemical analysis and sediment assessment, but bacterial contamination from the external genitalia makes them unsuitable for bacterial culture.
- *Catheterisation* – This should only be performed on sedated or anaesthetised cats. Urine collected by this method can be used for routine biochemical analysis, sediment assessment, and bacterial culture. However, there is usually some contamination from the external genitalia; 100-1000 bacterial colonies per ml may indicate contamination.
- *Cystocentesis* – This can be collected using a 5/8" 23 gauge needle attached to a 5 or 10 ml syringe. However, the use of a butterfly needle reduces the risk of urinary leakage into the abdomen following the procedure and is strongly recommended when performing cystocentesis on a blocked cat. The procedure is well tolerated in most conscious cats. Urine collected by this method can be used for routine biochemical analysis, sediment assessment, and bacterial culture. However, some degree of haemorrhage is fairly common, so the presence of blood contamination should not be over-interpreted. A bacterial count of 100-1000 colonies per ml is suspicious of bacterial infection and >1000 colonies per ml is considered significant.

Urine should be assessed for physical appearance, routine biochemical analysis (including pH and specific gravity), microscopic examination of sediment, and bacterial culture and sensitivity (C&S). Samples usually need to be transported to a commercial laboratory for C&S, quantitative sediment analysis, analysis of uroliths, and non-routine chemical analysis. However, since accurate results require examination of very fresh samples, it is highly preferable that routine biochemical analysis and sediment assessment are performed within the practice. When urine samples have to be sent to other laboratories they should be sent as quickly as possible or, if the laboratory requests it, preserved using boric acid, formaldehyde, or other preservatives. The speed of assessment is imperative because urine starts to change as soon as it has been voided. Within two hours crystals may start to precipitate out, particularly if the urine has a high specific gravity and/or has been placed in a fridge. However, if the urine is not placed in a fridge the biochemistry may begin to alter within 30 minutes, and any bacteria that are present will replicate rapidly, spoil the sample, and modify the biochemistry and sediment. To be representative, bacterial culture must be performed within 12 hours of sample collection and the sample must have been kept cold.

- *Physical appearance* – The urine should be assessed for colour and turbidity. Normal cat urine should be yellow and clear. Because cats with FLUTD often have very concentrated urine it may appear very dark yellow to light brown. Haematuria may be seen as a slight pink tinge through to severe haemorrhage. However, when it occurs in a cat that does not have an increased frequency of urination the changed blood may turn the urine dark brown. Turbidity may result from inflammatory exudate, white blood cells, infection, or lipid droplets.

- *Routine biochemistry* –The 'dip stick' tests are designed for use with human urine, so they do not always give reliable results with cat urine. The most unreliable test is that for specific gravity (SG) and for this reason SG should always be assessed using a refractometer. For most other tests the dip sticks are adequate, and they are very practical and inexpensive. There are many reasons for altered urine biochemistry (see Davies, 1998), but in cats with FLUTD the most important concerns relate to SG, pH, and protein. Most cats with FLUTD have concentrated urine, with an acid pH and moderate protein content. The pH may become alkali in response to diet, certain bacterial infections (e.g. urease-producing bacteria such as *Staphlococci*, but not with *E.coli* which is the

most common cause of bacterial urinary tract infection in cats), or with time once urine once has been voided. However, perhaps the most common cause of alkali urine in cats is hyperventilation due to stress. In cats with FLUTD the proteinuria usually results from protein and blood leaking from the inflamed bladder wall.

- *Sediment assessment* – Sediment should be assessed for the presence of crystals, red blood cells (RBC), white blood cells (WBC), and casts. Very concentrated or turbid urine can be assessed without prior centrifugation. Most other samples benefit from sedimentation at 1500 rpm for 5-10 minutes, then re-suspension in a drop of the urine. The amount of sediment present varies with the concentration of the urine (and the severity of the changes). It is therefore important to spin the maximum amount of urine possible, particularly when the urine is very dilute. The sediment can then be assessed directly as a 'wet preparation', or examined after suitable staining. Care must be taken with interpretation of sediment findings. Cystocentesis can result in blood contamination, and therefore lead to increased numbers of RBC and WBC. Crystals occur commonly in normal cat urine and can precipitate rapidly as it cools. It is therefore very important not to over interpret their significance when they occur in low numbers, or when there is no evidence of stone formation or secondary infection. It is not unusual to see lipid droplets of various sizes in cat urine. It is important to recognize these for what they are and not mistake them for crystals, cells or bacteria. (There are many reference texts available with pictures to aid in the interpretation of urine sediments. For a comprehensive review see Davies, 1998).

- *Quantitative culture and sensitivity (C&S)* – Ideally, this should be performed on a sample collected by cystocentesis, and if the sample is being posted, it should be kept in a fridge and then posted to arrive at the laboratory as quickly as possible. The analysis should be quantitative, and sensitivities need to be performed.

	Significant	**Suspicious**	**Contaminant**
Cystocentesis	>1000	100-1000	<100
Catheterisation	>1000	100-1000	<100
Midstream voiding	>10000	1000-10000	<1000
Manual compression	>10000	1000-10000	<1000

For a bacterial infection to be significant the growth is usually pure. It is important to note that cat urine is less permissive to bacterial growth than urine from dogs or humans, so lower levels of infection may be more significant.

5. Survey radiographs and further diagnostic investigations

There are a number of different ways by which the bladder and urethra can be imaged. Survey radiographs may be sufficient to identify radio-opaque bladder stones. Note: while the feline os penis is rarely seen using analogue radiography it can be seen in ~40% of older cats using high quality digital images; it should not be dis-diagnosed as a stone or abnormal mineralisation. However, contrast studies (see Appendix B for indications and technique), and/or abdominal ultrasonography may be necessary to detect radiolucent bladder stones, bladder diverticula, urethral strictures, anatomical defects, neoplasia, or polyps. Where available, cystoscopy can also be useful. While survey radiography and ultrasound examination can be performed on well-behaved or sedated cats, general anaesthesia is required for most other types of further investigation. Although ultrasonography is gaining favour because it is non-invasive and does not require anaesthesia, it can not be used to examine the full length of the urethra, which means important pathology may be missed. Also, fat droplets within the urine may be mistaken for sediment so the presence of hyperechoic speckles should not be over interpreted.

Diagnostic Imaging – findings in cats with FIC:

- Radiographs of cats with FIC are frequently unremarkable. However, changes may be seen on double contrast cysto-urethrography, including diffuse bladder wall thickening (particularly affecting the apical/ventral area), mucosal irregularities, urethral narrowing or, occasionally, leakage of contrast media through the layers of the bladder wall.

- Ultrasonography may reveal hyperechoic material (possibly crystals, or fat droplets), blood clots, mural irregularities, or thickening of the bladder wall.
- Cystoscopy, where available, may reveal evidence of increased mucosal vascularity, urothelial ulceration, or focal areas of submucosal haemorrhage (“glomerulations”).
- Unfortunately, none of these changes are pathognomonic for FIC.

To confirm a diagnosis it is often necessary to collect material for cytology or histopathology. Transitional cell carcinoma is a major differential diagnosis that may need to be ruled out in older cats. Unfortunately, this type of neoplasia rarely sheds cells into the urine. The easiest way to collect a tissue sample is to perform a suction aspirate. This very simple technique requires only a urinary catheter with side holes and a 5ml syringe. The bladder is emptied of urine, and the catheter advanced to the level of the area of interest. If the lesion is within the bladder the bladder is then squeezed firmly around the catheter and an aspirate collected. If the area of interest is in the urethra the aspirate can be taken directly, after selecting the widest size of catheter that can be passed into the urethra. Samples collected in this way can be used to make smears or ‘crush’ preparations, or fixed in formalin and processed routinely. While this technique can be very useful at detecting mucosal inflammation, hyperplasia, and neoplasia (e.g. TCC), a full-thickness bladder wall biopsy is required to confirm a diagnosis of interstitial cystitis.

If no lesions are identified after a full diagnostic work-up then a purely behavioural problem should be considered. However, if the cat is not currently symptomatic repeating the investigation when it is showing clinical signs may reveal more obvious bladder pathology. It is important to remember that many cats which are believed to have a purely behavioural problem have a history of haematuria at some time in their past. So there probably is, or was, underlying physical disease at some point.

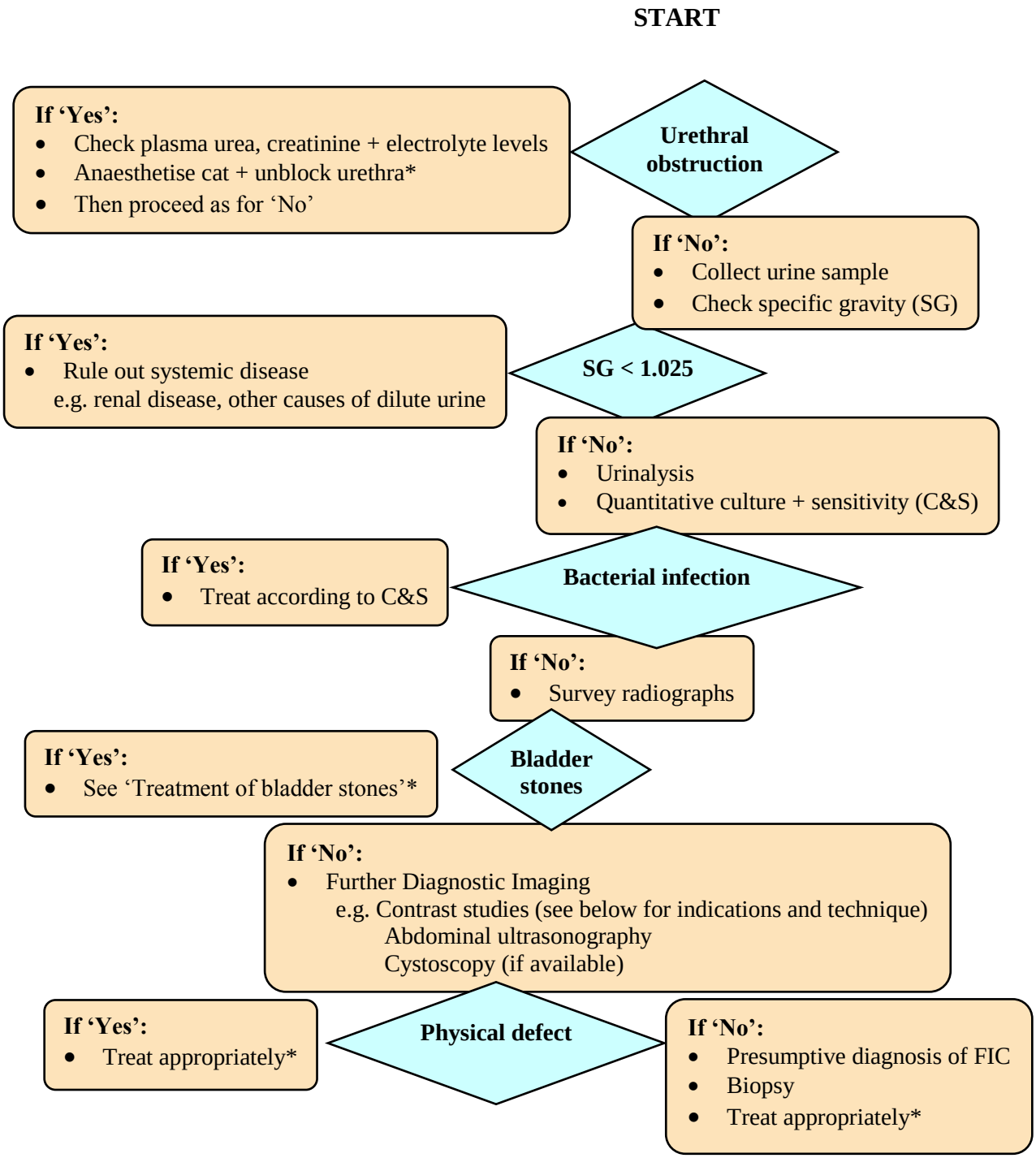


Figure 5. Diagnostic approach to cats with FLUTD.
**See 'Treatment' next section.*
NB : In blocked cats it is preferable to perform a rectal examination and plain radiographs before any attempt is made to unblock the urethra: this should identify the presence and number of any urethral stones.

TREATMENT

INTRODUCTION

The key to successful treatment is a correct diagnosis. Where a specific cause can be identified then its treatment can be undertaken. Where no underlying cause can be identified then the cat should be managed as for feline idiopathic cystitis (FIC) (see below).

Treatment of the Blocked Cat

Obstructive FLUTD can be caused by many different disorders, including those affecting the urethra (FIC [often with spasm], urethral plugs, urolithiasis [stones], neoplasia, prostatic disease, anatomical defects [strictures etc]), and/or the bladder (FIC, urolithiasis, neoplasia, anatomical defects). Affected cats typically present with a history of stranguria, dysuria, pollakiuria, or anuria, although owners may report constipation as this may be confused with stranguria. The severity and duration of the obstruction will determine the severity of the clinical signs.

Obstruction can lead to post-renal azotaemia, renal azotaemia, hyperkalaemia, hyperphosphataemia, hypocalcaemia, and acidaemia. These combined metabolic and renal disruptions can rapidly prove fatal. Therefore, cats presenting with lower urinary tract obstruction require immediate treatment.

Diagnosis of obstructive FLUTD is based on history and physical examination (abdominal palpation revealing an enlarged tense painful bladder). If the history suggests a lower urinary tract obstruction, but there is no palpable bladder, urinary tract rupture and uroabdomen should be considered.

Prior to the correction of the obstruction the overall status of the cat should be assessed. A minimum database should include assessment of the cardiovascular system, haematology, serum biochemistry and electrolytes. Ideally, acid-base status should be checked and monitored. If severe metabolic derangements (such as hyperkalaemia) are present, these should be corrected prior to sedation or anaesthesia. Fluid therapy should be administered in all cases. The choice of intravenous fluid will depend on the overall condition of the case. Ideally, if hyperkalaemia is present then potassium containing fluids (such as Hartmann's solution) should be avoided; 0.9% sodium chloride is the crystalloid of choice. The significance and severity of the hyperkalaemia should be determined by measuring the serum potassium concentration, assessing the cat's heart rate and rhythm and, ideally, performing an ECG.

Management of Hyperkalaemia

Severe life threatening hyperkalaemia

- Calcium gluconate 10% (diluted 1:1 with normal saline): Give as a slow intravenous infusion over 5-10 minutes (as it can cause bradycardia and/or arrhythmia). This does not lower the potassium concentration, but provides immediate (short-term) myocardial protection. It should be the first line treatment for hyperkalaemia in obstructed cats as many of these cats are also hypocalcaemic: ~1/3 have low total calcium concentrations. Once hyperkalaemia and acidaemia have developed, ~3/4 of the cats have low ionised calcium concentrations (Lee and Drobatz 2003). If the hypocalcaemia is left uncorrected this will exacerbate the cardiac instability.

Moderate to severe hyperkalaemia

- Glucose (5-10% solution as a constant rate infusion or 20-50% IV). If using hypertonic glucose solutions these should be administered slowly into a large vein. Glucose acts by stimulating endogenous insulin release causing cellular uptake of glucose and potassium.
- Glucose combined with regular insulin. When doing this it is important to monitor the blood glucose concentration for evidence of hypoglycaemia. The synergistic action of glucose and insulin acts to stimulate cellular uptake of glucose and potassium.
- Sodium bicarbonate: This is particularly useful if there is concurrent acidosis; however, it is contra-indicated with hypocalcaemia (which may be present in ~3/4 of hyperkalaemic blocked cats). It acts by exchanging intracellular hydrogen for potassium.

Asymptomatic Hyperkalaemia

- Fluid therapy (ideally, potassium free)
- Restoration of urine output

Treatment of the Obstruction

If the cat is alert then sedation or anaesthesia will be required, and analgesia should be administered. The choice of anaesthestic agent depends primarily on the degree of renal compromise and any other underlying disorders. The bladder may require immediate decompression, in which case, careful cystocentesis can be performed and the bladder emptied (ideally by using a fine-gauge butterfly needle as this leads to less bladder trauma; remove as much urine as possible). In order to perform the most suitable approach to unblocking the urethra it is important to perform a rectal examination and possibly even take plain radiographs before any attempt is made to unblock the urethra. The urethral obstruction can then be addressed as described below, and in Appendix A. In cases where the cause is known to be recurrent urethral spasm, and systemic biochemical changes are limited, then a protocol for managing these cases has been published which avoids urethral catheterization. It involves giving ACP (0.25mg/cat IM or 2.5mg/cat PO q8h), buprenorphine (0.075mg/cat PO q8h) and medetomidine (0.1mg/cay IM q24h), performing decompressive cystocentesis and giving SQ fluids as needed, and placing the cats in a quiet, dark environment to minimise stress (Cooper et al 2010). Treatment success is defined as spontaneous urination within 72 hours and this protocol was effective in 11 of 15 cases in a recent paper.

A rectal examination should be made in all cases; it will help to detect urethral stones, trauma, neoplasia, or swelling (e.g. hyperplasia of the urethral muscle in response to repeated spasms), and it can also be useful for urethral massage or in retrograde hydropulsion of urethral stones (Figure 6). In order to relieve a urethral obstruction gentle urethral massage can be attempted. This can be performed on both the penile urethra and the intrapelvic urethra (per rectum). If this is not successful, urethral catheterisation and retrograde hydropulsion should be attempted. This may be facilitated by giving intraurethral atracurium (see Treatment of Urethral Spasm). There are several types of catheter available for this purpose. Once a suitable catheter has been selected the tip should be covered with a sterile lubricating gel. The penis should then be extended caudally and the catheter gently advanced whilst flushing with warm sterile saline. If the catheter can be advanced into the bladder, the bladder should be gently compressed until it is empty and should then be slowly flushed with saline until the saline runs clear. Normal saline has a pH of 5 so it is good at dissolving struvite crystals. The use of more irritant solutions should be avoided (e.g. Walpole's solution), as they will cause irritation to the mucosal lining of the bladder and urethra. Once the instilled saline remains clear, the bladder should be completely emptied, the catheter secured to the cat by suturing it to the prepuce and a sterile closed drainage system attached (and secured with tape to the tail) to enable urine output to be monitored.

In cases where a urinary catheter cannot be passed along the penile urethra, an emergency urethrostomy or a temporary tube cystotomy may be required. For emergency decompression of the bladder, a tube cystotomy is preferred to multiple cystocenteses. This approach allows the cat to be stabilised for a later repeated attempt at catheterisation or, if that fails, possible surgical correction. Tube cystotomy can be performed via a midline incision, made midway between the umbilicus and the pubis. The bladder is exteriorised and stabilised using stay sutures. A purse-string suture is placed through the serosa and muscularis layers of the ventral, apical bladder wall. A stab incision in made within the purse-string, and a Foley or mushroom tip catheter introduced (size dependant on the size of the cat, typically 8-10F). Remember to pass the catheter through the body wall via a separate incision first! The balloon (if present) is inflated using sterile saline and then the purse-string tightened. Omentum may be incorporated. The bladder may be pexied to (sewn onto) the abdominal wall for additional security and the catheter secured to the outer body wall using a friction (Chinese-finger trap) suture. The catheter is connected to a closed-circuit drainage system and urine output monitored. Discussion on the potential complications and practical application of perineal urethrostomy is beyond this article; however it is important to remember that unless the obstruction is in within the penis then this procedure is unlikely to help. In addition, perineal urethrostomy is not without significant surgical risks (e.g. local haemorrhage) and longer term complications (e.g. stricture formation, recurrent urinary tract infections).

Aftercare

After re-establishing urinary output diagnostic investigations can be undertaken to determine the cause of the obstruction. The volume of the urine output should be closely monitored and the urine sediment should be examined daily for evidence of infection. If the urine output fails to rise, or falls to <0.5ml/kg/hr, treatment for oliguric renal failure should be considered. Once post obstructive diuresis has been achieved, the serum potassium concentration should be monitored closely as hypokalaemia may warrant potassium supplementation. Analgesics are usually required (e.g. buprenorphine; *Vetergesic™* at 10-30 ug/kg PO, SQ, IM or IV q8-12h). Unless there is a strong contraindication (e.g. if acute renal failure is still present) then urethral relaxants can be given while the catheter is in place, and continued for a week following the removal of the catheter (e.g. prazocin; *Hypovase™* at 0.5-1.0 mg/cat PO q8-12h); this may help to improve catheter comfort, reduce catheter-associated spasm and reduce the chance of rapid re-obstruction when the catheter is removed.

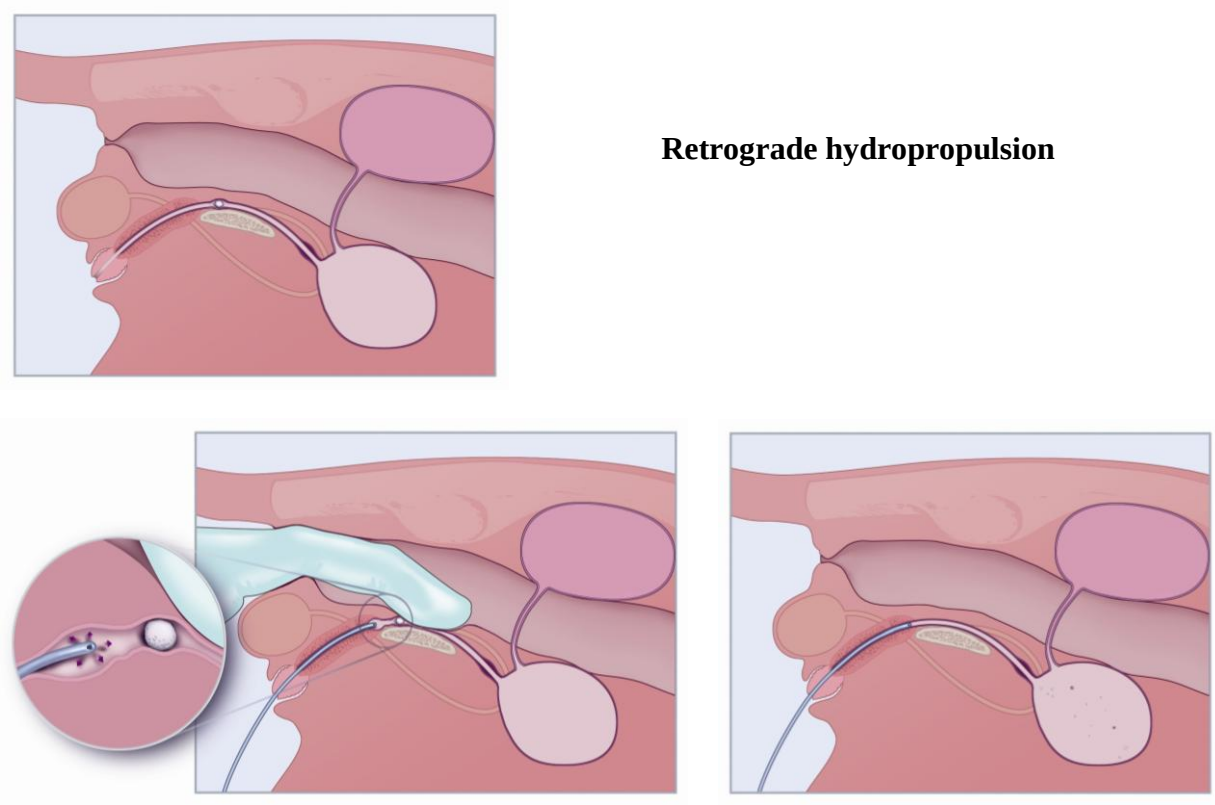


Figure 6. Retrograde hydropulsion. Two people are needed. One person places a finger per rectum to compress the urethra as far proximal to the stone as they can reach. The second person passes a catheter into the proximal urethra, and then compresses the prepuce around the penis to prevent back-flow of saline. With the other hand they instil saline through the catheter into the urethra until distension pressure lifts the walls of the urethra off of the stone. At this point the person with their finger in the cat's rectum lifts their finger off of the urethra and a firm flush of saline propels the stone back into the bladder from where it can be removed by cystotomy. (Pictures included with permission from Affinity Petcare).

Treatment of urethral plugs

Urethral plugs consist of protein-colloid matrix plus or minus trapped crystals which have become wedged within the urethra. Initially, the urethra must be unblocked (see above and Appendix A).

In the longer term treatment may be aimed at reducing;

- the protein matrix (see 'Treatment of FIC')
- the crystals:

  Normal cats commonly produce crystals in their urine, especially when they are fed many dry cat foods. The first line of treatment is therefore to change their diet to wet food. Where significant crystalluria persists the nature of the crystals should be assessed and an appropriate prescription diet can be fed (preferably the wet form).

  Do not feed an acidified diet if the urine is already acid and/or where struvite crystals are not a problem. Long-term use of highly acidified diets can result in metabolic acidosis, hypokalaemia, renal damage, and loss of bone density, especially when given to immature cats. These diets also increase the risk of oxalate urolithiasis.
- urethral spasm (see 'Treatment of urethral spasm').

Treatment of uroliths

The two most common types of urolith found in cats are struvite (magnesium ammonium phosphate) and calcium oxalate. While it is known that feeding diets with high magnesium content and that produce poorly acidified urine can predispose to the development of struvite stones, the pathogenesis of calcium oxalate stones is less well understood, but appears to relate, at least in part, to feeding diets that are acidifying. Because of this, it has been challenging to formulate a diet based on pH change that will reduce the risk of both forms of stones.

It can be difficult to correctly predict the type of stone that is present based on urine analysis. Many cats with bladder stones do not consistently void crystals in their urine, and in ~10% of cases the type of crystal will be different from the type of stone that is present. Inferring the type of stone from the pH of the urine can also be misleading. This is because while an alkali pH can be associated with a response to diet, it can also result from certain bacterial infections (e.g. urease-producing bacteria), with time passed since the urine was voided and, perhaps most importantly, with hyperventilation due to stress.

Uroliths occur most commonly in the bladder and urethra. Since calcium oxalate stones are not amenable to dissolution following diet change they are best removed surgically. Urethral stones, if they are small enough should be repelled back into the bladder using 'retrograde hydropulsion' (see Figure 6), or expelled from the urethra using 'voiding hydropulsion'. The latter can be performed by holding up the heavily sedated or anaesthetised female cat, then initiating micturition by squeezing its bladder gently but firmly. Struvite stones may be dissolved using an appropriate prescription diet (which acidifies the urine and is low in magnesium content). However, the use of these highly acidified diets cannot be recommended for older cats as they can exacerbate renal failure, cause hypokalaemia, loss of bone density, and increase the risk of oxalate urolithiasis. Even in younger adult cats, these diets should only be fed for short periods of time (<2 months). Difficulties in determining stone composition based on urine analysis (see above) means that some cats will be falsely thought to have struvite stones, treated for perhaps two months with an inappropriate diet and so incur un-necessary suffering from the presence of a calcium oxalate stone. Because of this the author prefers surgical removal of bladder stones; particularly if they are a cats first stones (later stones are generally likely to be the same composition if the cat's diet has not been changed). Once removed the stones should be sent for quantitative analysis.

Renal uroliths are very difficult to treat. Diets designed to reduce the relative supersaturation (RSS) for calcium oxalate may help, and hypercalcaemic cats may benefit from being fed a lower protein, higher fiber diet, (e.g. PURINA Feline EN, Hill's w/d), perhaps with potassium citrate added (this is an alkalinizing agent and a source of citrate: aim for a urine pH of 7.5). Surgical intervention can be detrimental to renal function, but remember to give long courses of antibiotics if bacterial infections occur concurrently. Ureteral stones may be encouraged to pass into the bladder by giving amitryptylline (see tricyclic antidepressants) which appears to have an acute anti-spasmodic effect on the ureters.

Prevention of urolithiasis

Cats that have previously formed a urolith have an increased risk of doing so again. Preventative recommendations aim at reducing this risk. Dietary manipulations can affect urine concentration, volume, pH, and mineral content. While much interest has been placed on altering urine pH and the mineral (particularly magnesium) content of the urine, it is now believed that the most important factors are the rate of water turnover and relative supersaturation (RSS) of the urine. The aim of dietary manipulation is therefore to create less concentrated urine (ideally, specific gravity ≤1.035) which encourages more frequent urination, dilutes the urine and makes stone formation less likely. Rather than altering the content of a dry diet, it is preferable to feed a wet (canned) one. It is also important to get the cat to drink as much water as possible (see below in treatment of FIC). Some achieve this with higher levels of salt (NaCl) (e.g. Royal Canin Urinary SO and Purina UR ST/Ox) while others choose a different route (Hill's c/d Urinary Stress – which also contains L-tryptophan and milk protein hydrolysate to reduce stress and GAG's [see below]) – e.g. adding potassium citrate; all three of these diets have extra vitamin B_6 (to reduce oxalate formation), and omega 3 and 6 fatty acids (to reduce inflammation, amongst other things), plus vitamin E and beta-carotene (as anti-oxidants). These diets can effectively decrease urine specific gravity and RSS and so reduce the risk of further stone formation (in addition to reducing bladder inflammation in cats with FIC). While these diets are often effective in the short to medium term, we do not, as yet, know their long-term consequences although there are now trials where they have been fed for over a year with no negative consequences. There is still debate about the potential long-term consequences of feeding high salt diets to cats that may be developing kidney disease.

Treatment of urethral spasm

For the treatment of severe urethral spasm see above under Treatment of Obstruction. Urethral spasm may occur in many cases of FLUTD, regardless of the underlying cause. Spasms may be initiated by local pain or inflammation, and may affect the smooth and/or skeletal muscle of the urethra. Interestingly, a recent study confirmed that even female cats with FIC have increased smooth and skeletal urethral muscle tone. It may therefore be beneficial to give drugs to counter both of these effects. While these drugs are rarely associated with side effects in young cats, the risk of concurrent renal or cardiac disease should be assessed before these drugs are given to older cats. Injectable drugs (e.g. ACP) may be given at the time of relieving a urethral obstruction, after which the author commonly prescribes a 7-14 day course of prazosin (and, in very severe cases, dantrolene). These two drugs can be given together, and longer or intermittent courses of prazosin may be required in some cases. The author prefers to wean off these drugs over a few days rather than stopping them suddenly, usually stopping the dantrolene before the prazosin.

- Smooth muscle anti-spasmodics include:
  Acepromazine (ACP™) 0.05-0.2 mg/kg IV, IM, SC or 1-3 mg/kg PO
  Prazosin (Hypovase™ 0.5 or 1.0 mg tablets) 0.25-1.0 mg/cat PO q8-12h
  Phenoxybenzamine (Dibenyline™ 10 mg capsules)* 0.5-1.0 mg/kg PO q12h - give for 5 days before evaluating efficiency.
  Amitriptyline (Amitriptyline™) 0.5-1.0 mg/kg PO q24 hours - particularly useful at reducing ureteral spasm associated with ureteral stones

- Skeletal muscle anti-spasmodics include:
  Dantrolene (Dantrium™ 25mg capsules)* 0.5-2.0 mg/kg PO q12h (0.5-1.0 mg/kg IV, but very expensive).
  Atracurium bensylate 0.2ml of 10mg/ml solution diluted in 3.8ml of 0.9% sodium chloride to give a final volume of 4ml of 0.5mg/ml used as intraurethral flush.

**Re-encapsulate 1/8 –1/4 of the contents of a capsule into empty size 2 or 4 gelatin capsules.*

There have been only a limited number of studies into the use of these drugs in the relief of urethral spasm in cats; however, prazosin, phenoxybenzamine, dantrolene and amitriptyline have been shown to be most beneficial.

All smooth muscle relaxants can cause hypotension, and dantrolene and amitriptyline may cause liver toxicity. Please note that prazosin is dosed per cat and not per kg, and refer to a veterinary drug formulary (e.g. the BSAVA Formulary) for more information about the use and toxicity of these drugs.

Treatment of bladder diverticula
If a diverticulum does not spontaneously regress with successful management of the underlying cause of the FLUTD then surgical resection is recommended. Resected tissue should be sent for histopathology and routine bacterial culture.

Treatment of bladder neoplasia
Bladder neoplasia, whenever possible, should be surgically resected. Unfortunately, this is often not possible, either because the tumour is affecting too much of the bladder, is positioned too close to the trigone, involves one or both of the ureters or, occasionally, because metastases have already been detected (usually in the lungs).

Some cases of transitional cell carcinoma (TCC) may be amenable to palliation using meloxicam (or piroxicam). Studies have shown that piroxicam may provide palliative treatment and occasional long-term remission in humans and dogs with bladder TCC (mean survival of 181 days [range 28->720 days] in dogs). The mechanism of the anti-tumour activity is currently unknown, but it appears to be more than a simple anti-inflammatory action. Unfortunately, although piroxicam has been studied most in other species, it is difficult to use in cats because its therapeutic window is very narrow and required dosages are so small that they necessitate professional drug reformulation. That said, the author has used it in cats with TCC and can report positive responses. However, since meloxicam is believed to have similar actions to piroxicam the author uses this in preference to treat cats with TCC, and has again seen positive responses, with some cats having very long periods of tumour remission (in some cases >5 years).

As with other non-steroidal anti-inflammatory drugs (NSAIDs) these drugs can cause gastrointestinal and renal toxicity. It is therefore essential to check urea and creatinine levels, and urine specific gravity, before starting treatment, and to continue to monitor them regularly.

- Meloxicam (Metacam™) 0.1 mg/kg PO q24h for 4 days, then 0.05 mg/mg PO q24h longer term as needed
- Piroxicam (Feldene™) 0.3 mg/kg PO q48-72h

Bacterial infections
Bacterial infections should ideally be treated according to culture and sensitivity, using antibiotics that are excreted in the urine and that are not harmful to renal function. Where an underlying cause can be found it should, where possible, be corrected. When concurrent renal failure is present, or the bladder wall is very thickened (and may therefore contain sequestered infection) prolonged courses of antibiotics are often required (4-6 weeks dependent on the severity of disease). Repeated courses of antibiotics may be needed where recurrent infections occur. It is important to remember that antibacterial resistance is likely to develop, so repeated cultures may be needed.

Treatment of FIC
While most cases of non-obstructive FIC are self-limiting, and usually spontaneously resolve within 5-10 days, treatment is recommended for a number of reasons:

- FIC is very painful and distressing to the cat.
- Cats with FIC may self-traumatize their perineal region.
- Cats with FIC may become anorexic (and since many cats with FIC are over-weight they have an increased risk of developing hepatic lipidosis).

- Male cats with FIC are at risk of developing urethral obstruction, which if not treated urgently may be fatal.
- Cats with FIC may develop behavioural changes, such as overgrooming and/or the onset of inappropriate indoor elimination. In some cases they may also become aggressive to their owners or other cats within the household.
- Having a cat with FIC can be very distressing to an owner.

Unfortunately, few treatments for FIC have been investigated by well-controlled double-blinded experimental studies. Most recommendations are therefore based on uncontrolled clinical observations and personal opinion. Also, since FIC is usually self-limiting, many treatments may *appear* to be effective, when they actually have no positive effect. All treatments should therefore be considered with appropriate caution.

As more drugs are tried, the list of those that are either unhelpful, or even harmful, is growing. Treatments that have been critically assessed include *corticosteroids* and *antibiotics*, and neither was found to be beneficial. A number of drugs should never be given to cats, e.g. the urinary tract antiseptic, *methylene blue*, and the urinary tract analgesic, *phenazopyridine*; both of which can result in severe Heinz body anaemia.

The entire list of medications and interventions that have been considered for the treatment of FIC is far too extensive to be included in these notes. The author will therefore consider the most practical approach to the management of FIC, which aims at addressing the factors underlying the disease (see above for pathogenesis), and includes both medical and behavioural interventions.

1. *Reduce stress:*

Stress plays a key role in the pathophysiology of FIC: It has been identified as a *"flare factor"* that can precipitate a recurrence of clinical signs. Identified stressors include living with another cat with which the FIC sufferer is in conflict (i.e. cats belonging to different social groups); abrupt changes in diet, environment or weather; overcrowding; owner stress; or the addition of new pets or people to the household.

2. Social stress is particularly relevant to cats living in multi-cat households; however, it should also be considered in single cat homes if there is evidence of tension with other cats in the neighbourhood. Issues such as visual access into or out of the home are often overlooked and these can be particularly effective at inducing chronic stress in cats living in highly populated areas (i.e. cats being able to see other cats through windows). Reducing stress for these individuals can be a challenge since not all factors are under the control of the owner. However, it can be beneficial to pay attention to entry and exits points into the property, invest in secure cat flaps (such as the microchip controlled Pet Porte®), and to restrict visual access into and out of the home by covering windows with semi-opaque coverings, and modifying the availability of resting places on window ledges and in the garden (so that inside cats cannot see out and/or outside cats cannot see in).

Cats are naturally solitary hunters and have a relatively low requirement for social interaction. They naturally live in groups of related individuals and are hostile to the intrusion of cats from other social groups. Most importantly, in terms of multi-cat households, they do not like to share essential resources between social groups and the provision of adequate and suitably distributed resources within the home is a key factor in minimising social stress. The five key resources are water stations, feeding stations, latrines, resting places, and points of entry and exit to and from the territory.

Feeding is not a social behaviour in cats and they prefer to eat their meals in privacy. The common approach of offering cats food in timed meals is not only inappropriate from a physiological perspective, it also brings all of the cats into one area in order to feed which significantly increases social tension. Provision of ad lib or self service style feeding favours more natural feeding behaviour and offers cats the chance to feed alone. This can be further enhanced by providing multiple feeding stations around the house.

When cats find themselves in situations of tension their natural coping strategy is to escape to a safe location. The provision of safe escape routes within multi-cat households is therefore essential and adequate provision of resting places and elevated positions (such as climbing posts and the top of cupboards) is part of providing a suitable environment for domestic cats. The opportunity to hide and have periods of privacy is also important. Disputes over entry and exit points can be a source of chronic stress and it is not uncommon for cats to be denied access into the home by incompatible individuals within the household. Provision of separate entry and exit points can therefore be an important part of the environmental management in some of these cases.

Stress associated with urination can be particularly significant for cats suffering from FIC. It is therefore important to provide a safe and secure area in which the cats can toilet and to ensure that litter boxes are positioned in locations that offer privacy. An appropriate number of boxes is important in order to ensure that cats are not expected to share latrine sites with cats from other social groups. The positioning of the boxes should allow the cats to have free and immediate access without having to run the gauntlet of other cats. The number of boxes is not as important as the number of latrine locations and these should be matched to the number of social groups within the household. It is no good having two boxes positioned side by side if the two cats in the house belong to different social groups since access to the boxes will be potentially restricted. While covered litter boxes may be thought to provide a safe and private place to eliminate, many cats do not like them as cats from different social groups may try to pounce on them as they leave the box.

Cleaning regimes should be adequate to ensure that all boxes are sufficiently clean to encourage regular use and the litter type should be selected with this in mind. Daily scooping of urine and faecal deposits is essential and full cleaning of the box and replacement of the litter should take place at least once a week. The litter type should also be selected to maximise substrate preference and those litters which are perfumed or uncomfortable underfoot should be avoided. Since the depth of the litter has been shown to be important in encouraging the use of the box owners should be encouraged to invest in deep sided boxes and to use sufficient quantities of litter to ensure adequate digging and burying behaviour during elimination. (That said, remember that older cats may develop arthritis and may no longer be able to climb into a high sided box, so owners need to think about their individual cats' requirements).

One way in which feline perception of the home as a safe and secure location can be enhanced is through the use of pheromone mediated communication. One of the fractions of the feline facial pheromone complex (F3) is available in a synthetic form (marketed by Ceva Animal Health under the trade name Feliway™). This so called "familiarisation pheromone" serves to decrease perception of threat and increase a sensation of safety within the home. It is applied to the environment via a diffuser device which is designed to be switched on for 24 hours a day in order to obtain an even distribution of the pheromone throughout the house. A spray formulation for application to specific locations is also available but in the management of chronic social stress it is the diffuser that is the most useful (this spray version can also be useful in cat carriers and veterinary clinic cages).

Clinical evidence suggests that Feliway™ can be particularly beneficial in multi-cat households where social tension is contributing to problems of FIC but the use of the pheromone signal alone will not be enough to over-ride other signals of social incompatibility. Because of this work still needs to be done on integrating the cats from a behavioural perspective. The use of a Feliway™ diffuser during this process is recommended as it reduces the risk of marking behaviours, such as indoor urine marking, but it has also been shown to reduce signs of defensive aggression and passive withdrawal.

Many different forms of positive environmental enrichment can help to reduce stress. While this should always include climbing frames and escape areas (as discussed earlier), it should also include games that stimulate natural cat behaviour, such as the provision of paper bags and boxes to play in, fishing rod toys to chase, and hunting games (e.g. hiding toys filled with cat nip or little bits of food).

One way in which social stress can be controlled is through appropriate selection of feline housemates while paying adequate attention to the demands of normal feline behaviour. Restricting numbers of cats to socially compatible levels and resisting the temptation to expand feline households by the introduction of strangers will significantly help in the management and treatment of stress related medical conditions such as FIC.

Effective cleaning of any surfaces that become contaminated with urine is essential to reduce the stimulation for cats to urinate in that place again. All inappropriate urine deposits should be thoroughly cleaned using biological washing powder (something enzymatic and not containing bleach or ammonia), then died thoroughly. A number of specialist products are available to remove cat urine contamination, e.g. Urine-Off (www.urine-off.comm).

3. Create dilute urine

Altering the diet most easily modifies the content of urine. While much interest has been placed on altering the urine pH, and the magnesium and calcium content of the urine, it is now believed that probably the single most important factor in reducing signs of bladder discomfort is the rate of water turnover. While reducing the urine specific gravity will reduce the signs of bladder pain it is unlikely to alter the underlying pathology of FIC, behavoural modification and stress reduction are needed to address this. The aim of dietary manipulation is therefore to create less concentrated urine (specific gravity ~1.035) which encourages more frequent urination and dilutes any noxious components within the urine. Rather than altering the content of a dry diet, it is advisable to feed a wet one. However, not all wet diets are created equal. Care should be taken when feeding high-fibre diets since they result in increased faecal fluid loss and therefore reduced urine production. For more information of how dietary formulation can lead to reduced urine specific gravity see 'prevention of urolithiasis'.

- Gradually change the diet to an appropriate wet food.
- Supply free access to water and encourage the cat to drink.
- In order to achieve the above it is necessary to educate owners on the requirements of cats in terms of the provision of drinking water. Cats generally prefer to eat and drink in separate locations so containers which encourage the provision of food and water directly adjacent to one another should be avoided. Different social groups are unlikely to share water stations so it is important to provide an adequate number and location of watering stations for each of the social groups living in the household. In order to decrease the risk of water taint and increase the visibility of the surface of the water it is best to avoid containers made of plastic and those that offer only a small surface area. Instead, cats should be provided with a large water bowl (with a large surface area) made from glass, ceramic or metal. Most cats like to avoid shadowing the surface of the water as they drink so they do not like putting their head directly over the top of the receptacle, or inside it. This means that cats rarely drink from water bowls that are not entirely full and it is important to keep the water filled up to the top of the receptacle at all times. Moving water is more attractive than still water to many cats and the provision of a 'pet water fountain' or access to a dripping tap should be considered. If owners are still finding it difficult to encourage drinking they can consider offering fish or chicken stock and diluting cat food to form 'soup'. (N.B. Do not use stock cubes designed for human consumption as they usually contain large amounts of onion powder which can result in Heinz-body anaemia in cats).
- For discussion of the use of prescription diets where significant crystalluria is present see 'Treatment of urethral plugs' and 'prevention of urolithiasis'.

4. ***GAG supplements:***

These may be beneficial if exogenous GAG attaches to the defective urothelium and decrease its permeability. They may also have analgesic and anti-inflammatory properties. They have been effective in some human studies with interstitial cystitis (IC). There are currently five published double-blinded placebo controlled studies in cats. Oral N-acetyl glucosamine (NAG) resulted in no significant difference in a six month-long study (Gunn-Moore and Shenoy 2004), and a slight reduction in haematuria and unquantified reduction in pain in a one month study (Panchaphanpong et al 2011). Pentosan polysulphate (PPS) has not proved beneficial, either when given orally in a six-month study (Chew et al 2009), or by subcutaneous injectable (3mg/kg on days 1,2,5,7 and10) in a 12-month study (Wallius and Tidholm 2009). However, some individual cats do appear to benefit from GAG

supplementation, and a recent pilot study suggested that GAG (hyaluronic acid, chondroitin sulphates and NAG; A-Cyst™) instilled into the bladder on three occasions within 24 hours, showed potential to reduce the risk of recurrence of re-obstruction within the first week (Bradley and Lappin 2013). From human studies, it appears that there are differences in the relative efficiency of different GAGs and the same may also be true in cats.

In one of the published studies the author gave *N-Acetyl Glucosamine,* which is a precursor for GAG. e.g. Cystease™ (Ceva Animal Health) 125mg per cat PO q24h, plus hyaluronic acid. However, it can also be given at higher dose at the time of the initial presentation, and then reduced to a maintenance level. This produce also contains L-tryptophan to reduce stress. Another study used injectable pentosan polysulphate e.g. *Cartrophen Vet* (FORTE Healthcare Ltd).

Possible side effects include prolonged bleeding times, inappetence, and possibly, insulin resistance.

4. Treatment of urethral spasm:

Treatment for urethral spasm may reduce the severity of clinical signs in some cats, and may reduce the risk of urethral blockage recurring (see above for details).

5. Tricyclic antidepressants (TCAs) and Serotonin re-uptake inhibitors (SSRIs):

TCAs have been found to be beneficial in the treatment of some humans with interstitial cystitis and, anecdotally, shown positive effects in a number of cats with FIC. However, there are few well-controlled studies in cats, and the two that have been published have shown that short courses (7 days) do not aid in the resolution of clinical signs, and may even be associated with an increased risk of recurrence. Unfortunately, there are no published well-controlled studies on the longer term use of TCAs in the treatment of FIC, so the actual effect of longer courses remains unknown. In other aspects of behavioural medicine the clinical effects of TCAs generally do not become apparent until the fourth week of treatment so it is still possible that long term treatment may be beneficial. TCAs have both behavioural and organic effects. They have anticholinergic (including increasing bladder capacity and relaxing the urethra and urethers), anti-inflammatory (including preventing histamine release from mast cells), anti- adrenergic, analgesic and antidepressant effects. In addition, they also reduce ureteral and urethral spasm and may, at least in some species, reduce the renal interstitial inflammation that results from urinary tract obstruction. Long-term use of TCAs should be used with caution in cats, and reserved for those cases with very severe or chronic disease, or when a potential source of stress can be predicted but cannot be avoided e.g. moving home or a stay in the cattery.

Amitriptyline (Amitriptyline™) 0.5-2.0 mg/kg PO q24 hours (evening); wean down to as low a dose as possible.

Clomipramine *(Clomicalm™)* 0.25-0.5 mg/kg PO q24 hours (evening); wean down to as low a dose as possible

Side effects include somnolence, weight gain, urinary retention, and raised liver enzymes. Liver function should be assessed prior to starting therapy, reassessed one month later, and then every 6-12 months while the cat is on treatment. In cases where cats have been reported to be significantly sedated on clomipramine the possibility of overdosing should always be considered due to the extreme difference between the licensed canine dose and administration frequency of this drug, compared to the recommended dosage range and administration frequency for the cat.

SSRIs e.g. fluoxetine (Prozac; 1mg/kg PO q24h) or paroxetine (Paxil), may produce fewer side effects than TCAs, but they are not licensed for use in cats and there have been no studies into their use in the treatment of FIC.

6. ***Analgesia and anti-inflammatory drugs:***

Analgesia alone may reduce the severity of the clinical signs, but is rarely sufficient on its own. It should therefore be combined with environmental and dietary modifications.

- While NSAIDs have not been investigated for the treatment of FIC they appear to help in many cases (and especially in those with TCC or pre-TCC, see above).
- Buprenorphine (*Vetergesic ™* at 10-30 ug/kg PO, SQ, IM or IV q8-12h) or fentanyl patches (which attached to a shaved area on the back of the neck), may show some degree of positive effect.
- Corticosteroids have been shown to be non-effective.
- Since the inflammation of FIC is mediated though substance P, it has been suggested that maropitant (an NK-1 antagonist that blocks substance P from activating receptors) may have a role in the treatment of FIC. As yet, no studies have been published.

Prognosis

The prognosis for cats with FLUTD clearly depends on the cause:

- The clinical signs of bacterial cystitis often respond very favourably, however, the cat's underlying condition (e.g. urinary obstruction due to FIC, urethral plugs or stones, or polyuria due to chronic kidney disease, diabetes mellitus, or hyperthyroidism, etc.) often carries a more guarded prognosis.
- Bladder stones that can be surgically removed or dissolved with diet, then prevented with diet change usually carry a reasonable prognosis; although any underlying hypercalcaemia must be assessed and ideally corrected.
- FIC without obstruction rarely proves fatal, that is, unless an owner feels the cat's quality of life is so poor they opt for euthanasia.
- Bladder cancer typically carries a guarded prognosis; however, some TCCs will respond very well to meloxicam.
- Cats with urinary obstruction due to FIC, plugs or stones all carry a significant risk of recurrent disease: ~50% will continue to show clinical signs of bladder discomfort, ~30-40% will re-obstruction, and ~20% will be euthanased because of continued disease.

Summary of Treatment for Feline Idiopathic Cystitis (FIC)

It is important to remember that all current treatments for FIC are merely palliative. The best results are gained by instigating a number of changes, i.e. reducing stress and paying particular attention to the issue of social stress, feeding a wet diet, increasing water intake by providing behaviourally sound water stations, and if necessary, relieving urethral spasm and possibly replacing GAGs. In most cases, when tailored to the individual cat, this will reduce or prevent further clinical signs. TCAs and SSRIs should only be used in very severe recurrent cases. Referral to a veterinary behaviourist may be necessary in order to accurately identify and resolve sources of chronic stress.

Where possible, it may help to be proactive. This can be achieved where observant owners are able to notice their cat showing prodromal signs before an episode of FIC becomes clinically obvious. The duration of these signs may vary from a few days to a few hours, and they may include increased perineal and hind-end grooming, or altered behaviour (often seen as inter-cat aggression initiated by the FIC sufferer). These signs probably relate to increasing perineal and/or bladder pain. Making or reinforcing management changes at this time may help to reduce the severity and duration of the episode, i.e. further reduce stress (give the cat more attention and cuddles, install a Feliway™ diffuser [or replace the empty one!], and use Feliway™ spray in cat carriers or cattery cages), increase fluid intake, and/or giving prazocin or a GAG supplement, or increase their dosage. This approach can also be used if a stressful episode is anticipated, (e.g. a visit to the vet, a stay in a cattery, builders in the home, etc.)

Please note that few of the drugs listed are licensed for this use in cats. Please refer to a veterinary drug formulary (e.g. the BSAVA Formulary) for more information about them and potential side effects.

Appendix A: **Unblocking a tom-cat's urethra**

Method (also see section on *Treatment of Obstruction*)**:**

1. Collect blood for assessment of urea, creatinine and electrolyte concentrations. If hyperkalaemic, treat accordingly (see above and in critical care texts). Assess for the presence of acute renal failure.
2. Start IV fluid therapy.
3. Anaesthetise the cat (the author prefers this to heavy sedation as it ensures the urethra is as relaxed as possible).
4. ***Perform a rectal examination*** to feel for urethral stones, trauma, neoplasia, or swellings (e.g. muscle spasm, bruising, etc.) before trying to unblock the urethra. Ideally, take a plain radiograph to confirm the presence of any uroliths.
5. Where possible, catheterise the bladder without first decompressing it as cystocentesis significantly increases the risk of urine leakage into the abdomen. However, if this is not possible, perform cystocentesis and remove as much urine as is feasible. Rather than using a needle directly attached to a large syringe (which tends to induce hand tremor and needle tip movement when aspirating, resulting in bladder trauma) use a fine-gauge butterfly needle attached to a three-way tap and a syringe.
6. Fully extrude the cat's penis (if possible) and examine it for signs of trauma, swelling or inflammation. Small uroliths (stones) or tightly packed urine-sand can become lodged in the very tip of the penis and can often be massaged out with gentle manipulation.
7. Some authors suggest instilling 4 ml atracurium besylate solution (0·5 mg/mL) into the urethra to incur urethral relaxation and so aid catheterisation (Galluzzi *et al* 2012). As yet, the author has not tried this.
8. Select a non-traumatic, ideally open-ended, urethral catheter, and lubricate it well with sterile lubricating jelly. Occasionally it is necessary to use a catheter with a very small aperture, e.g. the sheath of a 22 gauge intravenous catheter, or even a lachrymal catheter.
9. Standard (Jackson-type) Tom cat catheters are often useful as they are easy to handle, stiff and inexpensive. However, most have side holes rather than being open-ended, so where the obstruction is near the penis tip it may not be possible to get the catheter holes sufficiently far into the urethra to allow flushing with saline. In addition, the rough edges of the side holes can be very traumatic.
10. Slippery Sam, Cook's shorter urethral catheters, Vygon Cat Kath, or Fioniavet HP catheters are often very useful as they are open ended and atraumatic. However, only the stiff non-stylet form of Slippery Sam catheters should be used, not the softer form with the stylet. That is because in the latter the soft catheter tends to get pushed back from the stylet potentially resulting in the stylet causing damage to the urethra.
11. Position the catheter within the penis tip, and then advance it until it reaches the base of the penis. Once the catheter reaches the base of the penis, let go of the penis, and hold the prepuce, then pull it caudally and dorsally to fully straighten the urethra This acts to straighten out the urethra and allows for easier and less traumatic catheterisation. Urethral trauma is likely to occur if you do not do this, particularly when excessive force is applied.
12. The catheter should be gently advanced whilst flushing with sterile saline which acts to distend the urethra and to flush obstructing material either back along the catheter and out of the penis tip or into the bladder (i.e. retrograde hydropulsion). NEVER use Walpole's solution, it is highly irritant and will cause severe inflammation of the mucosal lining of the urethra and bladder.
13. Urethral massage per rectum and retrograde hydropulsion using saline may assist in flushing urethral stones or debris back into the bladder. Urethral massage per rectum can also help to relax urethral muscle spasm.
14. Once the catheter has been advanced into the bladder, the bladder should be gently compressed until it is empty, and then flushed until the saline runs clear. It should then be left empty.
15. **Do not leave a urinary catheter in situ unless it is really necessary** – it is not a benign this to do.
16. If a catheter is to be left in situ it should be of a length sufficient to just reach into the bladder (this is typically at the level of the 6th lumbar vertebra on a lateral abdominal film), and the catheter should

be made of soft non-traumatic material.

Standard (Jackson-type) Tom cat catheters are not suitable for this purpose: They are too short and are made from very stiff plastic that typically has multiple side holes. These side holes have rough edges and since in most cats they end up sitting within the proximal urethra they can cause severe irritation and inflammation at this site, and may even result in perforation or stricture formation.

Slippery Sam catheters are not suitable for long-term use. Although the short stiff ones are much less traumatic than standard tom cat catheters, the 11cm long ones will end up sitting in the proximal urethra of larger cats. In addition, the hub is not well attached to the catheter so the two can come separated within the cat so the manufacturer's recommend that they are not left *in situ* for >6 hours. The soft hubs, while much more comfortable for the cat, can be rather fiddly to attach to the closed collection system. The use of a 'Little Herbert' luer lock adapter will help making this connection (made by the same company). The longer softer silicone catheters (14cm or 18cm long, depending on the size of the cat, also from SurgiVet) are suitable for longer term use.

Fioniavet HP Tomcat catheters are suitable. They are similar to Slippery Sam (3.5F diameter), and are 14 cm long and have a firm hub that swivels to try to reduce catheter twisting.

Vygon Cat Kath catheters are suitable. They are similar to Slippery Sam (3.5F diameter), and are 11, 14 or 18cm long, the 18cm is of adjustable length (similar to the Mila [see below]) and have a firm hub that swivels to try to reduce catheter twisting.

The Mila EZGO (Interurethral UC 310, 25cm long, 3.5F) made by Mila International Inc and supplied by Direct Medical Supplies **and the Cook's** (25cm, 3.5F) **is suitable** as it is soft, atraumatic and its length can be determined by measuring it against the cat (then positioning the wings at the appropriate length on the catheter and securing the two pieces together with the clip-lock supplied or a suture at each end of the wings). The EZGO catheter is so soft it can be difficult to pass along the urethra until after the obstruction has been removed and the urethra has been flushed clean with saline. A newer version with a stylet has now been developed and may remove these concerns, but the author has not, as yet, used it, and care must be taken that the stylet does not perforate both the catheter and the urethral wall.

17. The ideal position for the tip of an in-dwelling urinary catheter is just within the bladder. All catheters move while in situ and the movement at the tip is most extensive and likely to cause irritation: if the catheter is too short it will cause irritation within the proximal urethra, while if it is too long it will irritate the bladder wall (and can even cause perforation).
18. Secure the catheter to the cat by suturing it to the prepuce and attach a sterile extension line and closed-collection system. Tape the collection system to the tail so the tension is removed from the prepuce.
19. Fit the cat with an Elizabethan collar.
20. Monitor urine output and ensure the IV fluid input matches post-obstructional diuresis, and contains sufficient potassium.
21. Leave the catheter in place for 1-4 days (judge by the amount of blood within the urine). Guidelines are available: 1-2 days to allow for resolution of acute renal failure and urethral relaxation; 5-7 days to promote detrusor stability and repair of significant urethral damage.
22. Do not give antibiotics unless ABSOLUTELY essential. (Giving antibiotics while a urinary catheter is in place risks generating resistant bacteria). It is better to start antibiotics on removal of the catheter, preferable with antibiotics selected according to culture of the urine.
    Ideally, give a spasmolytic (e.g. prazocin 0.5-1.0 mg/cat po q8-12h) while the catheter is in place (to reduce the risk of the catheter causing urethral irritation and spasm), and for a further 1-2 weeks, as needed.

Catheters for female cats

1. To catheterise a female cat use a well lubricated Jackson Tom cat catheter or Slippery Sam catheter, insert it into the cat's vulva, then pull the vulva caudally and dorsally. This acts to straighten out the urethra and allows for easier and less traumatic catheterisation. Slide the tip of the catheter along the floor of the vulva and into the urethra).
2. Flush the bladder with sterile saline to remove debris, crystals, blood clots, etc.
3. It is very rarely necessary to leave an indwelling catheter in a female cat, but if it is use a suitably sized soft Foley catheter or, possibly, the Mila EZGO (as above; measure to ensure correct positioning to just within the bladder and suture the wings to the vulva). The standard long cat catheters (e.g. 4F/1.3mm 30.5cm long catheter) are too stiff and because their length is not adjustable they tend to irritate the bladder wall where they loop round and lie in contact with it. In addition, the latter two catheters tend to be too fine to fit snuggly within the urethra so some cats will urinate around the catheter and this may lead to perineal staining.

Appendix B: Double contrast cysto-urethrography

Indications:

Double contrast cysto-urethrography is the diagnostic method of choice for the assessment of the urinary bladder and urethra. The technique can be used to assess the position and integrity of the bladder and urethra, bladder distensibility and wall thickness, and the detection of intraluminal and intramural lesions such as tumours, polyps, diverticula, bladder or urethral stones.

Method:

4. Ideally, prepare the cat with a 24-hour starvation and give enemas (e.g. Microlax) to ensure that the colon and rectum are empty.
5. Anaesthetise the cat.
6. Take survey abdominal radiographs (ensure the renal shadows are included on the films so they can be assessed for their size and shape, and for the presence of stones or mineralization).
7. Catheterise and empty the bladder using an aseptic technique. (To catheterise a tom cat see Appendix A. To catheterise a female cat use a well lubricated Jackson tom cat catheter, insert it into the cat's vulva, then pull the vulva caudally and dorsally. This acts to straighten out the urethra and allows for easier and less traumatic catheterisation. Slide the tip of the catheter along the floor of the vulva and into the urethra).
8. If necessary, flush the bladder with sterile saline to remove debris, crystals, blood clots, etc.
9. Infuse gas to distend the bladder: CO_2 is preferable to room air as it is more soluble in blood.
   Generally ~ 2-4 ml/kg body weight. It is essential to palpate bladder to prevent over-distension. Very diseased bladders may be very poorly distensible. (When using a 20 ml syringe attached to a Jackson cat catheter via a 23 gauge needle and a bung the point when the pressure in the bladder begins to push back the syringe plunger is usually ideal).
   Obtain lateral projection radiographs.
10. Inject iodinated contrast medium (Conray 280, or Omnipaque 300) into the bladder: ~ 1-2 ml/cat. If a rupture of the urinary tract is suspected it is better to use a non-ionic preparation i.e. use Omnipaque rather than Conray.
11. Roll the cat 360^{o} to ensure that the entire bladder mucosa is coated with contrast media.
12. Obtain lateral and ventrodorsal projection radiographs.
13. Inject additional gas if further bladder distension is required:
    Care on adding the gas as air bubbles can cause misleading images.
14. Assessment of the urethra can be made either as a voiding study or by a retrograde urethrogram.
    A voiding study can sometimes be obtained by filling the bladder with contrast medium and obtaining lateral and/or oblique projections while expressing the bladder by abdominal compression (e.g. placing a light sand-bag across the abdomen).
    A retrograde urethrogram can be obtained in male cats using a tom-cat catheter. This can also be used in female cats. On some occasions the careful use of Babcock clamps may to needed to close the vulva. Alternately, a small Foley catheter can be used (ideally, 4 French). Place the catheter as distally in the urethra (or vulva) as possible, and obtain lateral radiographs as 2-3 ml of the iodinated contrast media is injected.

15. After completing the study remove the contrast media from the bladder.

Acknowledgement:
The author extends great thanks to Sarah Heath, Behavioural Referrals Veterinary Practice, Chester, for the information on behavioural causes of FIC and their control, and information about cat behaviour as it relates to group housed cat interactions and ways to encouraging drinking.

A very useful book designed to help owners of cats with FLUTD is available from www.catprofessional.com. Further information for owners of cats with FLUTD can also be found on the International Cat Care website www.icatcare.org.

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