State of the art
Critical nursing of the blocked cat

A closer look at ...
Managing the cat with painful osteoarthritis

How to ...
Choose the correct sample tube

Keeping cats safe
Dangers of ethylene glycol

Keeping cats safe
A case of antifreeze poisoning
Has your CKD patient lost its appetite?

Get it back with Royal Canin Renal.

Research shows that feeding a Renal diet improves longevity in cats with Chronic Kidney Disease*, but the development of food aversion associated with the disease makes it challenging to keep them eating the same diet long term. To help you keep your patients eating well for longer, Royal Canin is proud to introduce the new Renal diet range, providing your CKD patients with all the benefits of a Renal diet in 19 different taste and texture combinations.

Patient compliance, or your money back.

Contact your Veterinary Business Manager for more details

*Vetirable®. 80% taste and texture acceptance. 2010 PDRS Study.

NEW

ROYAL CANIN
As the temperature drops and the nights draw in it is starting to feel much more like winter, and at this time of year the use of antifreeze products increases. Antifreeze contains ethylene glycol which is highly toxic to cats. In this issue of *Feline Focus*, and as part of our Keeping Cats Safe campaign, we have two articles on ethylene glycol toxicity. One is a case study with a happy outcome — purely because the owners saw their cat licking at a puddle containing antifreeze and prompt treatment with an antidote was given. In many cases cats are brought to the vet too late and the mortality rate is high. As nurses and technicians we need to educate owners not just about the potential toxicity of this product (and hence advice on storing it safely) but also about the signs of poisoning so we can encourage our clients to present their pets to the practice as soon as they are unwell. Also in this issue, Emily Thomas discusses the management of ‘blocked’ cats (cats with urethral obstruction), a common presentation in general practice, and Professor Bennett completes his articles on feline osteoarthritis with practical information on how to help improve the quality of life of affected cats. We finish with an article by Professor Bruce Parry on blood tubes, something nurses and technicians handle daily. However, are you confident you know exactly which tube is used for what sample and why?

As always we welcome your contributions to the journal. Please get in touch if you feel there is a topic we haven’t covered and should, or you would like to contribute an article or case study.

Best wishes,

Sam Taylor, Veterinary Editor

**Contents**

375 **State of the art**
Critical nursing of the blocked cat

383 **A closer look at ...**
Feline osteoarthritis 2: managing the cat with painful osteoarthritis

393 **How to ..**
How to choose the correct sample tube

401 **Keeping cats safe**
Ethylene glycol poisoning

409 **Keeping cats safe**
Case: Molly survives antifreeze poisoning
• Fast and fair claims settlement
• Specialist animal insurer for 125 years
• Comprehensive lifetime veterinary cover

£25 annual healthcare voucher for your clients’ pets

Find out more
0800 369 9098
www.agriapet.co.uk/vet
vet.team@agriapet.co.uk
Critical nursing of the blocked cat

Cats with urethral obstruction (so called blocked cats) commonly present in first opinion practice and the condition is life-threatening. Analgesia and appropriate fluid therapy should be provided and the cat sedated or anaesthetised to facilitate urethral catheterisation. Catheterisation requires a careful and gentle approach, altering the cat’s position and straightening the distal urethral as needed. Retrohydropropulsion can help relieve some obstructions. After unblocking, most cases should be managed with an indwelling catheter and a closed urine collection system (handled aseptically) to allow monitoring of urine output. Fluid therapy should continue and match volumes lost via the urine. Analgesia should be maintained. The majority of patients will survive to discharge if treated promptly, but recurrence is not uncommon.

Felino urethral obstruction is a common complication of feline lower urinary tract disease in male cats. Blocked cats are typically presented as an emergency, and may have life-threatening cardiac arrhythmias due to elevated blood potassium. Immediate stabilisation is essential, including treatment of hyperkalaemia (if present), intravenous fluid administration, analgesia and relief of the obstruction. Post-obstructive nursing care is also of paramount importance to the patient’s recovery. With treatment, the prognosis for survival to discharge is excellent, but, unfortunately, recurrence rates of 14–57% are reported.

There are a surprisingly small number of clinical trials in blocked cats. Treatment is therefore based largely on opinion and anecdotal evidence, giving rise to some controversy. This article will review a general approach to nursing the blocked cat, with emphasis on the evidence available.

Feline urethral obstruction is a common complication of feline lower urinary tract disease in male cats. Blocked cats are typically presented as an emergency, and may have life-threatening cardiac arrhythmias due to elevated blood potassium. Immediate stabilisation is essential, including treatment of hyperkalaemia (if present), intravenous fluid administration, analgesia and relief of the obstruction. Post-obstructive nursing care is also of paramount importance to the patient’s recovery. With treatment, the prognosis for survival to discharge is excellent, but, unfortunately, recurrence rates of 14–57% are reported.

There are a surprisingly small number of clinical trials in blocked cats. Treatment is therefore based largely on opinion and anecdotal evidence, giving rise to some controversy. This article will review a general approach to nursing the blocked cat, with emphasis on the evidence available.

**Key point**

Bradycardia (heart rate <120 beats per minute) in a blocked cat is highly suggestive of severe hyperkalaemia.

Emily Thomas graduated from the University of Cambridge, UK, in 2005. She worked in small animal practice before completing a one year internship at Wey Referrals, Surrey followed by a further internship at the Royal Veterinary College. In 2009 she started a three year residency at the University of Pennsylvania in the USA in Emergency and Critical Care Medicine. She returned to the UK on completion of the residency and currently works at the Royal Veterinary College.
cardiovascular, respiratory and urinary systems. If a life-threatening disorder is suspected, the patient’s treatment is prioritised over that of more stable patients.

Feline urethral obstruction can occur in any cat, but young to middle-aged male, neutered cats are overwhelmingly represented. Blocked cats typically have a history of dysuria that may include straining to urinate, urinating more frequently or in inappropriate places, and vocalisation during urination. It is not uncommon for owners to mistake dysuria for constipation. Vomiting, inappetence, and persistent grooming of the perineum are also reported. Some cats present with collapse.

The bladder should be palpated at triage in any cat presenting with these or similar clinical signs. Urethral obstruction is typically diagnosed by palpation of a firm bladder that cannot be expressed with gentle pressure. Evaluation of the cardiovascular system includes heart rate, pulse quality and synchronicity, mucous membrane colour and capillary refill time. About 12% of cats with a blocked bladder present with bradycardia secondary to severe hyperkalaemia. In fact, a heart rate of <120 bpm in a blocked cat, particularly in the presence of concurrent hypothermia (<35°C), is highly suggestive of severe hyperkalaemia (≥8 mmol/l). If urethral obstruction is suspected, stabilisation should be started quickly whether or not bradycardia is present.

Initial stabilisation
An intravenous catheter should be placed at presentation. In a critically ill patient, blood samples can be withdrawn from the IV catheter at placement to avoid delays in diagnostic testing. As a minimum, emergency blood work should include packed cell volume (PCV), total solids (TS), blood glucose, electrolytes, and creatinine/urea. Further urgent diagnostics may include ECG and blood pressure measurement. If available, venous blood gases provide useful information on acid-base status. Diagnostic imaging can be delayed until the patient is more stable.

If severe hyperkalaemia is suspected based on physical examination, it should be treated immediately, ie, without waiting for blood results. Obstruction of urethral outflow of urine causes pressure to build up within the bladder which, in turn, increases pressure within the ureters and renal tubules. The backed-up pressure causes slowing and then stopping of glomerular filtration. The kidneys are, therefore, unable to excrete waste products including potassium, creatinine and urea and the patient becomes hyperkalaemic and azotaemic. The cardiac cell resting membrane potential relies on high levels of intracellular potassium and low levels of extracellular potassium. This gradient is reduced in hyperkalaemia and the resting membrane potential becomes less negative, which slows the inward sodium current required for depolarisation, and leads to bradyarrhythmias. Changes progress with the severity of the

Tip
There is a misconception that fluid administration should be delayed until after the urethral obstruction is relieved. However, if the cat is hypovolaemic, prompt treatment with a bolus of fluids can be life saving.
hyperkalaemia as shown in Table 1. Bradyarrhythmias decrease cardiac output causing severe shock, and may result in cardiac arrest if left untreated. Hyperkalaemia is treated with drugs as summarised in Table 2. Typically, calcium gluconate is used for immediate cardioprotection. However, this does not lower serum K+ therefore either dextrose plus neutral insulin, or dextrose alone, is given concurrently. If insulin is used, it is essential to supplement intravenous fluids with glucose and to monitor blood glucose frequently for the next 12 h or until the patient is stable, as there is a real risk of severe hypoglycaemia.

Many cats are dehydrated at presentation, secondary to vomiting and anorexia. Dehydration is fluid loss from the interstitial space. With severe dehydration (>8%) the interstitial space becomes so fluid-depleted that fluid is lost from the

<table>
<thead>
<tr>
<th>Table 1: Typical ECG abnormalities seen with hyperkalaemia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Serum K+ concentration</strong></td>
</tr>
<tr>
<td>≥5.5–6.5 mmol/l</td>
</tr>
<tr>
<td>≥6.6–7.0 mmol/l</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>≥7.1–8.5 mmol/l</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>≥8.6–10.0 mmol/l</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>≥10.1 mmol/l</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: Drugs commonly used to treat hyperkalaemia and its associated clinical signs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drug</strong></td>
</tr>
<tr>
<td>10% Calcium gluconate</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>50% Dextrose</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Neutral insulin and dextrose</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
vasculature, leading to hypovolaemia and shock.

Hypovolaemic shock is treated with one or more intravenous boluses of isotonic crystalloid fluids. There is a common misconception that administration of fluids should be delayed until after relief of obstruction in case it increases pressure within the bladder causing rupture. However, hypovolaemic shock is immediately life-threatening whereas bladder rupture is not. Therefore it is not appropriate to withhold fluids if the cat is in shock.

In cats with a heart murmur or gallop rhythm fluids should be administered with caution. The fluid of choice is a balanced, isotonic crystalloid such as Lactated Ringer’s solution. Despite the fact that they contain a small amount of potassium, balanced solutions have been shown to allow more rapid correction of acid-base status in feline urethral obstruction than 0.9% sodium chloride.³

**Analgesia**

Analgesia is essential in this painful condition. The choice of analgesic depends on the patient’s cardiovascular status, the presence of comorbidities, and clinician preference. Commonly used analgesics include methadone and

**Tip**

Analgesia is **ESSENTIAL** for cats with urethral obstruction. It is extremely painful and the pain can contribute to further urethral spasm. Local techniques such as sacrococcygeal epidurals may be very effective.

---

**Figure 1:** Palpation of the space between the sacrum and the first coccygeal vertebra. Manipulation of the tail facilitates palpation of this space just cranial to the mobile coccygeal vertebra.

**Figure 2:** A spinal needle or 25 G 1 inch needle is inserted through the skin on the midline and advanced through the ligamentum flavum.

**Figure 3:** The syringe containing lidocaine is attached and aspirated to ensure no blood is obtained before injecting the contents. No resistance should be felt on injection.
buprenorphine. Butorphanol has a short duration of analgesic action and is considered a less effective analgesic than buprenorphine or methadone in cats.\textsuperscript{4}

Local or regional anaesthesia can provide useful adjunctive pain management. Anecdotally, using Intubeaze spray (Dechra, UK) or EMLA cream on the tip of the penis can reduce discomfort during placement of a urethral catheter. A sacrococcygeal epidural can also be performed in these patients, providing anaesthesia to the perineum, anus, colon, urethra and penis.\textsuperscript{5} In cats, the spinal cord ends cranial to the coccygeal space therefore the risk of puncturing it is low with this technique, although complications such as infection/abscessation and lidocaine toxicity may still occur. Preservative-free 2\% lidocaine is used (from a new or sterile vial) at a dose of 0.1–0.2 ml/kg. In the sedated patient, the sacrococcygeal space is palpated (Figure 1) and a needle carefully inserted (Figure 2) before attaching the syringe and injecting the contents (Figure 3). Clinical studies to evaluate the efficacy of this technique are under way, but in the author’s experience it can be a useful tool both to provide additional analgesia and to facilitate unblocking in the cat. Further details can be found in the original paper and online.\textsuperscript{5,6}

Non-steroidal anti-inflammatory drugs such as meloxicam are contraindicated in the acute stages of management of feline urethral obstruction, because of the risk of renal toxicity.

**Unblocking**

Obstruction is relieved by placement of an indwelling urinary catheter. Some clinicians advocate performing decompressive cystocentesis to reduce pressure within the urinary system as quickly as possible. However, the bladder wall in a blocked cat is typically unhealthy (Figure 4) and the risk of damage by cystocentesis may therefore be high. A recent study suggests this risk may be lower than previously supposed.\textsuperscript{7} Nonetheless, in most cats placement of a urinary catheter is uncomplicated and in the author’s opinion cystocentesis is typically unnecessary.

Most cats require sedation for urinary catheter placement. In obtunded patients the catheter can sometimes be placed without sedation while stabilisation is under way. The author’s preference is to use a standard benzodiazepine/ketamine combination intravenously, providing flow-by oxygen during the procedure. Ketamine should be

\begin{figure}
\centering
\includegraphics[width=0.8\textwidth]{Figure4.png}
\caption{The bladder of a cat with urethral obstruction at post-mortem examination. Thickening and inflammation of the incised bladder wall, and multiple embedded calculi are evident.}
\end{figure}
avoided in cats with known or possible hypertrophic cardiomyopathy (eg, with a heart murmur or gallop rhythm) as it can exacerbate dynamic outflow obstruction. It is essential to achieve a good plane of sedation. If this is not possible then general anaesthesia is recommended. Careful monitoring of sedation/anaesthesia, including frequent measurement of blood pressure using Doppler ultrasonography is very important. Hypotension (systolic blood pressure < 90 mmHg) should be treated with fluid boluses and/or treatment of hyperkalaemia associated bradyarrhythmias.

The perineum should be widely clipped and aseptically prepared (Figure 5). Whilst few cats will have bacterial infection at admission to hospital, many develop significant bacteriuria while the urinary catheter is in place. Therefore aseptic technique at placement and strict hygiene during hospitalisation are essential: a closed collection system is used to collect urine and sterile gloves are used if this system must be broached for any reason (for example, if the urinary catheter requires flushing).

Many types of urinary catheter are available, varying in material and design. Catheters made of more rigid material enable easier unblocking, but may cause more trauma during placement and irritation if left indwelling, although no comparative studies have been performed. Many clinicians use a relatively rigid catheter for initial unblocking, followed by a softer indwelling catheter. One retrospective study suggested a reduced risk of reobstruction with smaller catheter size (3.5 versus 5 French) although a prospective study is needed. Catheters may have an end-hole or a closed end with side-holes.

Retrohydropropulsion (see below) is more effective if performed using a catheter with an end-hole. Some catheters have a flange that can be directly sutured to the prepuce through pre-placed suture holes (Figure 6), whereas others are attached using adhesive (zinc oxide or Elastoplast) tape applied in a butterfly pattern and sutured to the prepuce (Figure 7).

Cats can almost always be unblocked without too much difficulty, although it can take patience and time. The obstruction is frequently at the tip of the penis and in some cases can be dislodged by gentle massage of the penis prior to placement of the catheter. Once the tip of the catheter is within the
penis, the prepuce should be pulled caudally and dorsally to straighten the distal urethra and facilitate passage of the catheter (Figure 8). Good analgesia and sedation (or general anaesthesia) are essential for success. If catheterisation is proving difficult then sedation/anaesthesia should be deepened as a first step. It sometimes helps to change the cat’s position (eg, from lateral to dorsal recumbency). Using a different type of urinary catheter (or even an intravenous catheter with the stylet removed or an olive-tipped catheter) can help in difficult cases. When an obstacle is encountered past which the catheter cannot be advanced, retrohydropropulsion can be helpful. Descriptions of this technique are available online.10 Once the catheter is sutured in place, the bladder is fully emptied and gently flushed using copious sterile saline to rinse inflammatory debris clear. Complications of urinary catheter placement include urethral rupture or stricture, and infection. An Elizabethan collar must be placed before recovery from sedation, and should be worn at all times until the urinary catheter is removed.

Tips for successful urethral catheterisation
- Provide adequate analgesia and sedation/anaesthesia.
- Be patient, gentle and slow to avoid iatrogenic damage to the urethra.
- Massage the penis prior to catheter placement to dislodge debris.
- Straighten the distal urethra by pulling the prepuce dorsally and caudally.
- Change the cat’s position if catheterisation is difficult (eg, from lateral to dorsal recumbency).
- Retrohydropropulsion using a catheter with an end hole can help dislodge an obstruction.
**Post-obstructive nursing care**

Careful nursing is essential in the post-obstructive period. Opioid analgesia is typically continued at least until removal of the urinary catheter, and preferable after, and the patient should be assessed for adequacy of analgesia. Intravenous fluids are continued until azotaemia has resolved and urine is clear and then tapered. Urine output is usually measured every 2–4 h and, once any hypovolaemia and dehydration are resolved, the rate of fluid administration is adjusted at each urine output measurement to match output over the preceding 2–4 h (‘matching ins and outs’). Cats commonly develop post-obstructive diuresis (increased urine output after relief of obstruction) and may require disconcertingly high fluid rates. It is particularly important to carefully quantify and match ins and outs in these patients as they are at risk of dehydration and hypovolaemia if inadequate fluid is given. If urine output drops unexpectedly, blockage or kinking of the urinary catheter should be excluded by inspecting the catheter and palpating bladder size. If the catheter is blocked, it should be disconnected from the collection system and flushed using sterile saline and aseptic technique. If it is kinked, repositioning and reattachment to the cat may be required. If no catheter problems are found and the bladder is small, true oliguria or anuria secondary to acute kidney injury is suspected.

The optimal duration of urinary catheterisation is unknown. Common sense suggests that the catheter should remain indwelling until the urine is clear of inflammatory debris, and any post-obstructive diuresis has resolved. Urine appearance should therefore be monitored and recorded. Ideally, the sediment should be examined microscopically each day both for the presence of inflammatory debris, and the development of any bacteriuria. In the author’s experience the catheter can usually be removed after about 48 h.

Stabilisation of cats with feline urethral obstruction can be rewarding and is typically successful with a high survival to discharge. However, our understanding of this condition is still limited, and treatment is largely opinion rather than evidence based.

**References**

Feline osteoarthritis 2: managing the cat with painful osteoarthritis

A multimodal approach is necessary to manage the arthritic cat. Controlling pain is important, but so is adapting the environment. Chronic pain will disturb the cat’s ability to perform its normal behaviours and lifestyle patterns and this can become a significant ‘stressor’ for the cat, possibly exacerbating other medical problems. Addressing this by making changes within the home environment is believed to help improve the cat’s quality of life and again this is where the nurse, in collaboration with the veterinarian, can play a significant role in advising and guiding the owner. It is important that the practice takes an active interest in the arthritic patient and its response to therapy; routine re-examinations are important and the veterinary nurse can often be a key contact person for the concerned owner.

Non-steroidal anti-inflammatory drugs
Non-steroidal anti-inflammatory drugs (NSAIDs) are the most commonly used drugs to control the pain associated with OA in all species; they work primarily by reducing the level of PGE₂, an important mediator of inflammation, within the joint. Meloxicam is the

Recognition of osteoarthritis was discussed in Part 1 of this article Feline osteoarthritis 1: what is it and how can the veterinary nurse help in its recognition? published in Feline Focus 2015; 1(10): 349–358.
A closer look at... only NSAID licensed for long-term use in the cat, although there are some countries where even this drug is not licensed. The liquid formulation makes accurate dosing easy to achieve, particularly if the provided syringe is used. The veterinary nurse is well placed to demonstrate how the drug should be administered. It is highly palatable and is generally mixed with the cat’s food. NSAIDS are potentially toxic drugs and it is recommended to titrate to the lowest effective dose based on the clinical response as assessed by a veterinary physical examination and by regular review of the owner questionnaire (see Table 2 in previous article — *Feline Focus* 2015; 1[10]: 353). Median daily maintenance doses of 0.01–0.03 mg/kg have been shown to be effective,2,3 (well below the manufacturer’s recommended dose of 0.05 mg/kg).

Since it is mainly older cats that suffer with OA, it is possible that other concomitant diseases are present which may increase the potential toxicity of the NSAID. It is recommended that routine blood and urine tests are carried out to assess the general health status of the cat (especially screening for the presence of any liver or kidney disease). In a recent study 36.5% of cats with OA had pathological evidence of chronic kidney disease.4 In cats with pre-existing hepatic or renal disease it is advisable to start treatment at a dose lower than the recommended dose of meloxicam (eg, 0.02–0.03 mg/kg/day) and gradually increase the dose if necessary and with very careful monitoring. If the animal is overweight the dose of meloxicam should be based on the ideal weight rather than the actual weight of the animal. If the cat is receiving any other drugs for treating other diseases, the initial dose of the NSAID should be reduced by 50% to avoid any possible toxic effects created by drug competition for protein binding within the blood (although this is seldom a problem in the clinical setting). Monitoring blood pressure in older cats receiving NSAIDs is also recommended.5

Since chronic kidney disease is common in older cats with OA, it is important that the cat is always well hydrated, so it is advisable to feed moist diets to cats receiving long-term NSAIDs (Figure 1).

Owners should be made aware of the possible side-effects and told to contact the practice immediately if any appear. Vomiting and diarrhoea are common and occur in about 4% of cats receiving meloxicam.6,7 If these signs continue for more than 2–3 days the drug should be stopped. It can be re-introduced 3–5 days later at a lower dose or an alternative management protocol selected. Gastrointestinal protectants can be used in combination with the NSAID, although this is generally not...
necessary. NSAIIDs can cause gastrointestinal bleeding which is a more serious effect. If there is evidence of such bleeding in the vomit or faeces, the drug should be discontinued permanently. If the cat stops eating the NSAIID should be stopped immediately.

Despite the widespread concerns that veterinarians have with the potential toxic effects of NSAIIDs in cats with chronic kidney disease, long-term meloxicam can improve renal function in cats with chronic kidney disease. Another study showed that long-term meloxicam did not affect the longevity of cats with chronic kidney disease and OA, and that the most common cause of death in these cats was neoplasia, only 11% being attributed to chronic kidney disease.

Cats receiving long-term meloxicam must be monitored regularly. Routine blood and urine analysis should be carried out every 3-6 months depending upon the health status. Reappraisal of the health questionnaire can be done at the same time.

Other analgesic drugs (including combinations) can be used to control the pain of OA, but are subject to prescribing restrictions since they are not licensed for use in the cat and side-effects can be problematic.

**Glucosamine and chondroitin sulphate**

There are several oral preparations of glucosamine and chondroitin (generally with other additives such as minerals and antioxidants) which are categorised as nutraceuticals. Their use was initially based on the fact that they are involved in the synthesis of articular cartilage and increasing their daily intake might help the repair of damaged cartilage, or at least slow its degradation. They might have an anti-inflammatory and analgesic effect as well, possibly by reducing cartilage breakdown products being released into the joint cavity (which are instrumental in inducing synovial inflammation). There is some evidence that these compounds can improve mobility in cats with OA.

These nutraceuticals can be used in combination with meloxicam, although many veterinarians prefer to use them as an alternative to meloxicam as they are much safer. However, the analgesic effect of meloxicam is far superior to that of glucosamine and chondroitin.

There are issues with the regulation and quality control of these products and the ideal dose is unknown. It is advisable to only use products marketed by reputable veterinary manufacturers. Side-effects are rare (although minor gastrointestinal upset has been reported).

Polysulphated products are used by some clinicians; the most commonly used is pentosan polysulphate which is given parentally (although it is not licensed for use in the cat). It is wise...
A closer look at...

not to use these products if the cat is receiving NSAIDs as they have an anticoagulant effect which may potentiate any gastrointestinal bleeding caused by a NSAID.

**Omega-3 essential fatty acids**

Increasing the dietary intake of omega-3 fatty acids (relative to omega-6) will result in higher levels of omega-3 fatty acids in the cell membranes, which in turn reduces the amounts of pro-inflammatory mediators produced within the joint (PGE2 and LTB4). There are several specific omega-3 rich preparations available, but the most common way of administering these nutrients is by feeding special complete diets containing increased levels of these fatty acids.

There is evidence that these diets can improve owner assessed activity levels in arthritic cats.12 The main omega-3 fatty acids important for the cat are docosahexaenoic acid and alpha-linolenic acid; other ingredients are often included in the diet, eg, antioxidants, glucosamine and chondroitin. These diets can be used in combination with meloxicam and the moist form of the diet should be fed.

The use of diets rich in essential fatty acids does not appear to increase the risk of weight gain. These diets are also acceptable to use in cats with chronic kidney disease and OA rather than using a prescription diet specifically for kidney disease.

In those cats with diabetes and OA, the essential fatty acid-rich diet should not be used. A metabolic diet for diabetes should be used instead.

Green lipped mussel extract is popular with some clinicians in managing OA. Its mode of action is uncertain although the extract contains glucosamine, chondroitin,

---

**Weight reduction**

It is not clear whether obesity is a risk factor for feline OA or not. Only about 14% of older cats with OA are obese,6 although it is possible that some of these cats could have been obese when younger and the obesity contributed to the joint disease at that time. The classic reason given for why obesity is detrimental to joints is the increased loading that it produces, particularly during jumping and landing. However, obesity is also important for another reason; excessive fat deposits are known to produce increased amounts of lipokines in the blood (such as leptin and adiponectin) which are known to cause cartilage degeneration.13,14

If a cat with OA is obese then an initial attempt should be made to reduce its weight. This involves the use of reducing diets15 and, in cats with clinical OA, should always be attempted before commencing more specific therapies. However, weight loss in cats is not easy to achieve. The veterinary nurse is ideally placed to supervise weight reduction clinics and to provide essential owner support.
antioxidants and omega-3 fatty acids.

**Environmental modification**
As chronic arthritic pain results in many changes to the cat's behaviour and lifestyle, modification of the animal’s environment must always be considered in order to help overcome some of the difficulties and thus improve the physical and psychological welfare of the cat.\(^1\)\(^{16-18}\)
Modification of the environment can be fairly straightforward and is often based on common sense. The veterinary nurse with an interest in musculoskeletal disease is ideal to advise and encourage the owner using the guidelines below. A visit to the owner’s home might be useful in order to assess what modifications could be introduced.

**Improving security**
Cats are highly territorial and must feel secure in the core territory (owner’s home and immediate outside environment) and this security can be challenged if they are in pain and showing reduced mobility. The cat must have a place to hide where it can enjoy some ‘quiet time’ and, ideally, more than one access route to and from its core territory. Hiding places may just be simple cardboard boxes or more luxurious igloo beds (Figure 2). Major disturbances such as the introduction of additional pets should be avoided as this can cause anxiety and stress.

**Steps and ramps**
The vertical dimension is important to cats for observation and perching (Figure 3). The provision of steps or ramps (Figure 4) or moving furniture (Figure 5) to facilitate access to beds, sofas, window ledges and other favourite resting places is important. Cat flaps may need

---

**Tip**
Environmental modifications can be simple and inexpensive but make a great difference to an arthritic cat. Nurses should advise owners of arthritic cats and perhaps even visit their home to assess and discuss necessary modifications.

---

Figure 2: Environmental enrichment is an important part of managing a cat suffering arthritic pain. Cats must feel secure in their environment and the provision of ‘hideaways’ where the cat can seek seclusion and feel secure is important. These can be sophisticated igloo beds as shown here or simple converted cardboard boxes.

Figure 3: The vertical dimension is very important for cats who like to climb and perch at their preferred sites, be it the bed, sofa, window ledge, etc, where they feel safe and secure and can observe their environment without disturbance. The arthritic cat finds it difficult to reach these favourite resting places.
A closer look at...

**Figure 4:** The use of ramps and steps (which can be home-made or purchased) can help the cat to reach its favourite high point (*photograph courtesy of Drs Foster and Smith from www.DRSFosterSmith.com*)

**Figure 5:** Moving furniture to provide stepped access will also help the cat reach its preferred spot (*photograph courtesy of Deb Given*)

**Figure 6:** Arthritic cats often find it difficult to adopt a comfortable position for urination and defaecation. Litter trays should be easily accessible and of a generous size. This tray is made from a horticultural seedling tray (*photograph courtesy of Sarah Heath*)

**Figure 7:** Arthritic cats can also find it difficult to use scratching posts. As they become less active their claws can become overgrown. Ensuring easy access to scratching posts is important. A home-made version comprising a cardboard scratchpad in a wooden box is shown here (*photograph courtesy of Deb Given*)

alteration, eg, reducing the height of the flap from the floor, increasing its size and ensuring the closing mechanism is not too rapid.

**Access to essential resources**

There should be at least one litter tray per cat in the household and the litter should be sufficiently deep. Litter trays must be generous in size and easily accessible for a cat with mobility problems who that find it difficult to adopt the typical posture required for urination and defaecation (Figure 6). Several food bowls can be distributed throughout...
the home and hiding food bowls can encourage activity and mental stimulation. More than one water bowl should be provided and these should be shallow in design and should not be placed adjacent to food bowls. Raising food and water bowls may help where there is stiffness in elbows, shoulder or spine. Padded, comfortable bedding should be provided and stable scratching facilities made available (Figure 7).

**Interaction and exercise**
The owner should be encouraged to interact with the cat and engage with play for several minutes on at least three occasions each day (or according to the wishes of the individual cat), again to encourage exercise and mental stimulation. Encouraging the cat to play with different toys is likewise helpful (Figure 8A–D) and some cats may be amenable to exercise outdoors on a leash or harness (Figure 8E). Tickling the cat around the head is useful, since this releases a variety of neurotransmitters that can improve the cat’s mood and ability to cope with pain. Regular grooming of the cat (several times a day) will have a similar effect (Figure 9).

**Pheromone therapy**
Products containing feline facial pheromone (F3 fraction [Feliway; Sanofi] and F4 fraction [Felifriend; 1(11) feline focus 389

---

Figure 8: Playing with different toys provides mental stimulation and encourages exercise, helping to strengthen muscles, all of which is useful for improving the arthritic cat’s quality of life. A wide range of feeding devices and play toys is commercially available such as the SlimCat treat ball (A), Catit Design Senses Play Circuit and Scratch Pad (B) and Catit Activity Turn Around (C). An egg carton ‘puzzle box’ containing kibble (D) is a simple and practical alternative. For the non-free roving cat, mental stimulation and exercise may be provided via lead walks (E) (photographs A, D and E courtesy of Deb Given and photographs B and C by courtesy of Sarah Ellis)
A closer look at...

Sanofi can be used to help remove stress and anxiety such as might be experienced by a cat in chronic pain. Although these products are generally used in the veterinary clinic, they can also be used in the owners’ home; Feliway is available as a spray or a diffuser which is inserted into an electrical socket.

**Physical therapy**

Physical therapy is best designed and supervised by a trained animal physiotherapist, particularly if advanced techniques are to be used such as laser therapy or hydrotherapy. However, simple range of motion and massage techniques can be taught to owners and these can help alleviate muscular pain that is often associated with OA and improve joint mobility. This will also help to promote interaction between owners and their cats.

**Surgical treatment**

Although many surgical treatments have been advocated, they are of limited application to the feline patient. Multiple joint involvement is common in the arthritic cat and surgical targeting of individual joints is of limited benefit.

**Other therapies**

Autologous, adipose-derived mesenchymal stem cell therapy is available in the USA, Australia and some European countries. There are still many questions surrounding the efficacy of this treatment and its advisability. Although referred to as stem cell therapy, a more accurate description is ‘cell-based therapy’ since the majority of cells which are injected into the animal’s joint are not stem cells.

The intra-articular injection of platelet-rich plasma or platelet concentrate has also been used by some authorities. An anti-nerve growth factor monoclonal antibody is being developed for use in the cat for controlling pain, with some initial encouraging results.

Acupuncture is also advocated as a therapy for feline OA, but evidence-based case studies are lacking.

**References**

2. Gunew MN, Menrath VH and Marshall RD. Long-term safety, efficacy and...
383-392 Bennett-OA2.qxp_FF Layout1 14/10/2015 15:13 Page 9

A closer look at...

FREE WEBINARS

Kindly sponsored by Royal Canin

As a nurse/technician member of the International Society of Feline Medicine (ISFM), you are entitled to free registration for the society’s webinars and to use the online library of webinars at any time.

All members are emailed details of how to register for upcoming webinars.

Details also appear online at: www.icatcare.org/nurses.
How to choose the correct sample tube

Haematology, biochemistry, assessment of coagulation and serology, are routine diagnostic procedures in veterinary practice. Selection of the appropriate blood tube is a critical first step in sample collection, and as important as selection and interpretation of the relevant tests. The present article considers the general principles of specimen collection and handling. It then looks at the purposes of the various tubes that are commonly used, namely EDTA, heparin, citrate, fluoride oxalate, and plain tubes, and any potential pitfalls associated with their use. It also covers those tubes used to measure the activated coagulation time (ACT) and fibrin/fibrinogen degradation products (FDP).

Accurate and meaningful clinical pathology results require that specimens be collected, handled, submitted and processed in an appropriate manner. This begins with selection of the correct blood tube, which is commonly the role of the nurse or technician, and the management of the patient.

Collecting the sample
Whenever possible, samples should be collected from cats that have been fasted for 6 h (overnight). Non-fasted samples, ie, those that are post-prandial (after feeding) are likely to have lipaemia, which can interfere with the measurement of some biochemistry tests and artefactually increases the refractometer protein (total solids, TS) concentration. There is also likely to be a post-prandial hyperglycaemia.

Another consideration is the process of venepuncture itself. Stress should be minimised by using appropriate cat friendly restraint. The ‘stress’ of restraint and blood collection is associated more with the release of adrenaline than cortisol. Some of the effects of adrenaline include increased heart rate, contraction of...
How to...

**Tip**
Try to minimise ‘stress’ to the patient when collecting the sample as this may affect the results of certain tests.

the spleen with increased packed cell volume (PCV, haematocrit), haemoglobin concentration, red blood cell (RBC) count, and hyperglycaemia.

Most types of blood tube come in a variety of sizes and most modern analysers require a very small volume of blood for most tests. The total volume of blood required should be determined before collection commences, so that the appropriate size of syringe is used. All of the tubes required should be ready at hand.

**Filling the tubes**
When filling vacutainer-type tubes with blood collected into a syringe and needle, perforate the stopper with the needle and allow the tube to draw the sample in, do not physically inject the blood into the tube. When multiple tubes are to be filled using the same needle, it is recommended to fill them in the order: plain (with or without a clotting activator), sodium citrate, heparin, EDTA, and fluoride oxalate.

When filling blood tubes from which the lids/stopper have been removed, discard the needle (into a ‘sharps’ container) and gently express the blood from the syringe, until it reaches the ‘fill mark’ on the side of the tube. The latter is likely to be well below the total volume that could be placed in the tube. If the ‘fill mark’ is grossly exceeded, the blood will likely clot (possibly while in transit to the laboratory), because the volume of blood has overwhelmed the quantity of anticoagulant in the tube.

In all situations, tubes with an anticoagulant or a procoagulant should be gently inverted several times, immediately after addition of the sample, to ensure adequate mixing. For plain tubes that do not contain a clotting activator, allow 20–30 minutes to clot fully before centrifugation. Stand the tube up vertically during this time.

Plasma and serum are separated from cells by centrifugation for 10–15 minutes at 1300–1800 g. The corresponding revolutions per minute (rpm) value will vary with length of the rotor arm of the centrifuge. It is preferable to use a plastic pipette to harvest the plasma or serum. Transfer into a plain plastic tube (one without anticoagulant or procoagulant) for storage at 4°C until analysed, preferably within 24 h.

All tubes must be clearly labelled at each step of collection and processing. This should include the owner’s name, animal’s identity and date (and possibly time) of collection. Ensure that all relevant paperwork is also completed fully before submitting the samples for analysis, regardless of whether the tests are being performed in-house or at a referral laboratory.

**Tip**
Fill tubes to the correct level: putting more blood into the tube than required may result in clotting in transit.
Anticoagulant tubes

EDTA tube (haematology)
The top of an EDTA tube is usually a pink or lavender colour (Figure 1). These tubes are used primarily for haematology.

Ethylene diamine tetraacetic acid (EDTA) acts as an anticoagulant by chelating calcium ions and thus interfering with the coagulation cascade. It is adherent to the inside of the tube and is usually a sodium or potassium salt. Because of the latter, if an EDTA tube is grossly under-filled, RBC will shrink (‘desiccate’), resulting in a spurious decrease in the sample's PCV (haematocrit) and mean corpuscular volume (MCV; average size of RBC) and a spurious increase in mean corpuscular haemoglobin concentration (MCHC). Note that the actual RBC count is not affected.

Specimens are collected into EDTA tubes for:
- haematology (also known as haemogram, complete blood count, full blood examination);
- examination of body fluids (including cell counts, cytology and TS measurement);
- PCR tests;
- Coombs’ test;
- RBC for cross-matching blood samples;
- blood lead concentration (measured on whole blood by atomic absorption spectrophotometry).

Some laboratories prefer EDTA plasma for measurement of ACTH and cortisol concentrations. Some biochemistry tests can be performed on EDTA plasma, such as glucose, urea and creatinine, however, the latter are usually run on serum or heparin plasma. EDTA plasma cannot be used for the measurement of calcium, because its strong chelating property sequesters the calcium, rendering it undetectable. Furthermore, because EDTA is either a sodium or a potassium salt, measurement of these electrolytes on EDTA plasma will produce spuriously increased results.

Heparin tube (biochemistry)
The top of a heparin tube is usually green in colour (Figure 2). These tubes are usually used for biochemistry.

Heparin acts as an anticoagulant by potentiating the inhibition of thrombin by antithrombin and thus interfering with the coagulation cascade. It is usually present as a lithium or a sodium salt.
Haematology is not usually performed on feline blood collected into a heparin tube because the anticoagulant interferes with the staining characteristics of cells.

Blood collected into a heparin tube can be used for:
- measurement of RBC parameters, including PCV, haemoglobin concentration, RBC counts, and for total leukocyte counts.

Ensure that the tube is not grossly under-filled, to avoid potential spurious results for PCV, MCV and MCHC (as above).

And following centrifugation (to produce plasma) tests performed on heparin samples include:
- biochemistry;
- electrolytes;
- cortisol and thyroxine.

Under-filling of a heparin tube, while not recommended, should not interfere with such biochemistry and hormone tests.

Citrate tube (coagulation studies)
The top of a citrate tube is usually blue in colour (Figure 3). These tubes are used for coagulation studies.

Citrate acts as an anticoagulant by chelating calcium ions. It is present in solution (3.2%, 0.109 M) as a sodium salt. Citrate is a weaker chelator than EDTA and the anticoagulant effect is therefore readily reversible in vitro.

The citrate tube is used for the assessment of cases in which a coagulopathy is suspected. Tests that are run on citrate samples include:
- activated thromboplastin time (APTT) and prothrombin time (PT): most commonly for the diagnosis of anticoagulant rat-bait poisoning, but also in the initial stages of most other coagulopathies;
- thrombin time (TT): not commonly assessed in cats;
- specific clotting factor activity, eg, Factor VIII in the diagnosis of haemophilia A;
- von Willebrand factor activity/concentration: for the diagnosis of von Willebrand disease;
- fibrinogen concentration: not commonly assessed in cats;
- D-dimer concentration: for the
diagnosis of disseminated intravascular coagulation (DIC).

These tests may be performed on whole blood or plasma, depending on the instrument/method being used.

Because sodium citrate is present as a liquid, it is important to fill the tube to the correct level. Underfilling the tube will result in dilution of the clotting factors, potentially spuriously prolonging the various clotting times or decreasing the concentration of clotting factors.

Sodium citrate tubes are meant to contain one part anticoagulant with 9 parts blood. Therefore, a 2 ml tube will contain 0.2 ml citrate to which is added 1.8 ml blood, while a 3 ml tube will contain 0.3 ml citrate to which is added 2.7 ml blood and so on. If it is anticipated that the venepuncture may be a slow process, it is possible to add the citrate solution to the needle and syringe before collecting the sample, thereby anticoagulating the specimen as it is collected. Ensure that the correct ratio of anticoagulant to blood is used. Place the collected sample into a plain plastic tube and clearly mark the tube as containing a sodium citrate sample.

**Fluoride-oxalate tube (glucose measurement)**

The top of a fluoride-oxalate tube is typically grey or sometimes black (Figure 4). These tubes are used for glucose measurement.

Fluoride-oxalate tubes are recommended for the measurement of blood glucose, when there will be a delay of more than an hour between collection and processing (centrifugation and harvesting of the plasma). They contain potassium oxalate, which acts as an anticoagulant (by chelating calcium ions), and sodium fluoride, which inhibits cellular metabolism. The latter prevents the cells within the blood sample from utilising glucose and thereby decreasing the glucose concentration. For comparison, the glucose concentration in a sample that has been collected into a heparin tube can decrease by up to 10% each hour that it remains as whole blood at room temperature. Storing a heparin sample at 4°C before centrifugation will markedly reduce, but not eliminate, cell metabolism.

The collection of a sample into a fluoride-oxalate tube not only prevents cellular utilisation of glucose, but also the production of lactate. However, with the advent of ‘point of care’ instruments for the measurement of blood glucose and lactate, testing is immediate, thus negating the need for fluoride-oxalate tubes.

**Other blood tubes**

**Plain tube (biochemistry)**

The top of a plain tube is typically black, although sometimes it is white (Figure 5a). These tubes are used for biochemistry. When processed (centrifuged) they produce serum. Plain tubes contain no
How to...

anticoagulant. Blood samples will therefore clot after being placed in these tubes. However, the speed of clotting is inversely proportional to ‘physical trauma’ at the venepuncture (ie, the degree to which the coagulation cascade was activated when the sample was collected). This may vary from a few to 30 minutes or more. To facilitate clotting, some plain tubes contain a ‘clotting activator’ (Figure 5b).

It should be noted that plain tubes, while ‘clean’, are usually not sterile. Plain tubes that are guaranteed to be sterile are available for microbiological specimens. Centrifugation of clotted blood produces serum. For most biochemical tests, there is no difference between the concentration of the substance being measured in plasma or serum. The most notable exception is total protein (TP). Plasma TP is greater than serum TP, because the former contains the clotting factors, while the latter is devoid of them. The clotting factor that accounts for most of this difference is fibrinogen. However, calculation of the difference between the TP concentration of plasma and serum is not an accurate way to measure the fibrinogen concentration.

Figure 5: Plain tubes

(a): Plain tubes that do not contain a clotting activator can be used to store plasma or serum samples after they have been harvested

(b and c): Plain tubes with clotting activator. When a clotting activator is added to a plain tube, the time for coagulation of the sample is markedly shortened. Such tubes cannot be used to store plasma samples

Key point

Plain tubes produce serum and for most tests there is no difference between serum and plasma. The exception is total protein which is higher in plasma due to the fibrinogen.

Serum may be used for all routine biochemistry tests, including electrolytes.

Serum is mandatory for some tests (and the laboratory should be consulted for their requirements in this regard). Such tests include:

• **trypsin-like immunoreactivity** (TLI), for the diagnosis of exocrine pancreatic insufficiency;
• **bile acid concentration**;
• **serum protein electrophoresis**, for the separation of α, β and γ globulins;
• **serology**, usually for the measurement of antibody titres;
• **many therapeutic drug tests**.
Serum separating tube (SST)
These are plain tubes that contain a clotting activator and a gel (Figure 6). Provided that the cat has normal clotting factor activity, these tubes cause the sample to clot within minutes of collection.

When the tube is centrifuged, the gel layer ‘rises’ to separate the cells from the serum. SST may be used for the same purposes as plain tubes with a clotting activator, although they are not recommended for measurement of therapeutic drugs as the gel may interfere with some such tests (eg, phenobarbitone).

Activated coagulation time (ACT) tube
The ACT tube (Figure 7) contains a procoagulant substance, called diatomaceous earth, which is visible as a grey powder in the tube. It is a contact activator of the intrinsic pathway of the coagulation cascade. Use of the ACT tube according to the manufacturer’s directions standardises the activation of the cascade. If the ACT is prolonged (the patient’s result is greater than the reference interval for the test), it suggests a deficiency or inhibition of one or more of the clotting factors in the intrinsic and common pathways, namely XII, XI, IX and VIII, and X, V, II (thrombin) and I (fibrinogen), respectively. The ACT may also be prolonged by marked thrombocytopenia.

Fibrin/fibrinogen degradation products (FPD) tube
Measurement of FDP, for the diagnosis of disseminated intravascular coagulation (DIC), requires the use of a special collection tube. It contains a procoagulant (batroxobin), which is obtained from the venom of a snake (Bothrops atrox) and an inhibitor of fibrinolysis (soy bean trypsin inhibitor). This ensures that the FDP concentration of the sample does not increase after collection. The test is rarely used in clinical practice. It has been replaced by the d-dimer assay, which has less stringent collection requirements.

Key point
The ACT tube is a practical in-house test of the coagulation cascade.
Recordings of sessions at the ground-breaking pre-congress day on feline fertility and population control are now freely available to view at:

www.icatcare.org/vets/videos
Ethylene glycol poisoning is extremely serious in cats. A small dose can result in signs which are initially non-specific and may be easily missed. Ethanol is the antidote to ethylene glycol toxicity and works by preventing metabolism to toxic compounds. However, it is generally only worthwhile if started within a few hours of ingestion. Although a potentially lethal dose of ethylene glycol can be survived if treatment is prompt, many cats with ethylene glycol poisoning present late and as a result most cases have a fatal outcome.

Ethylene glycol (also known amongst other names as ethanediol) is a common ingredient of antifreeze; it is also found in some screenwashes or more rarely de-icers (Figure 1). Most antifreezes contain ethylene glycol (or occasionally methanol), and are liquids which are added to water in engine radiators to prevent freezing and improve cold weather performance. The usual final dilution is approximately 1:1.

Exposure
Cats may be exposed by drinking neat antifreeze from a spill, but are more commonly exposed after drinking the diluted fluid from drained vehicle radiators. Most exposures are not witnessed.

Nicola Bates
BSc (Brunel) BSc (Open) MSc MA
Nicola Bates has worked in human and veterinary toxicology for 25 years and has been with the Veterinary Poisons Information Service (VPIS) since it started. As well as providing emergency advice via the telephone she has written extensively on veterinary toxicology. In addition to service provision, she is involved in training of VPIS staff and veterinary professionals. She is currently the congress abstract editor for the European Association of Poisons Centres and Clinical Toxicologists (EAPCCT).

Key point
As with many poisoning cases in cats, ingestion is rarely witnessed. Prevention by informing owners of the dangers of leaving antifreeze around is far preferable, as mortality from ingestion is high.

Mechanisms of toxicity
The major toxic agent in ethylene glycol poisoning is not the parent compound but the metabolites produced by the action of alcohol
dehydrogenase (Figure 2). This enzyme oxidises ethylene glycol to glycoaldehyde. This is then metabolised to glycolic acid which appears to be the principle cause of the acidosis observed with ethylene glycol toxicity. Further metabolites of glycolic acid are glyoxylic acid and then oxalate; the latter causes renal damage and hypocalcaemia by binding to calcium to form calcium oxalate (crystals of which may be present in urine).

**Toxicokinetics**
Ethylene glycol is rapidly absorbed from the gastrointestinal tract; in cats the peak plasma concentration occurs about 1 h after ingestion and the urine concentration peaks about 3 h after ingestion.¹

**Toxic dose**
Cats are more susceptible to ethylene glycol than dogs and signs progress more rapidly, but it is not clear why. It may be that toxic metabolites are eliminated more slowly, or metabolites are metabolised more rapidly to other more toxic compounds.¹

The lethal dose of ethylene glycol in cats is commonly reported as 1.5 ml/kg.² In another study 1 g/kg (where 1 ml is approximately 1 g) was fatal to cats within 48 h, whereas this dose did not affect rats, rabbits or guinea pigs.³ Undiluted ethylene glycol-containing antifreezes generally contain 95% or more, with ‘ready to use’ products being approximately 50%.
How the antidotes work

The aim of antidotal therapy in the management of ethylene glycol toxicosis is to prevent formation of the toxic metabolites (Figure 2). This is achieved through administration of ethanol or fomepizole (4-methylpyrazole, 4-MP), both of which are competitive inhibitors of alcohol dehydrogenase, with a higher affinity for the enzyme than ethylene glycol. Fomepizole is the more potent inhibitor. Inhibition of ethylene glycol metabolism allows time for renal excretion of the unchanged parent compound.

In the study by Connally et al., cats only survived lethal doses of ethylene glycol if treated with fomepizole or ethanol at or before 3 h. In an earlier study, of nine cats given lethal doses of ethylene glycol (4, 6 or 8 ml/kg) and treated with ethanol at 4 h, five (55.5%) survived compared to only one (8%) survivor of 12 cats treated at 8 h. These studies therefore suggest that survival is most likely in cats if treatment with ethanol or fomepizole is started within 3–4 h of ingestion.

Fomepizole is effective in cats but the drug is expensive and the cost of treatment is cats is increased further because they require a much higher dose (6 x dose) than dogs or humans. In addition, this high dose causes sedation, ataxia and hypothermia in cats. As a result ethanol is more commonly used and is much more readily available.

Clinical signs

In the early stages of ethylene glycol poisoning, which occurs from 30 minutes to 12 h, there are central nervous system signs due to unmetabolised ethylene glycol. These include vomiting, ataxia, tachycardia and weakness. These early signs may be easily missed, particularly in an outdoor cat. Polyuria, dehydration, tachypnoea, acidosis and hypothermia may occur. Polydipsia, although common in dogs, is generally not seen in cats. Convulsions can occur at this stage in severe cases.

From 12–24 h cats remain depressed and develop cardiopulmonary signs with tachypnoea, tachycardia, acidosis, hyper- or hypotension, pulmonary oedema, arrhythmias, congestive heart failure and circulatory shock. Cerebral oedema may occur. Death can occur at this stage in some cases.

Renal system signs including oliguria, azotaemia and/or uraemia develop and the renal impairment exacerbates acid/base and electrolyte disturbances. Kidneys may be swollen and painful and there may be vomiting, anorexia, oral ulcers, severe depression, lethargy, coma and convulsions due to uraemia.

Laboratory changes

There is raised urea and creatinine, which is generally seen from about 12 h in cats, low urine specific gravity (due to osmotic diuresis induced by ethylene glycol), proteinuria, glucosuria, haematuria and albuminuria. Calcium oxalate crystals can appear in the urine within 3 h of ingestion (Figure 3), but the absence of oxalate crystals does not
rule out ethylene glycol poisoning. There may also be hyperglycaemia, hypocalcaemia (due to binding of calcium to oxalate), hyperphosphataemia and hyperkalaemia (due to acute kidney injury and acidosis). Clinical signs of hypocalcaemia generally do not occur in ethylene glycol poisoning because of the shift to the active, ionised form of calcium when metabolic acidosis occurs.6,8

There is acidosis, typically with a blood pH of <7.3 and acidic urine with a pH <6.5.9 The blood pH and plasma bicarbonate are decreased by 3 h after ingestion, and markedly decreased by 12 h.7 Neutrophil leukocytosis may also be observed.6

Prognosis
Prognosis should be based on an animal’s response to treatment,9 but the longer the time to treatment the less favourable the prognosis. Recovery may take 3–5 days if treated aggressively within a few hours of ingestion,4 but in most cases unless the ingestion was witnessed, animals usually present in the final stage of poisoning. Coma or acute renal injury indicates a poor prognosis.

In a study of 25 cases of ingestion of ethylene glycol in cats the mortality rate was 96%.10 In another report of 26 cats and 24 dogs with ethylene glycol poisoning only six animals (12%) survived. Half of the survivors were admitted within 12 h.6 In a review of all fatal cases of poisoning reported to the Veterinary Poisons Information Service (VPIS) the most common agent to result in a fatal outcome in cats was presumed to be (few cases had laboratory confirmation) ethylene glycol. Of 213 cats with suspected or confirmed ethylene glycol poisoning with known outcome, 38 died (17.8%) and 159 were euthanased (74.6); this is an overall fatality rate of 92.5%.11

Diagnosis
Diagnosis is generally based on history, clinical signs and laboratory findings. Ethylene glycol poisoning should be suspected in any animal with acute onset of signs, raised urea, creatinine and low urine specific gravity.9

Test kits are available for confirming ethylene glycol in blood but they have some limitations. Cats can be poisoned at concentrations below that detected by the kits (usually
500 mg/l) and some kits also give false positives in the presence of alcohol (such as ethanol). These kits only detect ethylene glycol not its metabolites. Therefore, in late presenting animals the test may be negative because the ethylene glycol has been metabolised or is below the limit of detection.

Many antifreeze products contain fluorescein (a green or red dye depending on the pH of the medium), which fluoresces under ultraviolet light. Sometimes the dye may be detected in urine or vomitus using a Wood’s lamp and examination of the paws, mouth and face may be useful. However, this is not a reliable test, as it is difficult to detect fluorescence in a test sample without a positive and negative control for comparison.

**Treatment**
The aim of therapy in ethylene glycol poisoning is to prevent metabolism and the production of toxic metabolites, reverse electrolyte and acid/base disturbances and maintain the glomerular filtration rate. Advice should be sought from a poisons information service and a specialist centre to optimise treatment of affected cats.

**Decontamination**
Treatment is recommended for any quantity but gut decontamination is probably only worthwhile within 1 h of ingestion. Adsorbents such as activated charcoal are not useful. In most cases cats do not present until the onset of signs, hours after ingestion.

**Monitoring, investigations and initial treatment**
In symptomatic cats the blood pH, electrolytes and renal function should be monitored. Intravenous fluids (2–3 times maintenance) are essential to ensure adequate hydration and therefore renal perfusion and to promote diuresis. If possible, the central venous pressure and urine output should be monitored in cats with acute kidney injury because of the risk of fluid overload and subsequent pulmonary oedema. If there is oliguria or anuria, diuretics such as mannitol or furosemide can be given if there is no response to fluid therapy alone. There is a significant risk of volume overload in cats with acute kidney injury and advice on treatment should be taken from a specialist and, ideally, the cat referred to a specialist centre. Peritoneal dialysis or haemodialysis can be used in acidotic cats with oliguria, but are rarely available.

Other treatments may include treatment of hyperkalaemia, management of nausea and vomiting and specific treatment of severe acidosis. Treatment of hypocalcaemia is rarely required.

**Antidotal treatment**
After ingestion of ethylene glycol the sooner antidotal therapy is started the better the outcome. A potentially lethal dose of ethylene glycol can be survived if treatment is prompt. Survival is most likely if treated within 3–4 h of ingestion. There is no point giving ethanol or fomepizole to block metabolism if the ethylene glycol has been metabolised. Unfortunately, cats

---

**Tip**
Antidotes must be given within 3–4 h of ingestion and, unfortunately, there is no point giving them to cats already suffering acute kidney injury.
Keeping cats safe

often present late by which time such antidotal therapy is no longer of use. Management in these cases is supportive/palliative. Antidotes

**Box 1: Ethanol regimen for ethylene glycol poisoning**

**Intravenous dosage**
- 5% solution as a constant rate infusion at a rate of 5 ml/kg/h for 48 h or longer
**OR**
- 5 ml/kg body weight 20% ethanol in saline IV every 6 h for 5 doses then every 8 h for 4 doses.

Ideally, a pharmaceutical grade of ethanol should be used but if not available oral ethanol can be given or an IV solution made up using 40% vodka, as follows:

- **To make a 5% solution**: add 125 ml of vodka to 875 ml of IV fluid lactated Ringer’s or saline, that is remove about 125 ml from the bag and replace with vodka. An in-line filter should be used for the IV.

- **To make a 20% solution**: dilute an equal volume of vodka with IV fluids such as lactated Ringer’s or saline (eg, 500 ml with 500 ml). An in-line filter should be used for the IV.

**Oral dosage**
- 2.4 ml/kg orally of a 40% solution (eg, vodka, whisky, suitably diluted; equated to 750 mg/kg) over the first hour, followed by 0.5 ml/kg/h (equates to 150 mg/kg/h).

This is best given via an indwelling nasogastric tube, periodically over the treatment period (that is, not all at once, as it is irritant and could result in vomiting).

*From Plumbs (2008)*

should not be used in cats with acute kidney injury as antidotes increase the half-life of ethylene glycol and if renal damage has already occurred the kidneys may not be able to effectively eliminate it.

Ethanol is the most readily available and commonly used antidote for ethylene glycol toxicity (Box 1). It can be given orally or intravenously but use of a constant rate infusion is preferred as it will result in more stable blood ethanol concentration. The dose of ethanol required will cause significant central nervous system (CNS) depression and hypothermia. Nursing care for a recumbent patient will be required. Ethanol may also worsen acidosis and can cause hypoglycaemia. The blood glucose should be monitored every 4-6 h, because of the risk of hypoglycaemia. The airway should be protected if there is significant CNS depression. If the cat survives it will be depressed and lethargic (that is, hung over) during recovery from ethanol therapy and require further supportive care (eg, nutritional support and fluid therapy).

**Conclusions**

Ethylene glycol ingestion is commonly lethal in cats, but prompt diagnosis and treatment with ethanol therapy can be life-saving. In many cases, however, the early signs may be missed or vague and non-specific resulting in late presentation. Clients should be educated on avoiding exposing cats, for example, in the garage.

**References**

2 Miles G. Ethylene glycol poisoning with suggestions for its treatment as oxalate poisoning. *Arch Path* 1946; 41: 631.
3 Gessnser PK, Parke DV and Williams RT.


At ISFM we are so excited to have over 6000 nurse and technician members that we want to offer 2 nurses the chance of winning £250 off the cost of our ISFM distance education courses (diploma or certificate in feline nursing — see http://icatcare.org/learn/nurses/distance-education-course).

In addition, or if you have already completed our courses, we will give another 5 lucky winners a print of their choice from our beautiful 2016 calendar.

At ISFM we know that by being cat friendly and ‘thinking cat’ you as nurses and technicians can make a huge impact on how cats are thought of and handled in your clinic. Therefore, to enter we want you to tell us about a case, in no more than 350 words, you have been involved with where being cat friendly has made a big difference to the cat’s experience in the veterinary clinic. If you can also provide us with photographs that would be fantastic.

Some examples would include cat handling, changes to rooms and equipment, hospitalisation procedures, communication with owners and even marketing that has encouraged a client into the clinic.

The competition is only open to ISFM nurse and technician members - to join go to www.icatcare.org/nurses. Please send entries to: distance-education@icatcare.org. (Deadline: December 31, 2015)
Keeping cats safe

Case: Molly survives antifreeze poisoning

Ethylene glycol is found in antifreeze products and is highly toxic to cats, causing acute kidney injury and death in many cases. The high mortality may be due to delays in presentation to the vet. In this case a young cat was witnessed ingesting antifreeze in a garage and was treated with fluid therapy and the antidote in the form of ethanol (vodka). The cat was monitored closely for complications such as hypothermia and volume overload and recovered fully because of prompt treatment.

Ethylene glycol is a colourless, odourless, chemical found in many household products, including antifreeze, de-icing products and screenwashes. Cats are notorious for finding their way under car bonnets looking for warm engines or wandering around in garages where there could be a spillage of antifreeze. This is where ethylene glycol poisoning becomes a grave concern. Prognosis is often poor, depending on the time between ingestion and presentation at the veterinary clinic. This case illustrates a case of ethylene glycol toxicity with a happy outcome. The veterinary team as a whole were vital to the successful outcome of this case.

History
Molly, an 8-month-old female neutered domestic shorthaired cat, weighing 2.6 kg, had been brought into her daytime veterinary clinic 1–2 h after having been seen licking a puddle of spilt ethylene glycol from a car engine on the floor of the owner’s garage.

On presentation she was lethargic and had hindlimb ataxia. She had been placed on intravenous fluid therapy (Hartmann’s solution) and then started on a continuous rate infusion (CRI) of ethanol (vodka). She

Tip
Make sure your clients are aware of the dangers of ethylene glycol — Molly’s owners were and promptly bringing her to the surgery meant she could start to receive the antidote ethanol in the form of 40% vodka.

Rebecca Gamble
RVN

Rebecca Gamble qualified in 2008 from Askham Bryan College after working for many years in general practice. Rebecca enjoys teaching new nursing students so became a clinical coach. After working for a Vets Now Emergency Clinic she recently became head nurse at Vets4Pets Catterick Garrison, UK. Rebecca finds nursing emergency patients rewarding and is studying for a certificate in emergency and critical care.

was transferred to my practice for overnight care and ongoing treatment. After seeking advice from the Veterinary Poisons Information Service (VPIS) we increased the
infusion dose using the following protocol:

- Make a 5% solution of ethanol by removing 125 ml of fluid from a 1 litre bag of Hartmann’s and replacing with 125 ml of 40% vodka. The CRI is run at 5 ml/kg/h so 13 ml/h. The CRI was given using a syringe driver to ensure accuracy of the dose (Figure 1).

Anti-emetics and gastro-protectants were also administered at regular intervals (ranitidine and maropitant).

Figure 1: A syringe driver should be used for continuous rate infusions to ensure both accuracy of dose and that the line is patent.

Nursing priorities
Nursing priorities included:

- Maintenance of the intravenous (IV) catheter including checking patency, condition of the insertion site (ie, checking for redness, pain, etc). The bandage was checked regularly to ensure it hasn’t slipped or become soiled.

- Management of a recumbent patient. The infusion of ethanol had resulted in Molly becoming very sedated and even more ataxic. Therefore a litter tray was placed close to her bed and she was helped into it. A urinary catheter could have been placed to monitor urine output, but as she could still posture to urinate in her tray output was monitored this way. Other concerns for a patient with reduced consciousness include airway management, regular turning and ocular lubrication if needed.

- Demeanour was monitored closely as the treatment and/or the ethylene glycol could have changed her mentation.

- Monitoring hydration as Molly could become dehydrated if her fluid therapy was not adequate or overhydrated if her kidneys failed to excrete adequate water. This included monitoring fluid intake, skin tent, packed cell volume (PCV), total solids (TS), urine output, mucous membranes and body weight. Her chest was

Key point
The ethanol infusion causes marked sedation and ataxia and treated cats need to be managed with attention to hydration, urination, turning, monitoring airway and ocular lubrication.

Key point
Cats with acute kidney injury, cardiac disease or being treated with high rate fluids must be monitored for overhydration by regularly auscultating the chest and checking pulse and respiratory rate.
auscultated regularly for crackles that could indicate overhydration.

**Nursing treatment**

Blood tests were taken every 6 h to check for renal dysfunction and electrolyte imbalances.

A urine sample was collected to check for the presence of calcium oxalate crystals, proteins and glucose suggesting acute kidney injury had occurred. In Molly’s case no evidence of kidney injury was noted. The CRI was maintained at 13 ml/h for the time Molly spent with us. Medication was given at regular intervals by intravenous route for rapid onset under the direction of the veterinary surgeon.

A bandage was used to include Molly’s foot to reduce the risk of distal swelling whilst the IV catheter was in situ. Molly was hypothermic on presentation so a heat pad was placed underneath her blanket. Molly was monitored regularly (temperature, pulse, respiration) and it was important to auscultate the chest regularly, monitoring for tachycardia and crackles indicating pulmonary oedema. Blood pressure monitoring can also be included in the regular observations.

**Cat friendly practice priorities**

Molly was normally a feisty cat who could be difficult to handle. This was not seen during her early treatment but as she began to improve she resented examination more. A blanket is a very useful tool when it comes to handling fractious cats. For some cats gently placing a blanket over their head can calm them and allow you to carry out procedures such as catheter checks and flushes. In general, Molly responded to a ‘less is more’ approach with patience and minimal restraint (Figure 2). EMLA local anaesthetic cream was used to facilitate the regular blood sampling. Molly was kept in a cat only ward and had regular human interaction when she was happy to accept it. Comfort is always a priority. Adding extra vet beds, blankets or towels it can make a cat’s stay much easier. As Molly was very depressed and sedated by the alcohol infusion she was groomed and cleaned around her eyes and anus.
Outcome
Molly was successfully discharged back to her day practice and made a miraculous recovery. We had an update 2 weeks after discharge to say that Molly was recovering really well and didn’t have any permanent renal issues. Molly went home a happy, lively and feisty cat.

Discussion
Ethylene glycol is highly toxic and ingestion is rarely witnessed. A test kit for diagnosis is available but may be negative if the compound has already been metabolised. Diagnosis is usually made using laboratory tests revealing abnormalities such as acidosis with calcium oxalate crystalluria and, if untreated, acute kidney injury. Prognosis for ethylene glycol toxicity is grave but is very dependent on the timing from ingestion to treatment. A lot of people do not realise what chemicals pose a threat to cats. Cats are very inquisitive and like to investigate so if you have your car bonnet open take care to check for a cat. Household products also contain ethylene glycol so care should be taken to store them carefully.

Conclusions
Treating cats with ethylene glycol toxicity can require intensive nursing and a clear understanding of the possible complications. The clients need to be aware of the financial burden that they will incur for a cat with a poor prognosis (particularly if the cat has acute kidney injury). However, if treated promptly and appropriately cats can survive as Molly showed. However, if her owners had waited before bringing her to the surgery the outcome would have been very different.