veterinary focus #29.1

The worldwide journal for the companion animal veterinarian

2019 - $10 / 10€

KITTENS AND YOUNG CATS

SAVE THE DATE!

AMERICAN ASSOCIATION OF FELINE PRACTITIONERS

5th WORLD FELINE VETERINARY CONFERENCE

Complex DISEASE MANAGEMENT

October 31 – November 3, 2019

Hilton San Francisco Union Square ▪ San Francisco, CA

www.catvets.com/education

LEARNING NEVER EXHAUSTS THE MIND

"The smallest feline is a masterpiece" — Leonardo da Vinci.

The term *polymath* defines "someone whose expertise spans a significant number of different subject areas" and many scholars regard Leonardo da Vinci as the prime example of a "Universal Genius". Certainly he is widely considered to be one of the most diversely talented individuals to have ever lived, a virtuoso who was equally at home with both science and art in many different forms — whether that be music or mathematics, architecture or astronomy, palaeontology or painting, or any number of other disciplines. The man seems to have been almost superhuman in his abilities, and the headline to this editorial — attributed to him — embodies his attitude that one can never have too much learning.

Of course Leonardo is nowadays best known for his art — notably the Mona Lisa, perhaps the world's most famous portrait — but there is much more, and at least one surviving sketch, showing cats in various realistic poses, suggests that he was both fascinated by the feline form and had studied it in some depth. Which brings us to this issue of *Veterinary Focus*, for which the above quote from Leonardo seems more than apt. We cannot promise that the reader can claim to be a polymath by simply studying the journal, but hopefully it offers both the art and science of veterinary medicine as it relates to kittens and young cats.

Ewan McNEILL
Editor-in-chief

• Focus on *Veterinary Focus*

A kitten that presents as an emergency requires the clinician to have a structured approach in order to achieve a quick but meaningful assessment, accurate prioritization of needs and immediate action for effective treatment.

p02

Feline Infectious Peritonitis is a viral disease which is most commonly seen in kittens and young cats, but the clinical signs can mimic many other conditions and definitive diagnosis can sometimes be problematic.

p21

p45

Cats are hunters by nature, and yet we often deny our pets this natural behavior at feeding time; **foraging toys** can both allow a cat to work for its food and provide useful environmental enrichment in both single and multi-cat households.

veterinary focus #29.1

PEFC 10-31-1668

Origine du papier : VIRTON (Belgique)
Taux de fibres recyclés : 0%
Certification : 100% PEFC
Impact sur l'eau : 0.012 P tot kg/tonne

Deputy publisher: Buena Media Plus
Bernardo Gallitelli and Didier Olivreau
90, rue de Paris 92100 Boulogne-Billancourt, France
Phone: +33 (0) 1 72 44 62 00

Editor-in-chief: Ewan McNeill, BVMS, Cert VR, MRCVS
Editorial secretary
- Laurent Cathalan (lcathalan@buena-media.fr)

Artwork
- Pierre Ménard

Printed in the European Union
ISSN 2430-7874
Legal deposit: March 2019
Cover: Shutterstock

Veterinary Focus is published in Brazilian Portuguese, Chinese, English, French, German, Italian, Japanese, Polish, Russian & Spanish.

Find the most recent issues on: http://vetfocus.royalcanin.com and www.ivis.org.

ROYAL CANIN

EMERGENCY CARE FOR KITTENS

Kittens will frequently present as emergencies at first opinion veterinary clinics, and the initial care they receive can make the difference between life and death. Guillaume Hoareau gives some basic pointers as to how such cases should be approached.

KEY POINTS

1. Every kitten presenting on an emergency basis should undergo a triage examination, and a clinic should have specific protocols designed to assess every animal that presents as an emergency.
2. Neonates and kittens have specificities that make their care unique. Nursing or vascular access can be challenging, and such patients also have different normal values on physical examination and laboratory work.
3. Appropriate dietary intake is key for young patients as they have a high metabolic rate. Sufficient calorie intake is vital to prevent common conditions, especially hypothermia and hypoglycemia in neonates.
4. Dehydration and shock may result from an imbalance between salt and water intake and losses. Since the baseline fluid requirement is higher for kittens than adult cats, fluid therapy should be adjusted accordingly.

Introduction

Kittens and young cats are often presented to veterinarians with life-threatening conditions. Due to their small size and unique physiology they can represent a significant challenge, and it is therefore crucial that veterinarians understand the specificities of this patient population and develop an adequate skillset to care for these animals in the acute care setting. This clinical review will present general concepts for the emergency management of kittens and young cats, and emphasize specific points relating to these animals. Note that it can be helpful to divide this patient population into neonates (from birth to two weeks of age) and pediatric patients (from two weeks to six months of age).

General emergency approach

Triage examination

Every patient presented on an emergency basis should undergo a triage examination. The word "triage" is of French derivation and refers to the action of attending to the patient while determining priorities for action. The goal of this process is (i) to decide if the patient requires immediate life-saving measures and (ii) to prioritize resources toward specific individuals when multiple patients require medical attention simultaneously. It is important that each clinic develops specific triage protocols tailored to their own situation, but it is also essential to remember that the triage examination is the first contact with a pet's owners, who can often be very distressed, and communicate with them accordingly.

Traditionally, the "ABC" algorithm has been used to initiate the triage, as it evaluates airway patency, breathing (is the patient breathing spontaneously? Are there signs of respiratory distress?), and circulation (are there signs of circulation or shock?) **(Figure 1)**. The presence of shock can be assessed on physical examination by evaluating perfusion parameters: mentation, heart rate, pulse quality, mucous membrane color, capillary refill time, and extremity-to-core gradient temperature.

Oxygen administration

The mainstay of therapy for patients in respiratory distress is oxygen administration and it should be instituted as soon as distress has been identified on triage examination. Multiple options are available, each with advantage and limitations **(Table 1)**. Once oxygen administration has been initiated, the underlying condition should be investigated and treated whenever possible.

Guillaume L. Hoareau,

DVM, PhD, Dipl. ACVECC, Dipl. ECVECC, Oak Ridge Institute for Science and Education, Oak Ridge, TN, USA

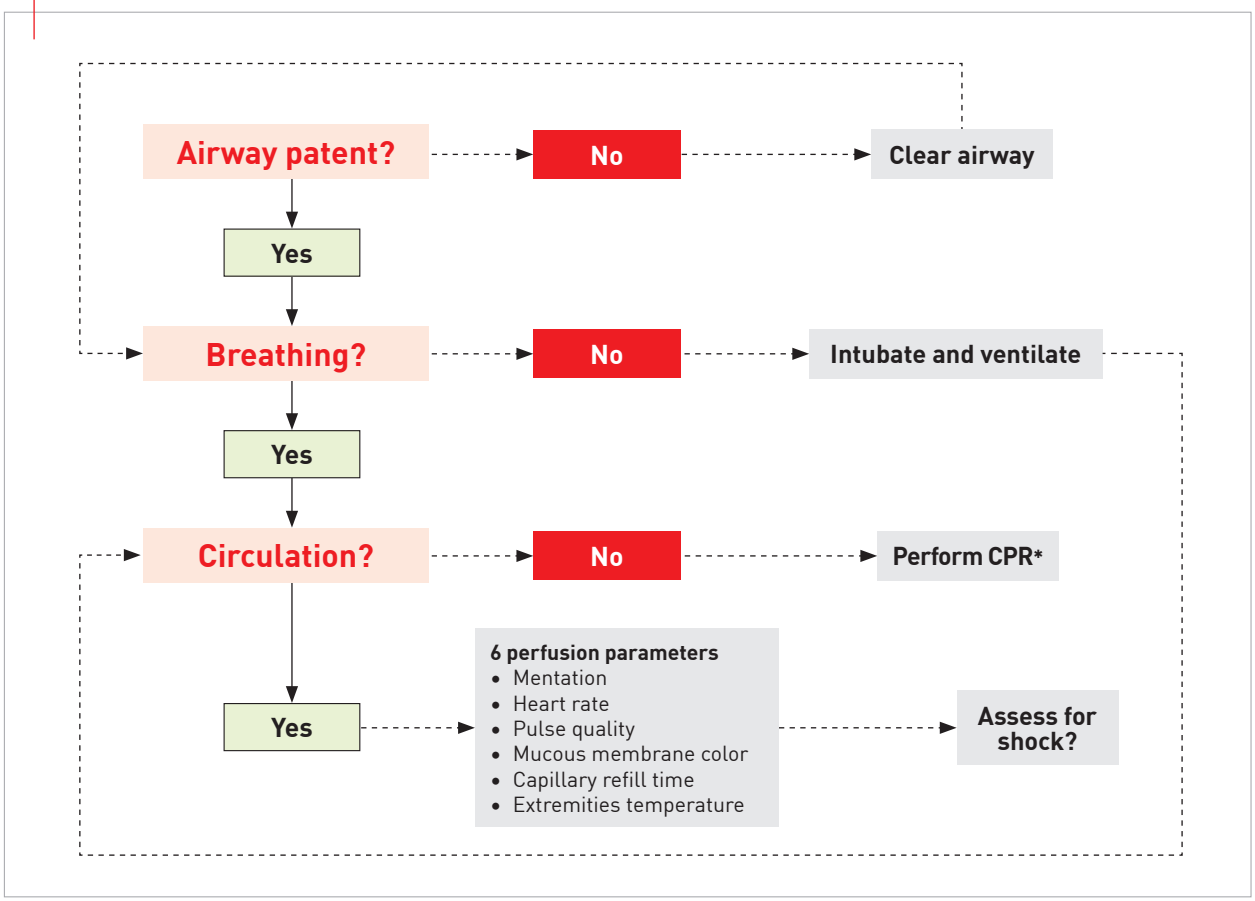
Dr. Hoareau earned his veterinary degree from the Toulouse National Veterinary School, France before completing a residency at the University of California-Davis. He is now board-certified by both the American and European Colleges of Veterinary Emergency and Critical Care, and also holds a PhD from the University of California-Davis in Integrative Pathobiology, specifically in resuscitation and hemorrhage control. He is currently a research fellow in trauma and critical illness in collaboration with the United States Air Force while continuing to care for veterinary patients.

Vascular access

Vascular access is a key intervention in acute care patients as they often need intravenous (IV) fluids or medications **(Figure 2)**. Vascular access can be challenging, in particular for patients in shock or with profound dehydration. In smaller animals, a narrow gauge catheter (*e.g.*, 22G or 27G) might be required to access a peripheral vein such as the cephalic or medial saphenous. Vascular access can also be established by placing a 18G or 20G catheter in a jugular vein. Finally, in patients with very difficult venous access (*e.g.*, if there is profound dehydration or hypovolemic shock, or for animals presented in cardiopulmonary arrest), an intraosseous (IO) catheter can be placed in the proximal femur or humerus **(Figures 3 and 4)**. While this is a rapid and safe procedure, conventional venous access should be secured as soon as possible thereafter.

Whether the catheter is IO or IV, the skin should first be cleaned and aseptically prepared. Catheter placement should always follow aseptic technique and the catheter should be secured to the patient and protected from environmental contamination with a bandage. The catheter insertion site should be inspected and cleaned at least once a day and

Figure 1. The "ABC" algorithm, which can be used to evaluate airway patency, breathing and circulation, with appropriate responses indicated.



*Cardiopulmonary resuscitation

replaced as soon as concerns for contamination or loss of function arise. Similarly, any swelling, heat or pain of the leg distal to the catheter should mandate evaluation.

Treatment of shock

Shock can be defined as a systemic decreased cellular production of ATP, the energy-rich compound used for most cellular metabolism. In order to produce ATP, cells need to be provided with, and process, oxygen. Adequate cell function and tissue oxygen delivery (DO_2) are thus critical for ATP production. DO_2 is dependent on several physiologic factors including cardiac output and oxygen arterial content.

The different shock etiologies can be classified as hypovolemic (or vasoconstricted), distributive (or vasodilatory), cardiogenic, metabolic, or hypoxic **(Table 2)**.

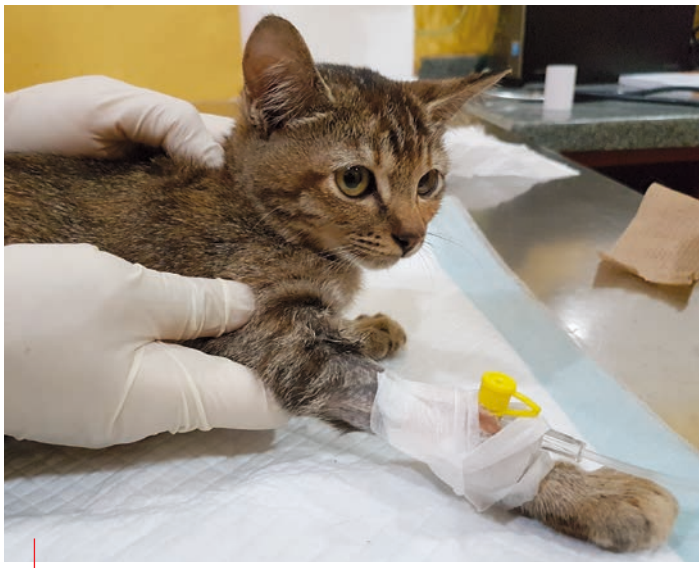
Hypovolemic and vasodilatory are the most frequently encountered types of shock in the emergency room, and their treatment will be the focus of the remainder of this discussion. The goal is to restore blood volume and maximize DO_2 using resuscitation fluids; these are preferentially administered via the IV route, although IO access can sometimes be used.

Fluids commonly employed in veterinary medicine for the treatment of hypovolemic or vasodilatory shock can be classified as either crystalloids (iso- or hypertonic) or synthetic colloids.

Table 1. The advantages and disadvantages of various oxygen administration techniques.

Technique	Advantages	Limitations
Flow-by	Easy to implement	May stress patient Limited FiO_2
Face mask	Easy to implement Higher FiO_2 than flow-by	May stress patient
Elizabethan collar	Higher FiO_2 than flow-by	May stress patient
Nasal prongs	No operator required Allows transport	Hard to maintain Requires humidification Can be uncomfortable
Nasal cannula	No operator required Allows transport	Hard to maintain Requires humidification Can be uncomfortable
Oxygen cage	Minimizes patient stress Higher FiO_2 than above methods	Limited or no patient access
Intubation	Maximizes FiO_2 Affords airway protection	Requires general anesthesia if the patient is not comatose Requires humidification

FiO_2 = fraction of inspired oxygen.



© Shutterstock

Figure 2. Vascular access is a key intervention in critically ill kittens, and an intravenous catheter should be secured whenever possible.

Crystalloids are a family of solutions that contain electrolytes. They are considered isotonic if they have the same osmolarity as the patient, or hypertonic if their osmolarity is higher. While the effects of isotonic crystalloids rely on their volume expansion properties, hypertonic saline exerts its effect through poorly understood mechanisms (increased cardiac contractility, microperfusion improvement, and immunomodulation). The various isotonic crystalloid products differ in their electrolyte and buffer composition.

Colloids are a suspension of macromolecules in a crystalloid solution and include Hetastarch solutions. These are macromolecules characterized by numerous hydroxyethyl substitutions on a glucose backbone, and are classified by the degree of substitution and their molecular weight. Their use for the treatment of shock has been proposed as they exert a significant colloid osmotic pressure and therefore a volume expansion greater than the volume infused. In addition, their chemical complexity allows them to be degraded slowly, so they remain longer in the bloodstream. However there are downsides; they are expensive, and have been associated with the development of kidney injury in several human trials. They can also lead to a dose-dependent coagulopathy (mainly decreased platelet function) in both human and veterinary patients. Synthetic colloids should therefore be used with caution in patients at risk for kidney injury, those that are coagulopathic, or may be in need of surgical intervention.

Dosing guidelines are presented in **Table 3**. The treatment of shock should be rapid — within 20 minutes of diagnosis if possible.

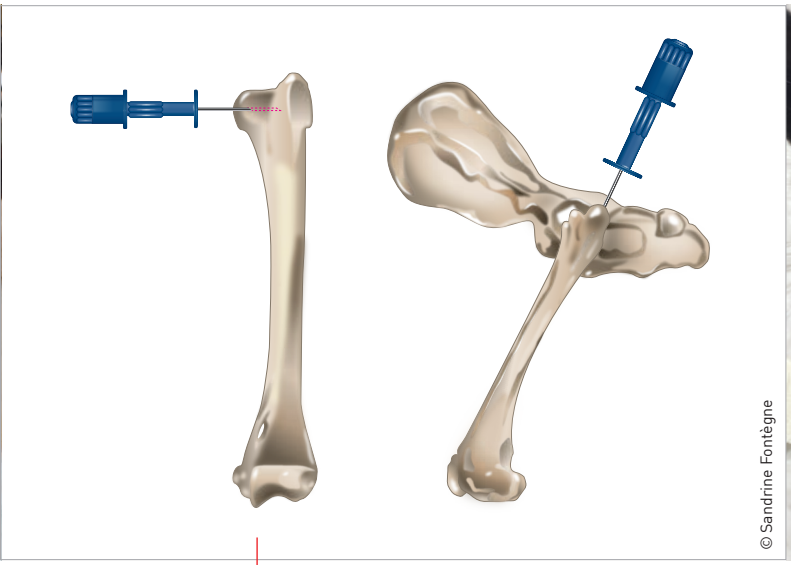


Figure 3. An intraosseous catheter can be placed in the proximal humerus or femur in patients with difficult venous access, as shown.

Figure 4. A young kitten with an intraosseus catheter *in situ*.

History

A full history should be gathered from the owner to understand the motive for presentation. It is important to note the age of the animal and identify the diet offered. Kittens fed inappropriately (insufficient diet caloric content or infrequent feeding) can suffer from dehydration, hypothermia, and hypoglycemia. This is a particular concern in very young or orphan animals. The patient's origin is also important, as some animals acquired from large catteries or poorly managed breeding programs may present with a significant internal roundworm (*Toxocara*), tapeworm (*Dipylidium*), or whipworm (*Trichuris*) parasite burden, as well as an external (flea) infestation. Dates of prophylactic treatments (deworming and vaccinations) should also be recorded and the presence of any coughing, sneezing, vomiting, or diarrhea noted. Potential exposure to common compounds known to be toxic to cats should also be investigated (*e.g.*, lilies of the *Lilium* or *Hemerocallis* genus, ethylene glycol, medications, rodenticides, etc.).

Full physical examination

After the triage examination and implementation of necessary emergency therapy, a full physical examination should be performed. In neonates, mentation can be assessed by evaluation of vocalization, although overt noise production is abnormal. Mobility and ability to suckle milk are also good markers of mentation. Dehydration is a common comorbidity in kittens and should be estimated by evaluation of skin turgor and moisture of the oral and ocular mucous membranes. Importantly, standards for evaluation of dehydration in adults cannot be translated to the young cat population without modification; the threshold for the diagnosis of dehydration should be lower in this age group. Any decreased skin turgor or dry mucous membrane is a reflection of severe dehydration.

The oral cavity should be carefully examined, as animals with cleft palates will present with failure to thrive, inability to swallow milk, or signs of respiratory distress. In some animals

Table 2. Classification of shock.

Shock type	Pathophysiologic hallmark	Examples of etiology in kittens
Hypovolemic or vasoconstricted	Reduced circulating blood volume	Severe dehydration, panleukopenia, burns
Distributive or vasodilated	Decreased vasomotor tone	Sepsis, anaphylaxis
Cardiogenic	Systolic dysfunction	Sepsis
Metabolic	Inability of cells to produce energy despite adequate oxygen delivery	Hypoglycemia, hypothermia, bromethalin intoxication
Hypoxic	Decreased arterial oxygen content	Anemia, pneumonia

Table 3. Guidelines for the volume and type of fluids for the treatment of shock*.

Fluid type	mL/kg
Hypertonic saline (7.5%)	3-4
Isotonic crystalloids	60
Synthetic colloids	5-10

* Since these are only guidelines, individual patients may require more or less depending on the nature of their condition. Hypertonic saline can be given as a bolus over 3-5 minutes. For the other fluids, the calculated volume should be given in 25-50% increments to avoid fluid overload over a 10-15 minute period before re-assessing the patient.

© Shutterstock

Figure 5. Kittens with severe diarrhea can develop rectal prolapse.

with severe diarrhea, rectal prolapse may also be found on physical examination **(Figure 5)**. Rectal temperature should be promptly measured to rule out hypothermia, which is frequent in these patients. Rectal temperature at birth ranges from 35.2-37.0°C and reaches 38.5°C around 28 days (1,2). Thoracic auscultation not uncommonly reveals the presence of a physiologic heart murmur, although congenital cardiac disorders are also possible in this age group. The physical examination will provide crucial information to decide on additional diagnostic and therapeutic interventions.

Emergency laboratory evaluation

Additional laboratory analysis may prove valuable information to complement the history and physical examination. It is vital to bear in mind that kittens may become anemic if too much blood is removed at sampling; a small sample volume should therefore be acquired, and only required tests should be prescribed. For kittens, packed cell volume (PCV), total protein and blood glucose measurements often prove helpful in managing common conditions encountered in this patient population. Such tests are typically inexpensive and offer a rapid method to gather a broad spectrum of information; for example, anemia and hypoglycemia are frequent conditions in young cats. Clinicians should remember that while in adults a refractometer specific gravity (SG) measurement on a urine sample provides key information for renal concentrating abilities, kittens have an inability to concentrate urine, which makes SG a poor surrogate to assess renal function.

If sufficient blood can be acquired and clinical indications are present, a complete blood count will provide valuable information about erythrocytes, leukocytes, and platelets. A biochemistry panel will give insight into renal function and liver function. Age-, and ideally machine-, specific normal values should be used, as shown in **Table 4** (1,2).

"The normal reference ranges for many common laboratory tests in kittens can vary quite markedly from those for adult cats, and care should be exercised when interpreting urine, biochemistry and hematology results."

Guillaume L. Hoareau

Table 4. Normal values for complete blood count and biochemistry panel in kittens and young cats (1).

Parameter	Normal value
Complete blood count	
Hematocrit at birth	35%
Hematocrit at 28 days	29%
Leukocyte count at birth	9.6 x 10^3/mm^3
Leukocyte count at 8 weeks	23.68 x 10^3/mm^3
Lymphocyte count at 8 weeks	10.17 x 10^3/mm^3
Lymphocyte count at 16 weeks	8.7 x 10^3/mm^3
Eosinophil count at 8 weeks	2.28 x 10^3/mm^3
Eosinophil count at 16 weeks	1.0 x 10^3/mm^3
Biochemistry panel	
Bilirubin	0.1-1 mg/dL
Alkaline phosphatase	68-269 IU/L
Gamma glutamyltransferase	0-3 IU/L
Total protein	4-5.2 g/dL
Albumin	2-2.4 g/dL
Glucose	76-129 mg/dL

© Shutterstock

Figure 6. Neonate kittens should be weighed daily to ensure weight gain, and immediate action should be taken if an animal is found to be losing weight.

Common conditions

Anemia

Anemia is a frequent problem in kittens and often the result of overt parasitism, especially flea infestation. Animals with flea-induced anemia may initially have a regenerative anemia that progresses to normocytic, normochromic, non-regenerative anemia in the later stages. Anemia in kittens can be further compounded by nutritional imbalances; iron and vitamin B_{12} deficiency are often encountered. Anemia not explained by flea infestation should be approached similarly as in the adult population and is classified as regenerative or non-regenerative; normocytic or microcytic; and normochromic or hypochromic. It can be due to decreased erythrocyte production (*e.g.*, aplastic anemia, retroviral infection), blood loss (*e.g.*, from hemorrhage, flea infestation) or erythrocyte destruction (*e.g.*, immune mediated, zinc toxicity). Testing for feline leukemia virus (FeLV) infection is an important step in the work-up of anemia in kittens (3).

Hypoglycemia

Young cats, and neonate patients in particular, are prone to hypoglycemia due to their high metabolic requirement for glucose and limited gluconeogenesis ability, as well as renal losses. Adequate nutrition is key to prevent hypoglycemia and hypothermia in kittens and young cats. Neonates should be weighed daily to ensure weight gain **(Figure 6)**. Voluntary intake should be confirmed — both the patient and the food can be weighed before and after each meal to confirm and quantify intake. Animals should be fed frequently with a caloric-dense diet tailored to their needs; neonates should be fed every 2-4 hours, whilst older kittens can be fed 3-4 times a day. Animals unwilling or unable to ingest food voluntarily may be fed via tube feeding (although this can be associated with catastrophic consequences should the feeding tube be inadvertently placed in the trachea). Pregnant and lactating queens should also have a diet tailored to their metabolic demand to ensure quality milk.

Animals with hypoglycemia may present with obtundation, stupor, coma, or seizure. Acquiring blood may be difficult in small patients, and for kittens with severe obtundation, coma, or seizures it is acceptable to assume and treat for hypoglycemia without testing. If clinical signs do not improve or recur despite adequate dietary and heat support, the underlying etiology should be investigated. Emergency hypoglycemia treatment can be achieved with an IV or IO injection of dextrose (0.25-0.5 mg/kg). Dextrose solutions often come in 50% (500 mg/mL) concentration and are therefore hypertonic; they should be diluted with sterile water (in at least a 1:1 ratio) to reduce irritation. In animals unable to sustain oral diet intake, supplementation of maintenance fluids with dextrose to achieve a final concentration of 2.5-5% (25-50 mg/mL) may be required. In patients with compromised vascular access, rubbing the gums with corn syrup might be a reasonable bridging therapy for transmucosal absorption until vascular access can be established.

Hypothermia

Kittens have a large body surface area and a small body weight, and since thermoregulation matures at around 4 weeks of age, kittens under one month are therefore prone to hypothermia. Neonatal animals should receive species-specific milk and provided with a heat source (heat lamp, warm water circulating blanket, heating pad, warm water bottles, etc.) while making sure to avoid superficial burns. Appropriate food intake should be confirmed and adjusted to the animal's age.

Figure 7. Vomiting and/or diarrhea is frequently seen in young kittens and may result in rapid and severe dehydration if remedial action is not initiated.

© Shutterstock

Patients presenting with hypothermia (< 34.4˚C) should receive active warming with one of the devices mentioned above. Warm water enemas can also help in increasing body temperature. If IV fluids are administered, especially for the treatment of shock, it is important to use warmed fluids. As the patient's body temperature increases, perfusion parameters should be monitored, since clinical signs of shock may arise as cold-induced peripheral vasoconstriction is reversed.

Dehydration

Dehydration is a common problem in neonate and pediatric patients because of several physiologic characteristics, including high surface-to-volume ratio, immature renal concentrating abilities, higher metabolic rate, and lower body fat content. Overall, dehydration is a result of excess losses in the face of inadequate intake, and medical interventions should aim at correcting this disequilibrium. Excess losses of salt and water are often the result of vomiting and diarrhea in this patient population **(Figure 7)**. Common infectious causes for enteritis in young cats include parasites such as *Giardia spp.*, *Cystoisospora spp.*, *Tritrichomonas foetus*, and *Cryptosporidium felis* infestation. Helminths [roundworm (*Toxocara*), tapeworm (*Dipylidium*), and whipworm (*Trichuris*)] can also be a source of enteritis and failure to thrive, whilst a wide array of bacteria such as *Salmonella*, *Clostridium*, or *Campylobacter* may also cause enteritis in this population. Feline panleukopenia due to parvoviral infection can also occur, especially in unvaccinated animals; the syndrome is very similar to the one encountered in dogs and is characterized by severe gastroenteritis and leukopenia (4).

Specificity compared to the adult patient

Daily fluid therapy

As with adults, the treatment of shock should precede building a daily fluid plan in kittens. Shock should be treated with infusion boluses as described above. In stable patients, the daily fluid plan should consider three crucial elements, as follows;

(i) maintenance, which encompasses insensible losses such as those through respiration, and normal urine and feces production.

(ii) the deficit in salt and water or dehydration; this is based on physical examination and expressed as a percentage of body weight.

(iii) abnormal ongoing losses, or sensible losses, such as vomiting or diarrhea.

Due to their higher metabolic rate and higher total body water content compared to adults, kittens, in particular neonates, have a higher maintenance fluid requirement than adults. The maintenance fluid rate for kittens is 3-6 mL/kg/hour, with neonates being on the higher end of the spectrum.

Dehydrated animals should be promptly rehydrated, ideally within 2-4 hours of presentation. For instance, a 100 g kitten with an estimated 8% dehydration may be given 8 mL of isotonic crystalloids over 2 hours. Lactated Ringer solution can be a good choice since the lactate can be a good source of energy for young animals (5).

Abnormal ongoing losses can be hard to quantify. Vomitus or diarrhea can be weighed, whilst urine production beyond the normal 1-2 mL/kg/hour may be measured by weighing diapers or incontinence pads used for bedding. Accurate urine production measurement can also be achieved in patients with an indwelling urinary catheter, but this is frequently not feasible in very small animals.

Regardless of calculations, patients should be re-assessed at least three times a day for clinical signs of shock, dehydration, or overhydration, and prompt appropriate adjustments to the fluid therapy plans should then be made.

CONCLUSION

Kittens and young cats can present with unique specificities, and emergency and critical care clinicians should be aware of these in order to care appropriately for their patients. Specific attention and reference values should be used when evaluating laboratory data in these animals. Hypothermia and hypoglycemia are common conditions in this patient population, particularly in neonates. Proper husbandry and prophylactic interventions (vaccination and deworming), along with appropriate dietary intake, are key.

REFERENCES

1. McMichael M. Critically ill neonatal and pediatric patients. In: Hopper K, Silverstein DC, eds. *Small Animal Critical Care Medicine*. 2nd ed. St Louis: Elsevier 2015;820-825.
2. Lawler DF. Neonatal and pediatric care of the puppy and kitten. *Theriogenology* 2008;70(3):384-392.
3. Hartmann K. Clinical aspects of feline retroviruses: a review. *Viruses* 2012;4(11):2684-2710.
4. Truyen U, Addie D, Belák S, *et al*. Feline panleukopenia: ABCD guidelines on prevention and management. *J Feline Med Surg* 2009;11:538-546.
5. Hellmann J, Vannucci RC, Nardis EE. Blood-brain barrier permeability to lactic acid in the newborn dog: lactate as a cerebral metabolic fuel. *Pediatr Res* 1982;16(1):40-44.

HOW I APPROACH... HEART MURMURS IN KITTENS

All clinicians will have been in the position of detecting a heart murmur in a young, apparently healthy kitten presented for vaccination or other routine examination. Meg Sleeper and Camden Rouben discuss a practical approach to such cases and identify which diagnostic tests are best employed.

Meg M. Sleeper,

VMD, Dipl. ACVIM (cardiology), University of Florida, College of Veterinary Medicine, Gainesville, Florida, USA

Dr. Sleeper graduated from the University of Pennsylvania Veterinary School *cum laude* and after becoming board-certified worked in the university's cardiology department until 2015. She is currently clinical professor of cardiology at the University of Florida College of Veterinary Medicine, and has published numerous peer-reviewed original papers, over 50 review papers or case reports, and four books. Her primary research interests include hereditary heart diseases, in particular inherited cardiomyopathies, comparative cardiology and therapeutic gene transfer.

Camden Rouben,

DVM, University of Florida, College of Veterinary Medicine, Gainesville, Florida, USA

Dr. Rouben is a cardiology resident at the University of Florida Veterinary Teaching Hospital. A graduate of Auburn University, Dr. Rouben went on to complete a rotating internship in small animal medicine and surgery at VCA Berwyn and Aurora Animal Hospitals before taking up his current position.

KEY POINTS

1. It is not uncommon to detect a heart murmur when performing a clinical exam on a young cat, and the clinician should know how to handle such a situation confidently.
2. Cardiac auscultation should be methodical and all four heart valve areas should be evaluated.
3. Any murmur should be classified as to its timing, location and grade.
4. The chosen therapy will depend on the clinical signs, investigative tests and diagnosis/prognosis.

Introduction

Young cats (< 1 year of age) frequently present to general practitioners for new patient exams, vaccinations, and breed screening evaluations, only for a heart murmur to be detected. In addition, there are occasions where a heart murmur can be found after clinical signs associated with heart disease are noted. It is important to know how to handle these situations in a confident and efficient manner in order to provide your patient with the best care and your client with the best service. Regardless of whether a heart murmur is present, if a patient is showing clinical signs associated with heart disease, referral to a cardiologist should always be considered.

A heart murmur is a sound wave created by turbulent blood flow moving through the heart or nearby vasculature. Heart murmurs are most

"If a patient is clinically unstable or in respiratory distress, initial stabilization of the heart problem is recommended before diagnostics are performed, with the possible exception of thoracic radiographs."

Meg M. Sleeper

notable when blood flows from a chamber of relatively high pressure to one with low pressure (*i.e.,* ventricle to atrium). Movement of blood between two chambers of similar pressure may not create a murmur that is auscultable with a stethoscope, and it is important to note that not all congenital heart defects in cats will cause a murmur (*e.g.,* reversed patent ductus arteriosus [PDA]), although nearly all do. In addition, murmurs frequently occur in cats without structural heart disease; these are termed benign or functional murmurs (1).

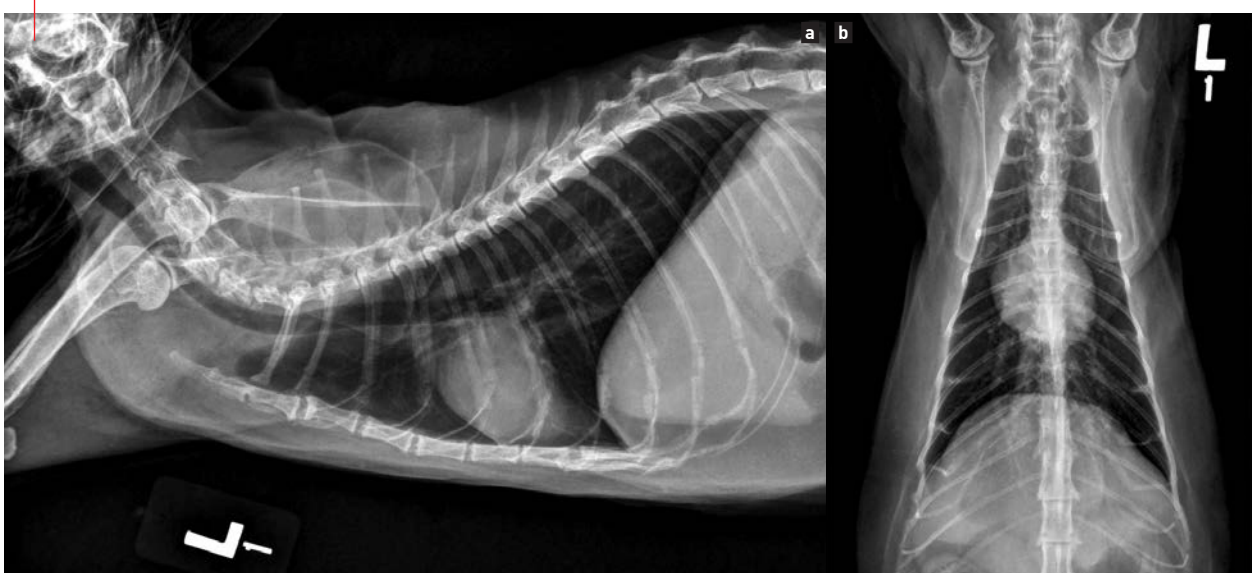
Regardless of why the cat is presenting to your exam room it is important to get a thorough history. If a heart murmur is noted on physical exam, specific details to ask the owner include: evidence of lethargy, exercise intolerance, weight of the patient in comparison to its littermates, any increased resting respiratory rate/effort, and any collapsing episodes. It is important to ask the owner about prophylactic deworming (specifically lungworm) and heartworm status. In addition, encourage the owner to ask the breeder if there were any cardiovascular concerns with the pet's littermates or parents.

Physical examination

Murmur assessment is only a small part of a thorough cardiovascular examination. We personally choose to start a cardiovascular physical exam from the tail and work towards the head, as this is often less threatening for a nervous cat. Femoral pulses should ideally be palpated while listening to the heart to ensure the pulses can be palpated with each heartbeat. Femoral pulses should be assessed for synchronization with the heartbeat and the actual pulse quality. The pulses should be characterized as weak, normal, or increased in strength (also described as hyperdynamic or bounding). Animals with weak pulses have a low systolic pressure or a high diastolic pressure (as with pericardial effusion or dilated cardiomyopathy). Animals with bounding pulses have a low diastolic pressure or a high systolic pressure (as with patent ductus arteriosus or aortic insufficiency).

Heart rate and rhythm should be noted and documented. Often waiting a few moments for the kitten to become acquainted with the new surroundings of the exam room allows for the animal's initial excitement-induced tachycardia to subside. If the rhythm is irregular, an electrocardiogram should be performed to definitively assess the cardiac rhythm. Mucous membrane color should and can be assessed at the gingival, vulvar, and nail bed areas. A normal, healthy cat should have pink mucous membranes with a capillary refill time of less than two seconds. Pale mucous membranes can occur in young cats with anemia. Cyanosis is caused by arterial

Figure 1. Normal lateral **(a)** and ventrodorsal **(b)** thoracic radiographs of a young cat. Three-view thoracic radiographs should be considered if any clinical signs referable to the respiratory system are noted in a patient.



hypoxemia due to severe respiratory or cardiac disease, and cyanotic mucous membranes can occur in cats with right to left intracardiac or great vessel shunts. Cyanosis is *generalized* with central venous admixture (*i.e.,* with a Tetralogy of Fallot), or *segmental/differential* when right to left shunting occurs (*i.e.,* with a reversed patent ductus arteriosus). Differential cyanosis is the term used to describe cyanosis of the lower extremities and vulva/prepuce while the upper extremities and oral mucous membranes appear well oxygenated (*i.e.,* pink).

Respiratory rate and effort should be evaluated when the patient is calm. Unfortunately, auscultation of the lungs is not a very sensitive method of diagnosing pulmonary edema or pleural effusion in cats. Therefore if any clinical signs referable to the respiratory system are noted in your patient, three-view thoracic radiographs (both laterals and a ventrodorsal projection) should be considered **(Figures 1-3)**. The abdomen should be gently palpated for evidence of organomegaly or ascites which would be suggestive of right-sided heart failure. Likewise, generalized venous

Figure 2. Lateral **(a)** and VD **(b)** radiographs of an 8-month-old kitten that presented with a two-day history of coughing and hiding away. The lateral view shows an abnormally enlarged, oval cardiac silhouette with elevation of the trachea. The VD view shows a markedly enlarged cardiac silhouette with distinct borders which are in contact with both left and right thoracic walls. A peritoneopericardial diaphragmatic hernia was diagnosed.

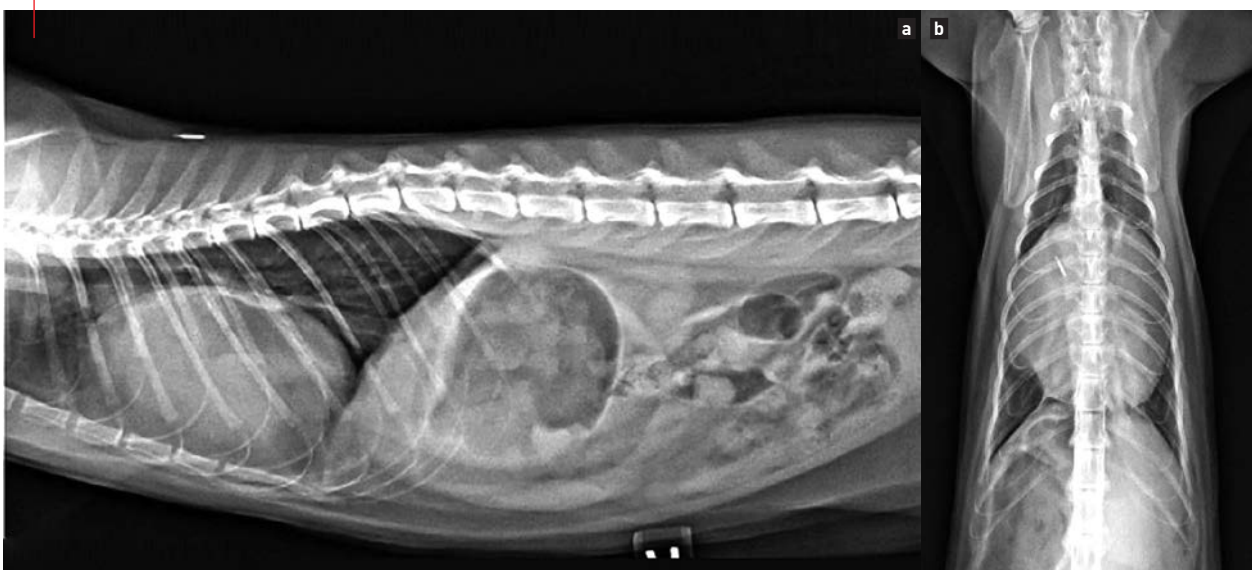


Figure 3. Lateral **(a)** and VD **(b)** radiographs of a young domestic shorthair cat that presented with an increased respiratory rate and effort. On the lateral projection, the cardiac silhouette is moderately enlarged with an elongated contour and rounded cranial margin. On the VD projection, the cardiac silhouette is wide (*i.e.*, "valentine" heart shape). The distribution of the unstructured interstitial to alveolar pulmonary pattern is most indicative of cardiogenic pulmonary edema. The cat was diagnosed with left atrial enlargement and hypertrophic obstructive cardiomyopathy on echocardiogram.

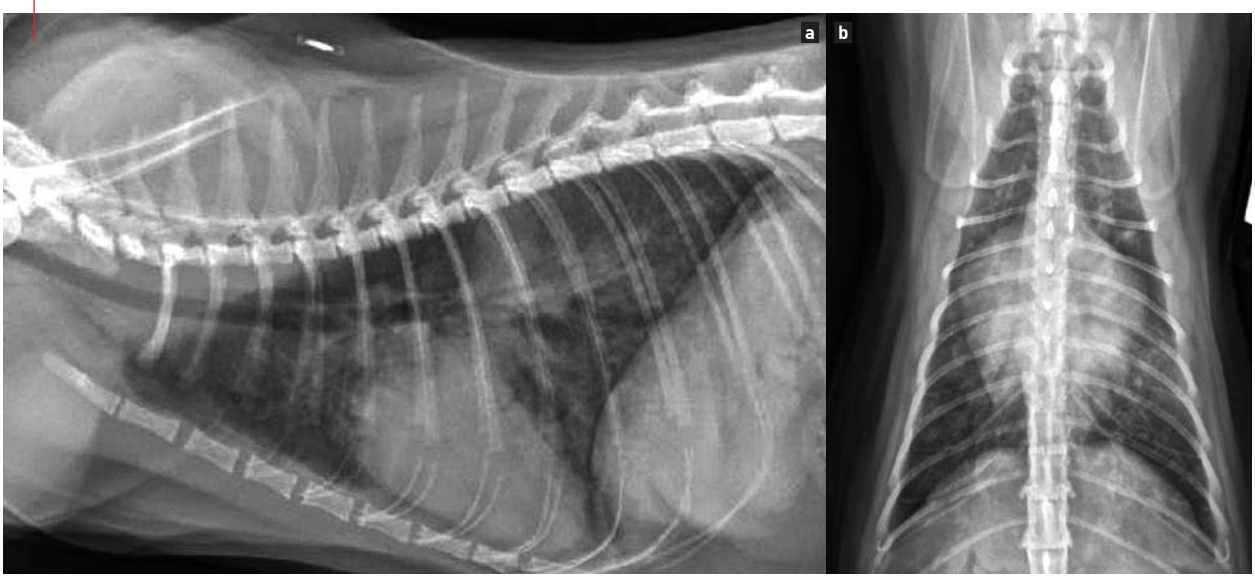


Table 1. The four most common congenital heart defects in cats (2).

- Ventricular septal defect, membranous
- Subvalvular aortic stenosis
- Valvular aortic stenosis/pulmonic stenosis
- Pulmonary artery stenosis

Table 2. Characteristics of a heart murmur.

Timing	Location	Grading/ Intensity
• Systolic • Diastolic • Continuous	• Apical (left, right) • Basilar (left, right) • Parasternal (left, right)	• I/VI • II/VI • III/VI • IV/VI • V/VI • VI/VI

© Shutterstock

Figure 4. Cardiac auscultation is a skill honed with practice. Whilst kittens can be very challenging to evaluate, all four cardiac valve areas should be carefully auscultated.

engorgement and/or jugular pulses are indicative of right heart disease. **Table 1** lists the most common feline congenital cardiac defects.

How to evaluate a murmur

Cardiac auscultation is a skill acquired during veterinary school and honed with years of practice. Kittens in particular can be very challenging to auscultate, as they are frequently non-compliant. Options to calm the kitten include feeding the patient its favorite treat, cradling the patient in one hand and using the other hand to guide your stethoscope, or having an owner or technician cradle the patient. Cardiac auscultation should occur over the anatomic locations of the four cardiac valves **(Figure 4)**. The normal heart sounds (S1 and S2) are high frequency sounds and best heard with the diaphragm of the stethoscope. Gallop sounds occur during diastole (S3 and S4), are usually low frequency sounds, and these sounds are best heard with the bell of the stethoscope.

If a heart murmur is auscultated in a kitten, it should be characterized to aid in creating a differential list **(Table 2).**

- The first characteristic is **timing** (*i.e.,* during which portion of the cardiac cycle is the murmur occurring?). Murmurs that occur between S1 and S2 are systolic murmurs. Murmurs that occur between S2 and the next S1 are diastolic murmurs. Murmurs that occur throughout systole and diastole are continuous murmurs. Because of the rapid heart rate in many kittens, differentiating systolic from diastolic murmurs can be challenging. However, diastolic murmurs are uncommon in small animals.

- The second characteristic is **location** (*i.e.,* where on the thorax is the point of maximal intensity (PMI) of the murmur? [left vs. right, and then apical vs. basilar vs. parasternal]). If a precordial thrill is palpable, it will be present at the PMI **(Figure 5)**.

- The third characteristic is **grading** the intensity of the murmur (*i.e.,* how loud is the murmur?). Murmurs are graded from I-VI. The grade of a murmur essentially refers to how intense it is; *E.g.,* grade I refers to a murmur so faint that it can be heard only with special effort, whereas a grade VI murmur is so loud that it is audible with the stethoscope just removed from contact with the chest wall. Murmurs that produce a precordial thrill, or are diastolic or continuous, are always pathologic and are best evaluated with echocardiography (3).

"Kittens can be very challenging to auscultate, as they are frequently non-compliant. A variety of options can be employed to calm the kitten in order to allow a full assessment of the heart."

Camden Rouben

Diagnostics

Based on the character of the murmur and the patient's clinical status, recommendations can be made for diagnostics and/or therapeutics. If the

patient is clinically unstable or in respiratory distress, initial stabilization is recommended before diagnostics are performed, with the possible exception of thoracic radiographs. Definitive diagnosis of the underlying cause of the murmur requires a complete echocardiogram. Obtaining an echocardiogram enables the clinician to quickly understand the etiology of the murmur, determine if intervention is necessary, and develop a prognosis for the patient.

However, it is unrealistic to assume every kitten with a murmur will undergo a complete echocardiographic evaluation. If the murmur is ≤ grade III/VI or is intermittent (*i.e.,* it varies with heart rate and/or is not present at every examination), it is reasonable to recommend that the kitten be followed throughout its vaccine sequence for persistence of the murmur. Obtaining blood to run a packed cell volume can be a quick, inexpensive test to rule out anemia if the kitten has pale mucous membranes. If the patient is anemic, the cause of the anemia should be investigated and then corrected. When the packed cell volume is corrected the patient should be re-evaluated to assess whether the murmur still exists. A serum NT-proBNP test can be useful, particularly in cases where an echocardiogram is not an option. In a patient with a serum NT-proBNP of greater than 100 pmol/L, heart disease is more likely, whereas in a patient with a normal serum NT-proBNP (less than 100 pmol/L) heart disease is unlikely and the murmur is more likely to be benign (4).

As previously mentioned, thoracic radiographs should be considered if the patient is exhibiting abnormal respiratory signs. If an owner declines definitive diagnostics, they should be alerted to monitor for the development of signs consistent with progression of heart disease, *i.e.,* signs of heart failure such as dyspnea or tachypnea.

Therapy and management

The possible therapeutic options, and therefore the discussion with the owner, are entirely dependent on the definitive diagnosis and echocardiographic findings. Medical management should be initiated in kittens with evidence of congestive heart failure unless the owners elect euthanasia. Other abnormalities that warrant medical management include tachy- or bradyarrhythmias, systolic anterior motion of the mitral valve, and severe pulmonary hypertension.

In kittens with congestive heart failure, furosemide and an angiotensin converting enzyme (ACE) inhibitor are regarded as the first line of treatment. The use of spironolactone and pimobendan should be considered in refractory cases or if the underlying disease is likely to benefit from these medications; for example, pimobendan is warranted in patients with evidence of systolic dysfunction. Typical doses are given in **Table 3**. The use of sildenafil should be considered in kittens with evidence of severe pulmonary hypertension. Atenolol can be

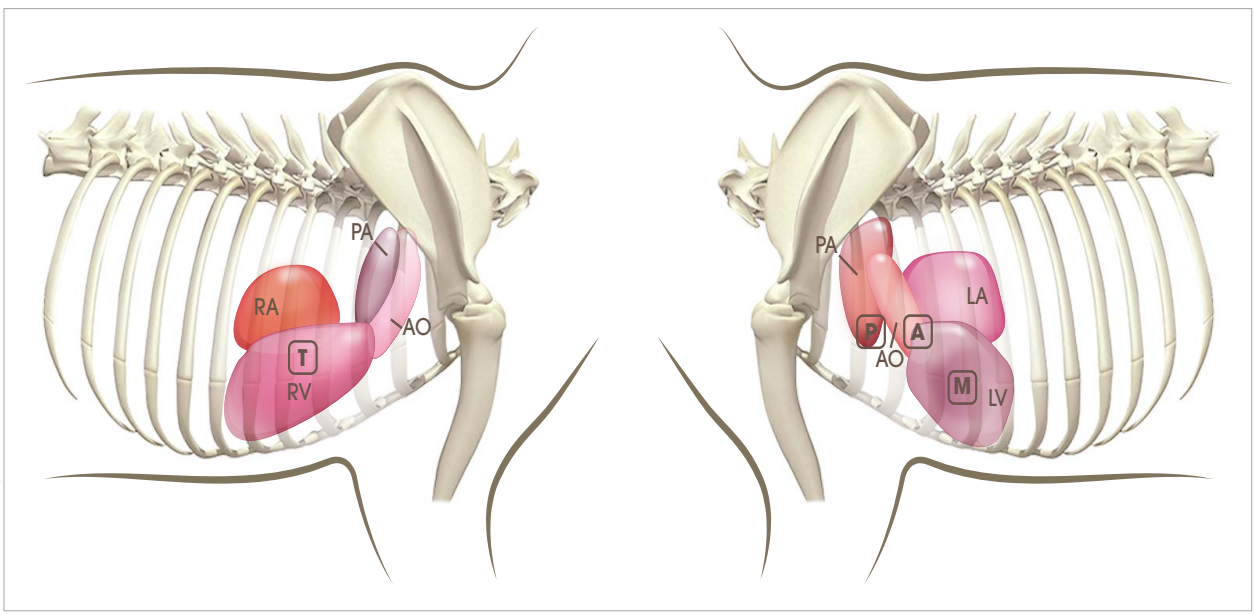
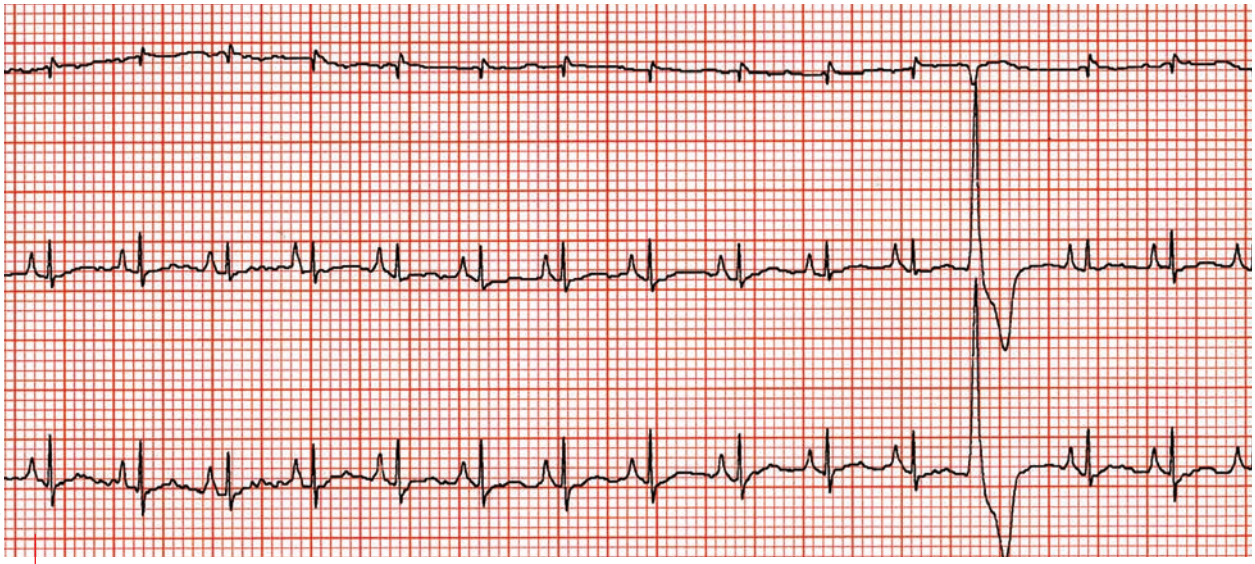


Figure 5. Cardiac auscultation should be over the anatomic locations of all four cardiac valves. The best location to identify each valve is shown (2).

Valve	Anatomical site
Mitral (M)	5th left intercostal space at costochondral junction
Tricuspid (T)	Between right 3rd and 4th intercostal spaces just above the costochondral junction
Aortic (A)	Between left 4th and 5th intercostal spaces just above the costochondral junction
Pulmonic (P)	Between left 2nd and 3rd intercostal spaces just above the sternum

Key; RA = right atrium; RV = right ventricle; LA = left atrium; LV = left ventricle; AO = aorta; PA = pulmonary artery



© Meg Sleeper

Figure 6. An ECG trace (25 mm/sec; 10 mm/mV) showing leads I, II and III from a cat demonstrating a ventricular premature contraction (VPC). Note the wide, irregular QRS complex.

considered for control of severe dynamic outflow tract obstruction, and some arrhythmias **(Figure 6)**, but it should not be started in patients exhibiting signs of congestive heart failure. For specific antiarrhythmic therapy, the reader is referred to one of the various review articles or book chapters for a complete discussion on determining when therapy is warranted and how to choose the best drug.

Some heart conditions may lend themselves to specific intervention. Catheter-based interventional procedures have been employed to effectively treat cats with patent ductus arteriosus (PDA) and pulmonic stenosis. However, surgical management via thoracotomy or thoracoscopy is more readily available for PDA ligations, vascular ring anomalies, and pericardial defects, and these approaches are as effective as the minimally invasive alternatives. Less common procedures, such as pulmonary arterial banding, have been effectively used to reduce shunting in cats with ventricular septal defects, and as cardiac bypass becomes more available in veterinary medicine, definitive surgical correction may become a reality for more of these patients.

Table 3. Common cardiac drugs and dosages.

Furosemide	1-2 mg/kg IV, IM or PO (dosing frequency depends on route of administration)
Angiotensin converting enzyme (ACE) inhibitor	0.5 mg/kg PO S/BID
Spironolactone	1-2 mg/kg PO S/BID
Pimobendan	0.25-0.3 mg/kg PO BID
Sildenafil	1-2 mg/kg PO TID
Atenolol	6.25-12.5 mg per cat PO SID-BID

CONCLUSION

It is not uncommon to detect a heart murmur in a kitten, and the clinician should have a systematic approach to such cases. A good history and thorough clinical examination are crucial in determining the next steps. Thoracic radiography can be useful for an initial assessment of a patient, but definitive diagnosis of the underlying cause of the murmur requires an echocardiogram, and this is recommended for murmurs that are grade 4 or above, or if there are clinical signs on examination. Therapy depends entirely on a definitive diagnosis.

REFERENCES

1. Fox PR, Sisson DD, Moise NS. The Physical Examination. In: *Textbook of Canine and Feline Cardiology* 2nd ed. London, WB Saunders, 1999; 52-59.
2. Schrope D. Prevalence of congenital heart disease in 76,301 mixed-breed dogs and 57,025 mixed-breed cats. *J Vet Cardiol* 2015;17:192-202.
3. Cote E, Edwards NJ, Ettinger S, *et al*. Management of incidentally detected heart murmurs in dogs and cats. *J Vet Cardiol* 2015;17:245-261.
4. Scansen B, Schneider M, Bonagura J. Sequential segmental classification of feline congenital heart disease. *J Vet Cardiol* 2015; 17:S10-S52.

THE CAT FRIENDLY PRACTICE PROGRAM

Paula Monroe-Aldridge,

DVM, American Association of Feline Practitioners, Hillsborough, NJ, USA

Dr. Monroe-Aldridge graduated from Oklahoma State University and is currently an associate veterinarian at River Trail Animal Hospital in Tulsa, Oklahoma. She has been part of the Board of Directors for the American Association of Feline Practitioners (AAFP) since 2014 and was elected president of the organization for 2018.

Cats and veterinary clinics may not be natural companions – indeed all veterinarians will have encountered more than a few unwilling feline patients. Paula Monroe-Aldridge briefly describes a scheme designed to make things a little less traumatic for all concerned.

KEY POINTS

- The Cat Friendly program addresses the cat's unique behaviors and needs, and ultimately should decrease the stress of a veterinary visit for both cat and owner. (1)
- The worldwide scheme is becoming more popular as various benefits become evident for practices that have been designated. (2)

Introduction

The Cat Friendly Practice® (CFP) program originated as a contest by the International Society of Feline Medicine (ISFM) and in 2012 was developed into a worldwide initiative involving a partnership between ISFM (1) and the American Association of Feline Practitioners (AAFP) (2). There are currently over 1200 recognized CFP's in North and South America, and the AAFP program is actively being expanded into other regions of Latin America. ISFM runs the Cat Friendly Clinic (CFC) scheme in the rest of the world, and currently has 1270 accredited clinics in total, with around 590 clinics in the UK and 324 in the rest of Europe, 77 in Australasia and 279 in Asia.

The main purpose of the program is to cater to the cat's unique behaviors and needs, and ultimately to decrease the stress of the veterinary visit for the cat as well as the cat caregiver. It also decreases the stress of the veterinary team by providing the tools and resources needed to properly manage their feline patients. According to the 2018 Cat Friendly Practice® (CFP) survey results, 88% of accredited practices reported positive team dynamic when it came to handling, treating, and caring for cats (3). All of these factors lead to better care for cats, and result in longer, happier, and healthier lives.

This global initiative to improve the feline veterinary experience for all cats is a collaborative effort that involves the entire veterinary team. A hospital located in North, Central or South America will follow the program managed by the AAFP. Hospitals located elsewhere in the world follow the ISFM's Cat Friendly Clinic program. AAFP/ISFM membership is a requirement for either program, which is provided as a member benefit.

What does the program involve?

The program is a self-assessment exercise in which practices have a list of requirements they must fulfill in order to be recognized as a CFP. Requirements address feline-specific needs within 10 main topics, as shown in **Box 1**.

There are educational resources that provide in-depth information on the importance of each checklist item, and also provide creative ways to integrate them into the practice. Upon approval, the practice receives access to a marketing toolkit in order to promote their new status, as well as ongoing educational resources.

Figure 1. The waiting room can be a source of stress for both owner and cat, but the CFP program scheme suggests ways in which the tension can be lessened.

Figure 2. The CFP strives to ensure that the entire veterinary team are able to handle cats and kittens in an empathetic manner.

What are the benefits?

The top benefits reported by Cat Friendly Practices are less stress for feline patients, higher satisfaction among current clients, improved client retention or more requested visits by cat owner clients, increased attention and time during examinations, and a demonstration of care for feline patients. The 2018 survey (3) also showed that 93% of CFPs improved their knowledge of feline care, 83% had increased visits because they are a CFP, 79% increased revenue, 80% gained new feline patients, and 61% decreased handling injuries.

By concentrating on these feline-friendly concepts during the kitten stage of life, the clinician can create more pleasurable veterinary visits, and getting the cat to the veterinarian for recommended care later in life will be less challenging for the caregiver. The CFP program aims to help a hospital provide a more pleasant environment for cats and clients, as well as enabling the veterinary team to:

- Speak with caregivers about their new cat or kitten. The team will be able to provide clients (and even potential clients on the phone) with recommendations and resources on how to acclimate their kitten to the carrier and traveling with a kitten. They will also be able to answer common questions on behavior (*e.g.*,"Why does my kitten act this way?" or "Why does my kitten scratch?").
- Create a less stressful environment for the patient in the waiting room **(Figure 1)** and the exam room. Unfamiliar smells, sounds, or unexpected interactions can be terrifying, especially for a kitten. The practice team will understand what might be frightening to a kitten and can be proactive to alleviate this stress; this can create a calmer environment for the clinical examination and a positive association with the veterinary visit. Something as simple as giving the kitten a treat can create an affirmative link and make the exam room a friendlier environment.
- Handle the kitten properly. Feline-friendly handling is key to creating a positive veterinary experience, as how the kitten is handled will set a precedent for the rest of his/her life. Respectful handling will go a long way to making future veterinary visits more relaxed for both the cat, client and the veterinary team **(Figures 2 and 3)**.
- Address specific concerns of kittens associated with hospitalization and/or boarding. If the kitten becomes ill and needs to be hospitalized, or just needs to board, making the stay as pleasant as possible will help the cat be more amenable to future stays. It is important that cats have all of their resources met, as well as the amenities they desire, in order to feel safe and secure when being hospitalized or boarded **(Figure 4)**.
- Learn the unique needs of anesthesia and pain recognition. It is important to understand kittens have singular needs when it comes to anesthesia

Box 1. The ten main topics covered by the CFP.

1. Staff Training & Continuing Education | Client Communications
2. Veterinary Practice Premises | Waiting Area
3. Feline Handling & Interactions with Clients
4. Examination Room(s) | Clinical Records
5. Hospitalization & Boarding of Cats
6. Pain Management | Operating Room & Anesthesia
7. Surgical Equipment | Dentistry
8. Diagnostic Imaging | Laboratory Facilities
9. Treatment | Health & Safety
10. Feline Preventative Healthcare Individualized by Life Stages

Figure 3. Cats have singular needs when it comes to diagnostic procedures, and it is imperative that these concerns are fully addressed by the hospital team.

Figure 4. If a kitten needs to be hospitalized, it is important to make the stay as pleasant as possible, and will help the cat be more amenable to future stays.

and pain control, especially since many kittens will be spayed or neutered. It is imperative these concerns are addressed for the safety of the young feline patient. Since cats in general are masters at hiding pain, it is important to know how to determine if a patient is in discomfort and how to address it.

- Learn about the different life stages in order to provide the very best preventative care for feline patients at all stages of their life. According to a recent study (4), 83% of kittens initially come to the veterinarian, but more than half never return. This is a sad statistic, which reveals that cat caregivers may not be aware how vital it is to continue check-ups beyond the kitten stage of life.

"Cat Friendly Practices have reported many benefits from following the program. These include less stress for feline patients, higher satisfaction among current clients, improved client retention or more requested visits by cat owner clients, increased attention and time during examinations, and a demonstration of care for feline patients."

Dr. Paula Monroe-Aldridge

CONCLUSION

Concentrating on making the veterinary visit as pleasant as possible is crucial for all cats, but especially for kittens. Providing a positive experience for the kitten will gain the trust of the client, and increase the likelihood of the kitten returning as an adult. We must all work together to drive this initiative forward in our profession. We have to continue to educate both our veterinary team and cat caregivers on all stages of life, and we must provide positive, low-stress veterinary visits. All cats deserve the very best care; however, we cannot provide this care if they do not return. Becoming a Cat Friendly Practice® is a win-win-win for everybody.

REFERENCES

1. https://catfriendlyclinic.org/ Accessed 16th November 2018
2. https://www.catvets.com/ Accessed 16th November 2018
3. https://www.catvets.com/public/PDFs/CatFriendlyPractice/2018_CFP_Survey_Results.pdf Accessed 14th December 2018
4. Volk JO, Felsted KE, Thomas JG, *et al*. Executive summary of phase 3 of the Bayer veterinary care usage study. *J Am Vet Med Assoc* 2014;244:799-802.

BEING FRIENDLY TO CATS... IS IT WORTH THE EFFORT?

Pere Mercader,

DVM, MBA, Veterinary Management Studies, Barcelona, Spain

Dr. Mercader has been established as an internationally recognized veterinary practice management consultant since 2001 and was a co-founder of the Spanish Veterinary Practice Management Association (AGESVET), serving on its board for eight years. He has conducted profitability and pricing research studies in Spanish veterinary clinics and lectured on practice management in more than 30 countries. His textbook "Management Solutions for Veterinary Practices" has been published in Spanish, English and Chinese. In 2008 he co-founded Veterinary Management Studies, a business intelligence company that provides a benchmarking service for more than 800 Spanish veterinary practices.

The adage "a cat is not a small dog" is as true as ever, and many veterinary clinics seem to be geared more towards treating dogs than cats. Pere Mercader reviews recent research that looked at how being a "Cat Friendly Clinic" can be good for business.

KEY POINTS

- Many cats find a trip to the veterinary clinic stressful; this encourages owners to avoid visiting the clinic, and can create a vicious circle.
- A recent survey identified that there are many advantages in being accredited as a "Cat Friendly Clinic".

Introduction

Cats have a unique nature and certain specific needs, which can make visits to a veterinary practice stressful for them, for their owners and for the veterinarians. This can potentially generate a vicious circle in which because cats are stressed when they visit the clinic, their owners tend to avoid or postpone these visits, resulting in veterinarians seeing cats less frequently than dogs and, as a consequence, becoming less used to handling them properly **(Figure 1)**.

To address this issue, the International Society of Feline Medicine (1) designed a program — the Cat Friendly Clinic, or CFC (2) — to help veterinarians create a more pleasant experience for their feline patients and clients **(Figure 2)**. The program includes information and support materials to help the interested clinics achieve a higher standard of cat care and to obtain the corresponding accreditation.

Royal Canin recently asked VMS[1] (Veterinary Management Studies) to perform a research project with the goal

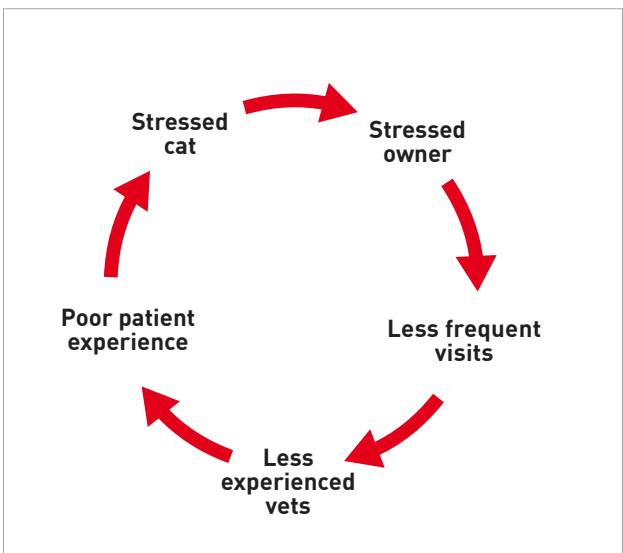


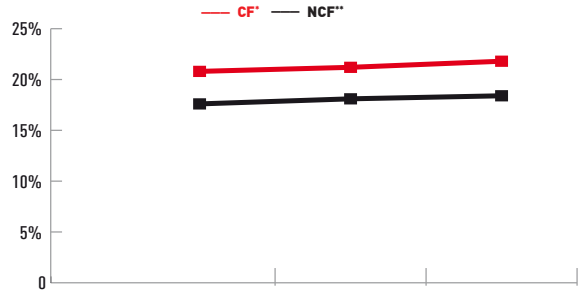
Figure 1. A vicious circle can develop because cats are stressed when they visit a clinic, so that their owners tend to avoid or postpone these visits, resulting in veterinarians seeing cats less frequently than dogs.

[1] www.estudiosveterinarios.com

Key findings

- **Cat Friendly Clinics attract a higher percentage of feline patients.**

% of feline patients vs. total active patients

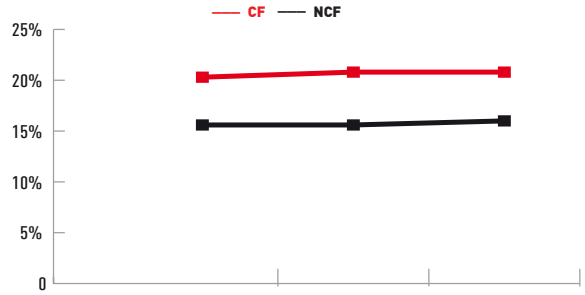


	2015	2016	2017
Cat friendly	20.8%	21.2%	**21.8%**
Non cat friendly	17.6%	18.1%	18.4%[1]
Total	17.8%	18.2%	18.6%

[1]P-values (95% confidence level): (1= 0,0139)

- **Cat Friendly Clinics generate a higher percentage of their revenue from feline patients.**

% of clinic revenue coming from feline patients

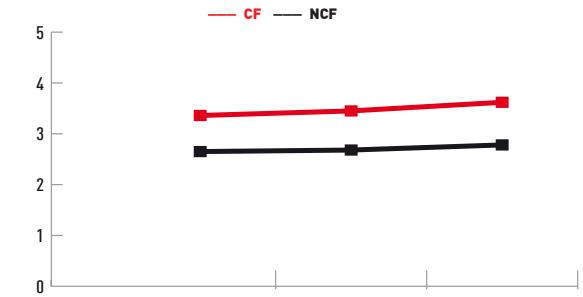


	2015	2016	2017
Cat friendly	20.3%	20.8%	**20.8%**
Non cat friendly	15.6%	15.8%	16.0%[1]
Total	16.0%	16.1%	16.4%

[1]P-values (95% confidence level): (1= 0,0030)

- **Cat Friendly Clinics achieve a 30% higher frequency of visits with their feline patients.**

Average number of transactions (visits) per year per feline patient

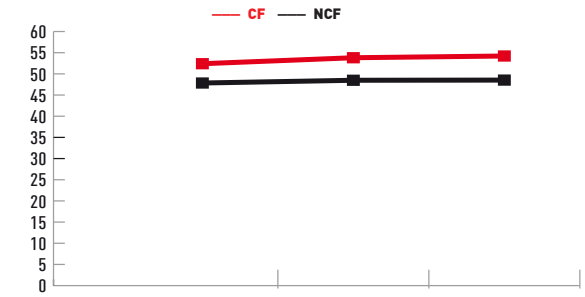


	2015	2016	2017
Cat friendly	3.36	3.45	**3.62**
Non cat friendly	2.65	2.68	2.78[1]
Total	2.70	2.72	2.84

[1]P-values (95% confidence level): (1= 0,000002096)

- **Cat Friendly Clinics achieve a 12% higher average transaction value with their feline patients.**

Average transaction in € value for feline patients

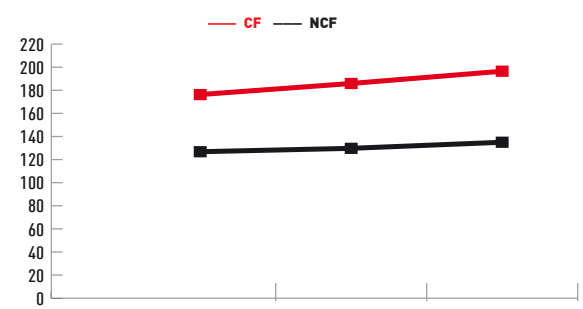


	2015	2016	2017
Cat friendly	52.40	53.81	**54.22**
Non cat friendly	47.84	48.49	48.53[1]
Total	48.20	48.92	49.00

[1]P-values (95% confidence level): (1= 0,002964)

- **Feline owners spend 45% more per year at Cat Friendly Clinics than for cats presented at "ordinary" clinics, and the gap is increasing with time.**

Average yearly spending per feline patient

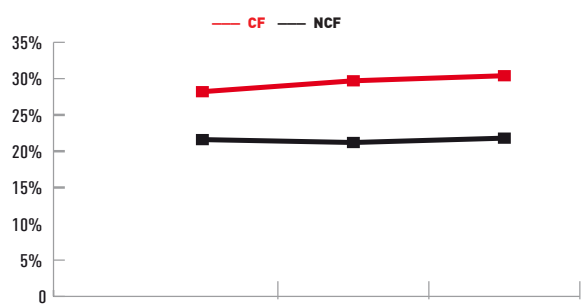


	2015	2016	2017
Cat friendly	176.29	185.90	**196.50**
Non cat friendly	126.80	129.74	135.0[1]
Total	129.95	133.27	138.96

[1]P-values (95% confidence level): (1= 0,000000008484)

- **40% more owners of feline patients buy petfood at Cat Friendly Clinics.**

% of feline patients buying petfood at least once per year



	2015	2016	2017
Cat friendly	28.2%	29.7%	**30.4%**
Non cat friendly	21.6%	21.2%	21.8%[1]
Total	22.0%	21.8%	22.3%

[1]P-values (95% confidence level): (1= 0,0001048)

*CF: Cat friendly; **NCF: Non cat friendly

© Shutterstock

Figure 2. Ensuring that the veterinary team makes both cats and owners feel welcome at the practice is a key component in the Cat Friendly Clinic Program.

of answering the question: are Cat Friendly Clinics able to generate a stronger bonding with their feline clients when compared to "standard" clinics? A summary of the research methodology, the key findings and the main insights that were obtained are set out on **page 19**.

Research methodology

VMS analyzed all the economic transactions of 8,490 feline patients from a sample of 29 accredited Spanish "Cat Friendly Clinics" between 2015 and 2017. These were compared to the economic transactions of 123,674 feline patients from a second sample of 537 Spanish practices that were not accredited as Cat Friendly, across the same period. Statistical checks were performed to validate that both sample groups had a comparable geographic and size distribution to avoid these factors confounding the research results. In Spain there are currently 94 Cat Friendly Clinics, within an overall total of 5,350 veterinary centers. The key findings are best represented in graphic format, as shown.

CONCLUSION

The results show that Cat Friendly Clinics are successful at establishing a higher-level bond with their feline patients. This translates into more cats visiting these clinics, a higher frequency of visits, a higher spend at each visit, and a higher total spend per year. In the meantime, given the above results, it would seem reasonable to conclude that being friendly to cats definitely pays off!

Possible future research themes

Future research could aim at validating the hypothesis of a cause-effect relationship by studying the trend of these results before and after achieving CFC accreditation. From a clinical perspective, it could also be very valuable to measure compliance levels and overall health indicators in the feline patients of these clinics, the hypothesis being that this stronger bond should also result in better well-being. As an example, the research showed a higher percentage of sterilized cats in the Cat Friendly Clinics. Additional insights could also be gained by interviewing or surveying the feline owners who attend these clinics, to better understand their satisfaction levels and the key differential factors that drive Cat Friendly Clinics.

REFERENCES

1. https://icatcare.org/isfm accessed 21st November 2018
2. https://catfriendlyclinic.org/ accessed 21st November 2018

FELINE INFECTIOUS PERITONITIS

Amongst the many feline viruses, the agent that causes FIP is perhaps the most elusive and frustrating to diagnose and treat. Elizabeth Berliner offers a review of the disease and some pointers as to what may be around the corner in terms of therapy.

Elizabeth A. Berliner,

DVM, Dipl. ABVP, Cornell University College of Veterinary Medicine, Ithaca, New York, USA

Dr. Berliner earned her DVM from Cornell University in 2003 and is boarded in both Shelter Medicine Practice (2016) and Canine and Feline Practice (2012) with the American Board of Veterinary Practitioners. She is currently Assistant Clinical Professor and Director of Maddie's® Shelter Medicine Program at Cornell University, and serves on the Board of Directors for the Association of Shelter Veterinarians and the credentials committee for the Shelter Medicine Practice board specialty. Her interests include diagnosis, management and prevention of infectious diseases; animal welfare, veterinary ethics, and decision-making; and innovative outreach programs promoting accessible veterinary care and humane behaviors.

KEY POINTS

1. Feline Infections Peritonitis (FIP) is the result of a mutation of the ubiquitous feline coronavirus (FCoV).
2. Risk factors for FIP include cats less than 2 years of age, group housing, and exposure to stressful events, including surgery or rehoming.
3. Diagnosis is often complicated and relies on a combination of history and clinical signs supported by diagnostic testing; FCoV serology should never be used to make a diagnosis of FIP.
4. FIP usually shows rapid progression of clinical signs and is generally terminal. Treatment is typically unrewarding, but there are currently some promising experimental therapies under investigation.

Introduction

Feline Infectious Peritonitis (FIP) is the result of a mutation of the ubiquitous and relatively harmless feline coronavirus (FCoV). First described in 1963 (1), the rise and increased incidence of FIP since its discovery has been associated with husbandry practices that result in group-housed cats; this includes breeding and sheltering facilities. The first commercial cat litter appeared on the US market in 1947 (2) — a reflection of the changing role of the cat as an indoor companion animal — and both breeding and rescue operations increased in the following decades, creating opportunities for transmission and amplification of infectious diseases in groups of cats. To date, FIP has evaded medical prevention modalities as well as a cure; furthermore, ante-mortem diagnosis often remains a clinical challenge. Current research includes enhanced diagnostic tools utilizing molecular sequencing and clinical trials of new therapies; both of these areas suggest promising advances in the field.

Etiology and pathogenesis

Feline coronavirus is a large, enveloped, positive-stranded RNA virus. Coronaviruses in general exhibit a high rate of mutation during replication, which leads to intra-species and cross-species recombination and transmission. Currently, FCoV

is considered to have two serotypes: type I, which is the most prevalent form found worldwide in naturally affected cats (with some geographic variation), and type II, which arose from a recombination event between type I FCoV and canine coronavirus. Although type 1 predominates in natural feline infections, the vast majority of research has been conducted on type II because it is more readily propagated in the laboratory for study. Both type I and type II FCoV serotypes have been implicated in FIP development (3). Type I and type II are distinguished by genetic differences in their S (spike) proteins **(Figure 1)**, which are considered important in the transformation of common FCoVs to the FIP-causing FCoVs (FIPVs).

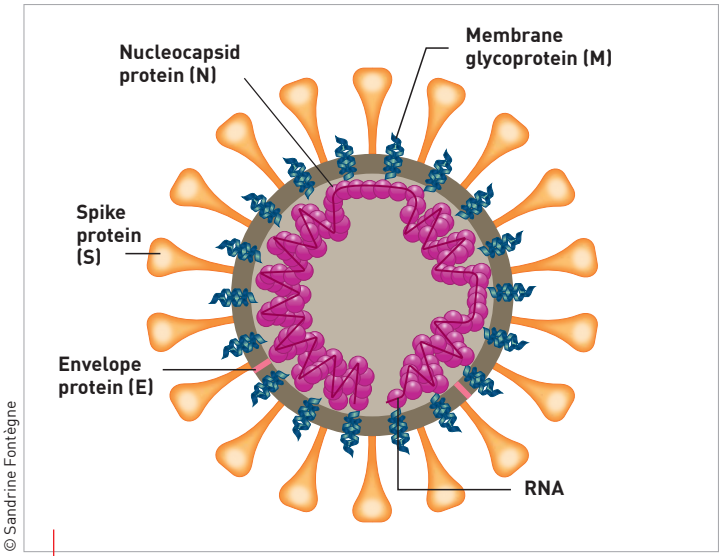
The main route of FCoV transmission is fecal-oral, with oronasal inoculation of the virus via direct transmission or fomites such as litterboxes or surfaces. After inoculation, FCoV moves into intestinal enterocytes, where the virus replicates. Infections with FCoV are often subclinical, but may result in a self-limiting diarrhea as the virus impacts the intestinal epithelium.

The transformation of the common FCoV to the lethal FIPV involves specific point mutations in the RNA genome. Structural features of interest are the viral spike (S) and membrane (M) proteins which act in allowing entry into and exit from cells **(Figure 1)**. An understanding of specific point mutations is thought to be the key in unlocking this lethal transformation; current efforts are focused primarily on the S and 3c genes, with the S gene being most commonly implicated in laboratory studies to date (4).

The macrophage is the primary inflammatory cell in FIP. Point mutations in the FCoV genome switch the virus from an epithelial tropism to a macrophage trophism. The resulting virus is then able to travel and replicate in macrophages, moving into organs and other tissues. Infected macrophages internalize antigen, allowing the virus to evade antibody-dependent lysis, while also activating complement which increases the influx of other inflammatory cells to infected tissues. The humoral branch of the immune response is also activated, resulting in the deposition of antibody-antigen complexes along vessels, causing profound and widespread vasculitis. Approximately 50% of FIP cases develop

"FCoV is a ubiquitous virus with high sero-prevalence rates in group-housed settings such as catteries and shelters."

Elizabeth A. Berliner



© Sandrine Fontègne

Figure 1. A schematic image of the FCoV viral antigen. Spike **(S)**, membrane **(M)**, and envelope **(E)** proteins are anchored in a bi-lipid membrane. S and M proteins are important in gaining entry into cells, and current research suggests point mutations in the S gene play a role in transformation from FCoV to FIPV.

effusive disease, while the other 50% develop the less-effusive granulomatous presentation; however, the classic dichotomy is a false one, as the disease acts along a spectrum between effusive and non-effusive signs. This variation is theorized to depend on which branch of the immune system is most active in responding: the humoral system results in more effusive disease, and the complement system in the more granulomatous presentation (5).

Epidemiology and risk factors

FCoV is a ubiquitous virus, with sero-prevalence rates ranging from 25% in single cat households to 75-100% in group-housed settings such as catteries and shelters (6,7). The fatal FIPV mutation is a relatively rare occurrence; the reported incidence of FIP in FCoV seropositive cats ranges from 1% to 12%, with the higher rates recorded in older reports that primarily studied cattery populations (8,9). In general, it is estimated (based on the literature) that following FCoV exposure, 5-10% of cats will be resistant to the virus, 70-75% will undergo a transient infection for weeks to months, 10-15% will become chronic shedders, and less than 3% will go on to develop FIP (8).

The commonly supported "internal mutation" hypothesis posits that point mutations resulting in FIPV occur within certain cats based on viral factors (particular FCoV strains and mutability), environmental factors (overcrowding and viral load) and cat factors (genetic predisposition and immune response). Until recently, therefore, FIPV was not considered to be horizontally transmitted between cats; however, rare outbreaks of identical FIPV

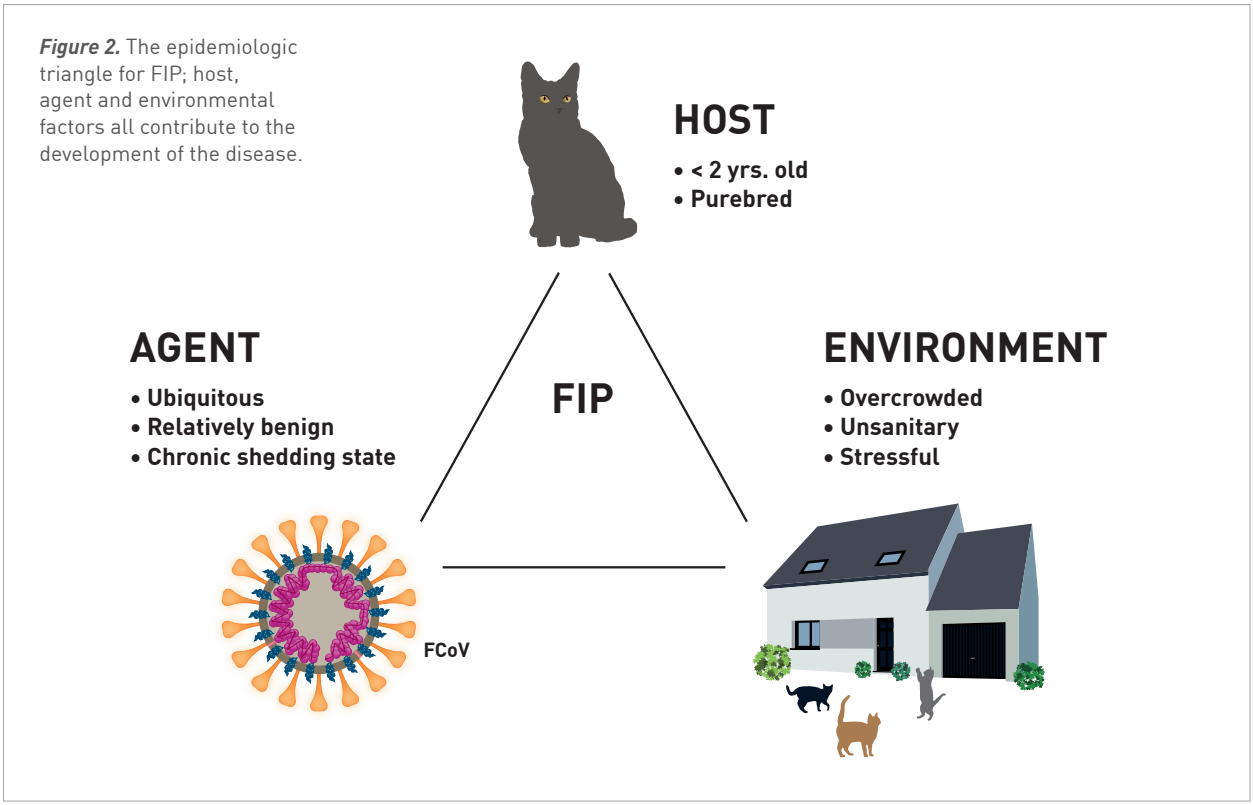


Figure 2. The epidemiologic triangle for FIP; host, agent and environmental factors all contribute to the development of the disease.

infections in groups of cats have been documented by molecular sequencing technology (10). FIPV is still not widely believed to be transmissible, although more high-risk strains or intermediate viral strains which are transmissible between cats may signal an increased risk for FIPV development and transmission in a population.

FIP is generally considered a disease of young cats (< 2 years of age). Kittens generally experience higher viral loads than adult cats, encounter more stressful events (including vaccination, neutering, and rehoming), and suffer from immature immune systems. While a subset of cats will eliminate high-risk mutations of the virus (as demonstrated in several laboratory challenge studies), most cats that develop FIP do so after their first exposure to FCoV, which usually occurs as kittens (5,8). Additional risk factors include being purebred and group-housed, especially in over-crowded or insanitary conditions, where high viral loads and physiologic stressors predominate **(Figure 2)**. Finally, older studies demonstrated a higher risk in cats also infected with FeLV or FIV, although this finding has not been consistent (11,12).

Clinical signs

Classically, FIP has been described in two clinical forms: "wet"/effusive and "dry"/non-effusive. However, FIP naturally occurs on a spectrum, with effusive disease at one end and non-effusive granulomatous disease at the other; the majority of cases present with both elements. Difficulties in diagnosing FIP relate to the non-specific clinical signs, the lack of pathognomonic abnormalities in hematology and biochemical tests, and the low sensitivity of current ante-mortem testing methods used in clinical practice.

Waxing and waning or persistent fever and inappetance are the most commonly reported early clinical signs. Particularly in kittens, early FIP can be confused with other more common infectious diseases, including panleukopenia and upper respiratory viruses. When effusion is present, it is the distinguishing feature and a key component of diagnosis. Cats with effusive disease often have abdominal distention, dyspnea, icterus or pallor. Many non-effusive presentations will include ocular lesions (uveitis, iritis, keratic precipitates)

"FIP occurs on a spectrum, with effusive disease at one end and non-effusive granulomatous disease at the other; the majority of cases present with both elements."

Elizabeth A. Berliner

© Gerald Duhamel, Cornell University

© Gerald Duhamel, Cornell University

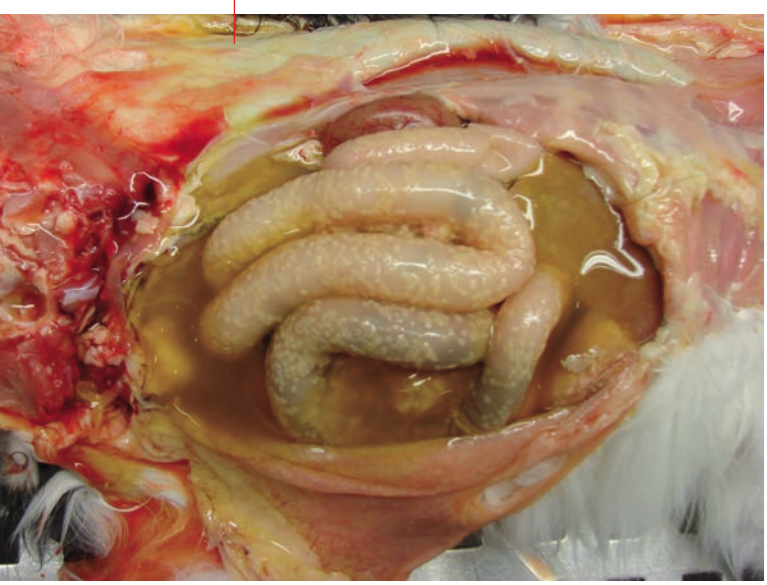
Figure 3. FIP effusion. **(a)** Classic FIP effusion is straw colored and highly viscous with a high protein count but low cellularity; fibrin clumps are also visible in this sample. **(b)** FIP effusion *in situ*. Pleural effusion surrounding FIP-affected lung lobes. Multi-focal to coalescing white-to-yellow granulomatous plaques are visible on the lung and the pleural lining of the thoracic cavity.

and neurologic abnormalities, which can raise the index of suspicion for FIP. Primary differentials for effusive FIP include neoplastic disease (lymphoma in particular), cardiac failure, and other causes of pleuritis and peritonitis. The less effusive form of FIP can mimic toxoplasmosis, FeLV, FIV, and cancer (lymphoma, adenocarcinoma and others).

Clinical signs are a direct result of antigen-antibody complexes binding to blood vessels. The result is the classic fibrinous and/or granulomatous vasculitis found on surgical or necropsy sampling of tissues. Fluid moves out of diseased vessels and into cavities, resulting in pleural, pericardial, and/or abdominal effusion **(Figure 3)**. In solid organs, lesions are primarily multi-focal to coalescing granulomas, which often track blood vessels **(Figures 4 and 5)**.

FIP is a progressive disease. Clinical signs change over time, and serial examinations in close succession (including ophthalmic and neurologic) can help to confirm an early clinical suspicion **(Figure 6)**.

Figure 4. The peritoneal cavity of a cat with FIP showing the classic pattern of diffuse multi-focal granulomas populating the serosal surfaces of the small intestine, the liver, and the peritoneum. Peritoneal effusion is also present.



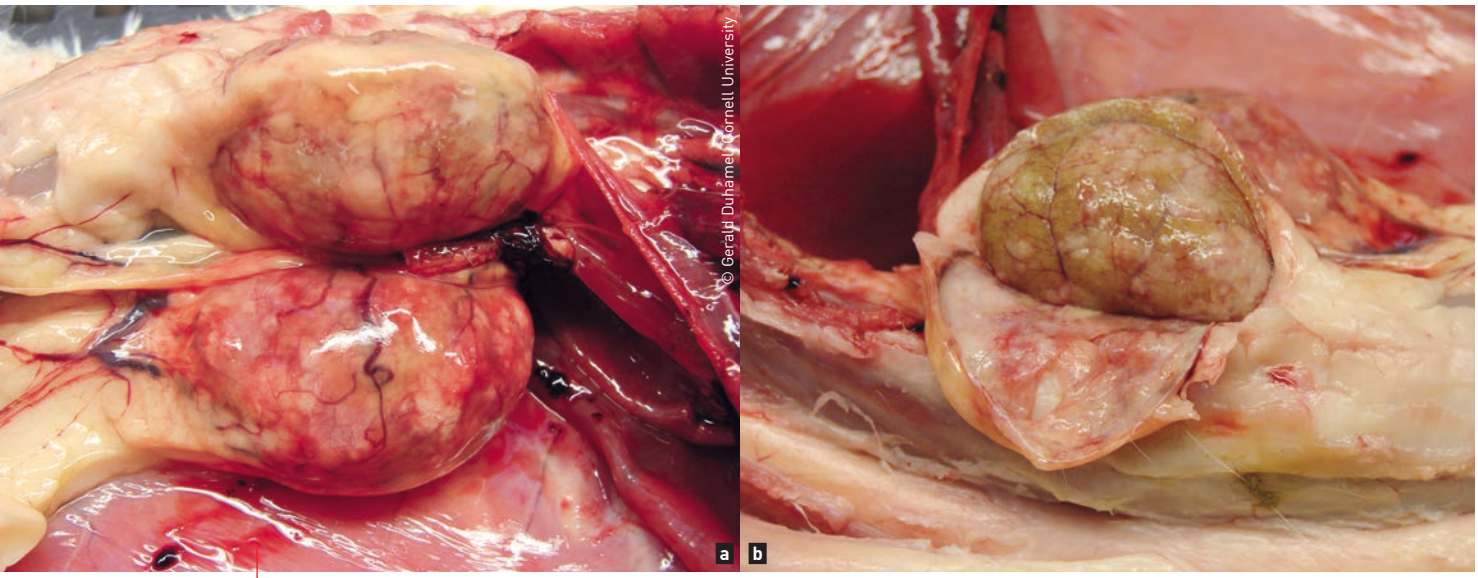
© Gerald Duhamel, Cornell University

Diagnostic testing

To date, the most definitive diagnosis of FIP is made by identifying FCoV or FIPV in tissue macrophages via immunohistochemistry and/or reverse-transcriptase PCR (RT-PCR). However, this requires collection of surgical biopsies or necropsy samples, which fails to offer non-invasive, ante-mortem means of diagnosis. Ante-mortem diagnosis is often presumptive, and is based on careful consideration of medical history and physical exam findings alongside hematology, clinical chemistry, and (when effusion is present) effusion analysis **(Box 1)**.

There are no pathognomonic bloodwork changes in FIP. Common findings on a complete blood count include a non-regenerative anemia with lymphopenia but usually without the neutrophilic leukocytosis commonly seen in a stress leukogram. Serum biochemistry profiles reflect an elevated total protein due to hyperglobulinemia in a majority of cats (13). Other associated findings include elevated liver enzymes and bilirubin levels due to organ damage.

Effusion analysis and testing provide the best ante-mortem confirmation of FIP. Effusion analysis, which can be accomplished patient-side, provides strong support for an FIP diagnosis when the total



© Gerald Duhamel, Cornell University

© Gerald Duhamel, Cornell University

Figure 5. The kidneys of a cat affected with FIP. **(a)** Multi-focal to coalescing granulomas concentrating around blood vessels are visible even through the capsule. **(b)** The capsule opened to reveal further detail of the lesions.

protein is greater than 3.5 mg/dL, and the cell count is minimal. An albumin:globulin ratio of less than 0.8 on the effusion is highly supportive of an FIP diagnosis. Immunostaining of effusions for FCoV antigen is not considered a sensitive modality since they contain few cells and/or antigen is often masked by bound antibodies (14).

RT-PCR for FIPV (not FCoV) on effusions is a relatively specific (95.8%) but fairly insensitive (68.6%) laboratory method for FIPV detection. As such, it is currently the best non-invasive method of confirming an FIP diagnosis. When positive, this test identifies particular mutations in the spike protein associated with FIPV. In cats with effusions, in which prevalence for FIP is 50-60%, RT-PCR for FIPV has a positive predictive value of around 95%. This test is not recommended for use on blood, serum or feces due to low presence of antigen and antibody-antigen binding. Additionally, many cats will have multiple coronavirus strains simultaneously, which can limit the interpretive value of this test.

Importantly, a positive serology for FCoV antibodies should never be interpreted as a diagnosis of FIP. Serology cannot distinguish between antibodies induced by the ubiquitous FCoVs and FIP-causing FCoVs.

Figure 6. Many cats with FIP will develop ocular signs (*e.g.*, uveitis, iritis, keratic precipitates) and the clinician should perform a full ocular exam as part of the clinical exam.

© Shutterstock

Treatment

FIP is considered uniformly fatal, although there are rare reports of prolonged disease or even recovery. It is usually rapidly progressive, with a median survival time of 9 days following diagnosis (15). Many antiviral drugs have been suggested in the past based on *in vitro* studies or use for other species and diseases; these include ribavirin, vidarabine, human interferon-alpha, and feline interferon-omega (13) but have been found to be largely ineffective for FIP. Palliative treatments that are readily available include immunosuppressants, which can have some impact on the progression of clinical signs; most commonly these include prednisolone or dexamethasone, but also include cyclophosphamide or chlorambucil (13). Non-specific immunostimulants have been used with anecdotal success to prolong life in some cats, but numbers are small and these are currently not recommended for FIP (16).

Currently treatment for FIP is a very active area of research, and there is great promise in some ongoing investigations. Polyprenyl immunostimulant (PPI) has undergone multiple laboratory studies and clinical trials,

Box 1. An algorithm for the diagnosis of FIP.

<table>
<tr><td colspan="2">History: less than 2 years of age, group housed (rescue, shelter, cattery), stressful event (neutering, rehoming), purebred cat</td></tr>
<tr><td colspan="2">↓↓↓</td></tr>
<tr><td colspan="2">Physical exam: pyrexia (persistent or intermittent), anorexia, weight loss, dullness</td></tr>
<tr><td colspan="2">↓↓</td></tr>
<tr><td>Effusion
• straw-colored, viscous, not purulent
• albumin: globulin ratio less than 0.8
• total protein greater than 3.5 mg/dL
• low leukocyte count (primarily neutrophils and macrophages)</td><td>No effusion
• requires further investigation
• intraocular signs (uveitis, iritis, retinitis)
• neurologic signs (ataxia, nystagmus)
• enlarged mesenteric lymph nodes
• abdominal masses</td></tr>
<tr><td>↓</td><td>↓</td></tr>
<tr><td>Likely FIP</td><td>Hematology: non-regenerative anemia, lymphopenia
Biochemistry: hyperglobulinemia, low albumin: globulin ratio, hyperbilirubinemia,</td></tr>
<tr><td rowspan="3">Confirmation: RT-PCR for FIPV specific mutations
Limitation: false negatives if antigen level is low</td><td>↓</td></tr>
<tr><td>Strong clinical suspicion for FIP</td></tr>
<tr><td>Confirmation: specialized testing on tissue biopsies
Limitation: invasive, expensive</td></tr>
</table>

demonstrating success in ameliorating disease in early cases of non-effusive FIP (17); furthermore, PPI is commercially available and licensed for treatment of feline upper respiratory infections in some countries. Other promising work includes a protease inhibitor (GC376) which has successfully resulted in temporary regression of clinical signs in both laboratory studies and clinical trials of affected cats (18). A commercial form of GC376 is expected to be licensed for release in the next few years in the US (19). A recent investigation of RNA transcription inhibitors (EVO984/GS441524) demonstrated dramatic reduction of viral replication in *in vitro* studies and reversal of clinical disease in 10/10 experimentally infected cats (20).

"Ophthalmic examination for iritis, uveitis, and retinal lesions is a useful component of FIP diagnosis in many cases."

Elizabeth A. Berliner

Vaccination

Currently there is one commercially vaccine available in the US, Europe and Canada for FIP. It is a modified live intranasal product containing a mutated FCoV. The American Association for Feline Practitioners (AAFP) groups vaccines into three general categories: core, non-core, and generally not recommended, and according to the AAFP Feline Vaccination Advisory Panel, the current FIP vaccine is not recommended, as there is "insufficient evidence that it provides clinically relevant protection" (21).

Implications for FIPV-exposed cats

As previously stated, FIPV is not thought to transmit horizontally between cats in most circumstances, which is why outbreaks of FIP are very rare. However, when a cat or kitten develops FIP, there is always concern regarding the degree of risk to other cats with whom that cat had contact. Unrelated cats exposed to a cat with FIP are considered to be at very low risk for developing FIP based on the "internal mutation theory" previously discussed. However, genetically related cats are at higher risk, given likely exposure to the same FCoV strain and similar genetic susceptibility to mutation; this is multiplied by the likelihood that related cats have also shared environments, and perhaps even shared stressors. Therefore, littermates of affected kittens are at highest risk for FIP development, and should be monitored for clinical signs.

The incubation period to FIP development, or course, can be months to years. Currently available diagnostic tests do not aid in predicting the outcome for cats that have been exposed to the virus but are currently nonclinical; however, molecular sequencing of FCoV point mutations may be the tool that changes this in the future.

Implications for FIP prevention in cat populations

FCoV can survive for up to 7 weeks in dry environments, but is easily inactivated by common detergents and disinfectants. In populations of cats, prevention and control measures for FIP are aimed at minimizing risk factors for development, including reducing exposure to FCoV as much as possible. Shelters and rescues should practice routine and thorough sanitation and disinfection protocols. Litter box hygiene should include frequent scooping, at minimum daily, and use of disposable litter boxes for kittens and cats with diarrhea. Avoiding overcrowding of cats is essential, and best practices in sheltering (22) to keep populations at humane levels and healthy should be followed. Ideally, unrelated litters of kittens should not be mixed, in order to avoid opportunities for sharing of viral strains and recombination events. However, an incidence of FIP of up to 1% is generally considered unavoidable in populations of cats. Investigation is warranted in catteries or shelters experiencing higher incidence of FIP; this should include assessment of sanitation and disinfection, handling and husbandry practices, cat housing, and stress management.

CONCLUSION

FIP is a devastating disease resulting from a complex interaction between mutated strains of FCoV, host immunity, and environmental loads and conditions. Researchers are simultaneously working to elucidate these points of mutation, means of early recognition or risk assessment, and treatments to slow or reverse progression of clinical signs. Promising advances have been made in the area of treatment in the last two years, and for the individual cat afflicted with this condition in private practice, these options may be both available and reasonable means of palliation. Eradicating FCoV is not an attainable goal, but minimizing viral load and exposure is the best method for reducing FIP occurrence in populations of cats.

REFERENCES

1. Holzworth J. Some important disorders of cats. *Cornell Vet* 1963; 53:157-160.
2. Gross D. How kitty litter went from happy accident to $2 billion industry. *Washington Post* Feb 2, 2015.
3. Benetka V, Kübber-Heiss A, Kolodziejek J, *et al*. Prevalence of feline coronavirus types I and II in cats with histopathologically verified feline infectious peritonitis. *Vet Microbiol* 2004;99(1):31-42.
4. Oguma K, Ohno M, Yoshida M, *et al*. Mutation of the S and 3c genes in genomes of feline coronaviruses. *J Vet Med Sci* 2018;80(7):1094-1100.
5. Pedersen NC. An update on feline infectious peritonitis: virology and immunopathogenesis. *Vet J* 2014;201(2):123-132.
6. Addie D. Clustering of feline coronaviruses in multicat households. *Vet J* 2000;159:8-9.
7. Pedersen NC, Sato R, Foley JE, *et al*. Common virus infections in cats, before and after being placed in shelters, with emphasis on feline enteric coronavirus. *J Feline Med Surg* 2004;6(2):83-88.
8. Addie D. Feline coronavirus infections. In: Greene CE (ed). *Infectious Diseases of the Dog and Cat, 4th ed*. Oxford, Saunders 2012;92-108.
9. Addie D, Jarrett O. A study of naturally occurring feline coronavirus infections in kittens. *Vet Rec* 1992;130:133-137.
10. Wang YT, Su BL, Hsieh LE, *et al*. An outbreak of feline infectious peritonitis in a Taiwanese shelter: Epidemiologic and molecular evidence for horizontal transmission of a novel type II feline coronavirus. *Vet Res* 2013;44(1):1.
11. Foley JE. Patterns of feline coronavirus infection and fecal shedding from cats in multiple-cat environments. *J Am Vet Med Assoc* 1997; 210(9):1307-1312.
12. Poland AM, Vennema H, Foley JE, *et al*. Two related strains of feline infectious peritonitis virus isolated from immunocompromised cats infected with a feline enteric coronavirus. *J Clin Microbiol* 1996;34(12): 3180-3184.
13. Addie DD, Belák S, Boucraut-Baralon C, *et al*. ABCD Guidelines on Feline Infectious Peritonitis. *J Feline Med Surg* 2009;11:594-604.
14. Hartmann K, Binder C, Hirschberger J, *et al*. Comparison of different tests to diagnose feline infectious peritonitis. *J Vet Intern Med* 2003;17(6): 781-790.
15. Ritz S, Egberink H, Hartmann K. Effect of feline interferon-omega on the survival time and quality of life of cats with feline infectious peritonitis. *J Vet Intern Med* 2007;21(6):1193-1197.
16. Pedersen NC. An update on feline infectious peritonitis: Diagnostics and therapeutics. *Vet J* 2014;201(2):133-141.
17. Legendre AM, Kuritz T, Galyon GD, *et al*. Polyprenyl immunostimulant treatment of cats with presumptive feline infectious peritonis in a field study. *Front Vet Sci* 2017;4;7.
18. Pedersen NC, Kim Y, Liu H, *et al*. Efficacy of a 3C-like protease inhibitor in treating various forms of acquired feline infectious peritonitis. *J Feline Med Surg* 2018;20(4):378-392.
19. Veterinary researchers and Anivive license antiviral drug for fatal cat disease [Internet]. Available at: www.k-state.edu/media/newsreleases/2018-09/fipantiviral92018.html [accessed Sep 30, 2018]
20. Murphy BG, Perron M, Murakami E, *et al*. The nucleoside analog GS-441524 strongly inhibits feline infectious peritonitis (FIP) virus in tissue culture and experimental cat infection studies. *Vet Microbiol* 2018;219:226-233.
21. Scherk MA, Ford RB, Gaskell RM, *et al*. Feline infectious peritonitis. *J Feline Med Surg* 2013;15:785-808.
22. The Million Cat Challenge. Capacity for Care [Internet]. Available at: www.millioncatchallenge.org/resources/capacity-for-care [accessed Sep 30, 2018]

THE THREE-STEP KITTEN CONSULTATION

Cyril Berg,

DVM, Mon Chat Et Moi, Orvault, Nantes, France

Dr. Berg graduated from Nantes Veterinary School in 1998 and worked in general first opinion practice for 13 years, as well as contributing to *Le Point Vétérinaire*, a specialist veterinary publication. In 2012 he opened a cat-only practice and is in the process of creating a second feline clinic. He is currently Vice Chairman of the Board at the Nantes-Atlantic National College of Veterinary Medicine, Food Science and Engineering.

KEY POINTS

- Bonding new owners and their kittens to the practice should be planned carefully to ensure that all essential points relating to pet ownership are covered.
- Offering a comprehensive preventative health program is beneficial to both the kitten and the practice.

Feline-only clinics are becoming more popular and cat owners will often expect a customized approach for their pet. Here Cyril Berg describes how he welcomes new kittens to his cat-only practice.

Introduction

Making a new kitten welcome to a veterinary clinic is very important, for three main reasons. It is beneficial for the cat's future health; it helps establish a good understanding between the pet and owner for their life together; and it aids in the development of the clinic. The veterinary team must be prepared to welcome each new kitten to the clinic using well-established procedures; it is essential that everyone knows their role and how to get the right messages across.

The different stages

Our clinic is accredited with the Cat Friendly Practice program, which has the aim of making "veterinary care less stressful for cats and their caregivers" (1). When the owner of a new kitten registers with our practice, we recommend three half-hour consultations when the kitten is between two and five months of age, with approximately one-month intervals between each one. We avoid longer consultations, as this can result in too much information being imparted, and which the new owners are unlikely to remember. Each consultation has specific aims and content **(Box 1)**. If a planned subject is not covered during a consultation — *e.g.*, because a medical problem is identified during the clinical

Box 1. The clinic aims to deal with the following factors during the three pediatric consultations.

Consult 1
Background details
Age and gender
Clinical exam
Basic nutrition
First vaccination
Parasite treatment
Infectious disease and preventative medicine
Behavioral and identification advice
Consult 2
Clinical exam
Growth check
Second vaccination
Parasite treatment
Behavioral advice
Consult 3
Clinical exam
Third vaccination (if required)
Good hygiene and health
Training
Neutering
Behavioral and identification advice
Virus tests and blood grouping

© Cyril Berg

Figure 1. Owners may appreciate being shown how to undertake tasks such as application of a flea product.

examination — the clinician will record what has been discussed, and the point(s) which have not been addressed can be dealt with at a subsequent consultation.

We encourage all owners to sign up to our comprehensive medical monitoring service, which we call our "prevention plan" — this encompasses the three pediatric consults, vaccinations, parasite products, neutering, and a "kitten party". This is a group session designed for owners with young (2-3.5 month old) kittens, with the idea of offering tips that help owners better understand and know their cat.

Visit 1: Introducing the idea of preventative medicine

Once we have welcomed the new kitten and owner to the practice, we start the first consultation by completing the patient's medical record, including information such as — Does the kitten have access to outdoors? What diet is fed? Is the cat insured? We discuss the principles of preventative medicine with the owner, explaining that cats grow quickly and that their needs will change as they mature. We explain that a cat may hide signs of illness or disease, and that it is essential for an owner to understand the issues involved in good medical monitoring, emphasizing that they should keep to our recommended program of visits to the clinic.

We then introduce the owner to our concept of the "health chain", from kitten through to senior cat: this involves the three pediatric examinations, neutering, a health check at one year of age, and subsequent half-yearly examinations.

We then check the cat's age and gender — it is not uncommon for a "male" cat to be female, or vice versa — and undertake a full clinical exam. Assuming all is well, the first vaccination is administered and the kitten treated for internal and external parasites. We take this opportunity to show the owner how to give oral medication and how to place a pipette (with a flea treatment product) on the skin **(Figure 1)**.

Identification of cats is compulsory in France, and we ensure that the owner is aware of this, and strongly recommend microchipping to help identify the cat if he/she strays from the house. We usually suggest that microchipping is done under anesthetic during neutering to minimize the chances of the kitten having unpleasant associations with the clinic.

We then provide some basic information on nutrition and advise that it is a good idea to introduce the kitten to different textures and smells. Owners are generally well aware of the importance of food in relation to their cat's health and will usually listen to our advice. However at our clinic, we prefer to go into full details regarding diet at the post-neutering check.

Lastly, during the first consultation we explain how to play with the kitten, the main idea being to discourage the kitten from playing with the owner's hands or feet. The objective is for a kitten to respect its owners and not view them as potential prey. It is important that the kitten learns about touch, so we also ask the owners to gently handle their cat daily. Touching the cat's mouth and teeth **(Figure 2)**, holding the paws and extending the claws, and stroking the ventral abdomen and lower back are all recommended.

Visit 2: Territorial and behavioral aspects

We start the second consultation with the owner by reviewing their past month with the kitten. We confirm that the topics of the first consultation have been learned, in particular how to approach the kitten and how to react in the event of aggression, as well as how to play with him/her. We repeat the clinical examination, check for satisfactory growth — using both body condition scoring and weight — and observe the progress of his/her behavior. This allows us to recommend any changes that may be necessary. The second vaccine is administered, along with appropriate antiparasitic products, and we briefly advise about possible adverse reactions.

"We recommend three half-hour consultations when the kitten is between two and five months of age; we avoid longer consultations, as this can result in too much information being imparted."

Cyril Berg

We then return to the idea that cats are territorial animals, and provide relevant advice (depending on whether the cat is indoor-only or has access to outside), such as emphasizing the benefits of environmental enrichment, and addressing issues regarding food intake, teaching a cat how to use a scratching post, etc.

Figure 2. Cats are best introduced to the concept of having their mouth opened — and teeth brushed — when young.

© Cyril Berg

Figure 3. A third full clinical exam is performed at the third visit, along with an assessment of the kitten's growth and behavior.

© Cyril Berg

Figure 4. Checking the kitten for flea dirt can be done at the same time as showing an owner how to groom their cat.

Figure 5. It is advisable that kittens become familiar with having their claws clipped if this is likely to be a regular part of their grooming routine.

Visit 3: Setting the stage for the future

Our last stage for the kitten involves a further medical examination, as well as monitoring its growth and behavior **(Figure 3)**. If required, the final inoculation is given — depending on the vaccination protocol employed (2) — and we discuss the principles of good hygiene. This covers aspects such as skin and hair care (brushing and shampooing); brushing the teeth; cleaning the ears and eyes; and clipping the claws **(Figures 4 and 5)**.

We then give some tips on training, for example using food or treats to help teach the cat some simple commands, a few games, and how a clicker box can be used as a training aid.

We end by discussing neutering, explaining its advantages and drawbacks. The owner should be given all the information in order to make a decision about neutering. We describe the surgery, the anesthetic and pain management. We also suggest that the cat is microchipped whilst under anesthetic, and recommend that we carry out tests for FeLV and FIV viruses, and determine the blood group for possible future reference.

CONCLUSION

A kitten's first visit to a veterinary clinic offers an ideal opportunity to educate the owner on how best to care for their pet. Key to this is the concept of preventative medicine, with an emphasis on regular clinical checks throughout the cat's life to ensure optimal health. A structured approach to the initial consultations will ensure that all aspects of pet healthcare are covered, maximizing the likelihood that the owner is bonded to the practice.

REFERENCES

1. https://www.catvets.com/cfp/cfp Accessed 10th October 2018.
2. Day MJ, Horzinek MC, Schultz RD, *et al*. Guidelines for the vaccinations of dogs and cats. *J Small Anim Pract* 2016;57;1. Available at; https://doi.org/10.1111/jsap.2_12431 Accessed 10th October 2018.

OPHTHALMOLOGICAL CONDITIONS IN KITTENS AND YOUNG CATS

Kittens and young cats are frequently presented at veterinary clinics with "eye problems". In this article Thomas Large and Ben Blacklock give an overview of some of the most common — and not-so-common — conditions that may be encountered.

KEY POINTS

1. Congenital ocular conditions can often present as multiple clinical abnormalities; therefore a thorough ocular examination is warranted in all cases.
2. Signalment, including breed and age, is especially important to consider when forming a complete "differentials list" to include congenital and hereditary causes of ocular disease.
3. PCR testing for infectious causes of ocular disease should always be interpreted in light of the clinical presentation, in order to avoid over-interpretation of results.
4. Diagnosis of infectious causes of conjunctivitis may be difficult, and trial response to therapy may be necessary as both part of treatment and diagnosis.

Introduction

A wide variety of ophthalmological conditions can present in kittens and young cats in practice. This article aims to review both common and uncommon clinical presentations of congenital and acquired ocular diseases to provide guidance on diagnosis and treatment. The conditions have been subdivided into those affecting different anatomical locations **(Table 1)** but inevitably crossover can exist, with some conditions affecting multiple ocular structures.

Globe

Microphthalmia

Microphthalmia is the congenital failure of the globe to fully develop and can present as a unilateral or bilateral reduction in globe size, with signs such as enophthalmos, third eyelid protrusion and entropion (1,2). Some case reports have shown that microphthalmia may present alongside other congenital ocular abnormalities such as eyelid coloboma, corneal dermoids, choroidal coloboma and choroidal hypoplasia (1,2). If secondary disease of the cornea or discomfort is caused by concurrent abnormalities then enucleation of the affected eye(s) may be necessary (2).

Periocular tissues

Eyelid coloboma

Eyelid colobomas are a congenital maldevelopment of the eyelids, for which the underlying cause is currently unknown. The condition can be unilateral or bilateral and usually involves the upper temporal eyelid margins, with the severity of defects varying in size from small notches to a complete absence of larger sections of eyelid tissue (3). Eyelid colobomas are often reported to be associated with other ocular abnormalities of the anterior and posterior segments — such as persistent pupillary membranes, retinal dysplasia and absence of a tapetum — as part of a "colobomatous syndrome" (1). In practice, the clinical signs relating to eyelid colobomas can vary depending on the severity of the defect. Clinical signs commonly include corneal inflammation, corneal ulceration and corneal irritation secondary to corneal exposure (due to ineffective closure of the eyelids) and trichiasis from adjacent hair shafts misdirected onto the cornea (1,3). An example of an eyelid coloboma is shown in **Figure 1**.

The treatment options for eyelid colobomas are predominantly surgical and focus on restoring as much of a functioning palpebral fissure as possible, as well as preventing trichiasis and further corneal

Thomas P. Large,

BVMedSci, BVM, BVS, MRCVS, Dick White Referrals, Cambridgeshire, UK

Thomas Large graduated from the University of Nottingham School of Veterinary Medicine and Science in 2015 and has been a practicing small animal veterinary surgeon since then. He recently completed a rotating internship at Dick White Referrals (DWR).

Ben T. Blacklock,

BVSc (Hons), Dipl. ECVO, MRCVS, Dick White Referrals, Cambridgeshire, UK

Ben Blacklock graduated from the University of Bristol in 2009 and spent his early years in a busy mixed practice in Lancashire. He then completed a small animal internship, followed by a residency in ophthalmology at the Animal Health Trust. Upon completing his residency, he moved to DWR to help expand and develop the ophthalmology department. Ben Blacklock is a European and RCVS recognized specialist in ophthalmology.

Table 1. Different ophthalmologic conditions in kittens.

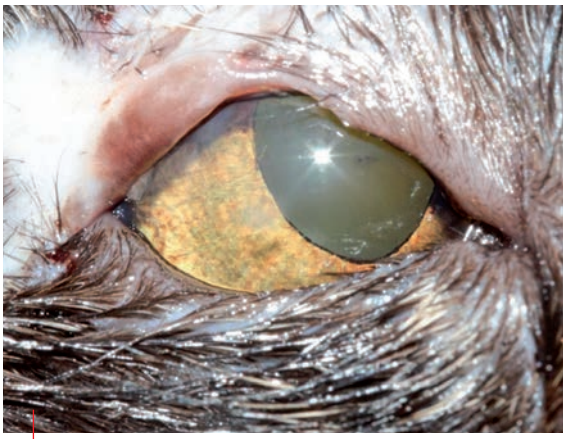
Globe
• Microphthalmia
Periocular tissues
• Eyelid coloboma • Entropion • Nictitans gland prolapse • Epiphora
Conjunctiva
• Infectious conjunctivitis • Neonatal ophthalmia
Corneal disease
• Dermoids
Uveal disease
• Persistent pupillary membranes • Uveal cysts • Lens disease
Retinal disease
• Retinal dysplasia

Figure 1. An eyelid coloboma seen in a young cat affecting the upper temporal eyelid margin. Note the trichiasis, epiphora and mucoid discharge.

irritation. For mild defects with inversion of the eyelid, a standard Hotz-Celsus procedure may be sufficient to prevent further corneal irritation from trichiasis. For larger defects several different surgical techniques are available which involve the transposition of adjacent periocular tissue to reconstruct the eyelid margin. One example, the Roberts and Bistner procedure, involves surgically dissecting a myocutaneous pedicle and transposing this from the lateral lower lid up to the lateral upper lid defect to create a new eyelid margin (4). Another procedure that has been shown to be successful in treating eyelid coloboma in cats creates a lip commissure to eyelid transposition, in which the superior and inferior lip is surgically dissected with a skin flap and rotated to create a new lateral canthus (5). An example of this can be seen in **Figure 2**. Eye lubricants may be helpful to protect the cornea prior to surgical correction in cases of corneal exposure or trichiasis.

Entropion

Entropion is the inappropriate infolding of either the upper or (more commonly) the lower eyelids and can cause chronic corneal irritation resulting in corneal edema, corneal ulceration, corneal pigmentation and vascularization. Primary entropion in cats occurs less frequently than in dogs and has been reported to occur more commonly in brachycephalic breeds such as the Persian (3).



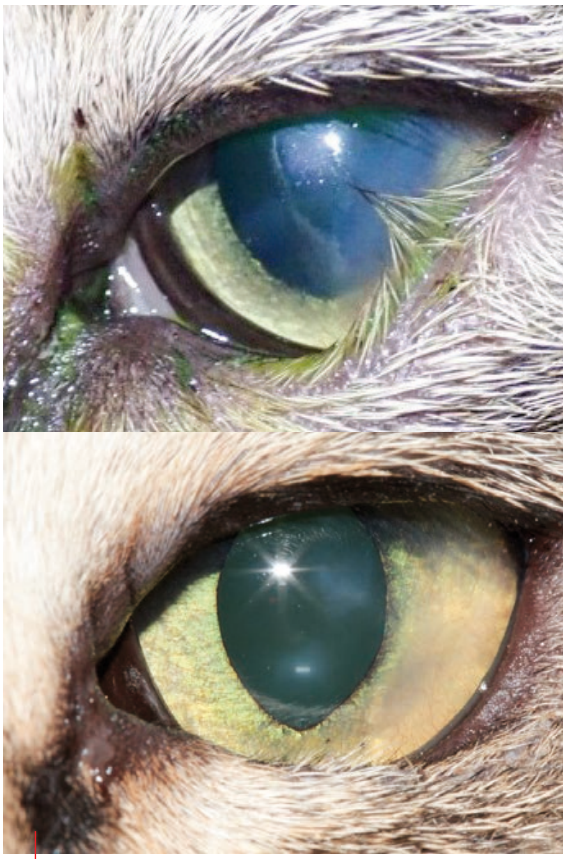
© Ben Blacklock

Figure 2. The same cat as in **Figure 1** following surgical correction using a lip commissure to eyelid transposition. Surgery has corrected the trichiasis and restored a functioning eyelid margin.

Entropion can also occur secondary to blepharospasm, in which the inversion of the eyelids can become permanent (3). Therefore, in kittens the etiology may be considered primary or secondary if there is a history of a painful or inflammatory ocular condition. Surgical treatment for entropion is necessary if secondary corneal disease is present. Mild cases may not require surgical correction but regular monitoring for signs of secondary corneal disease would be sensible. The preferred surgical technique is the Hotz-Celsus procedure (6) and the post-operative results can be seen in **Figure 3**. A recent review evaluating 124 cats that received surgical treatment for entropion found that this procedure, combined with lateral canthus closure, had a success rate of 99.21% (6). The results of the same review report that the Hotz-Celsus procedure alone can be sufficient to correct lower eyelid entropion, however in older cats a lateral canthus closure may help prevent recurrence (6).

"FHV is characterized by recurrent episodes of rhinotracheitis, conjunctivitis, corneal ulceration and keratitis, and is incredibly common; the vast majority of cats and kittens will be exposed to FHV at some stage in their lifetime."

Thomas P. Large



© Ben Blacklock

Figure 3. Pre- (upper) and post-operative (lower) pictures of a cat with lower eyelid entropion corrected with a Hotz-Celsus procedure. Note the trichiasis and secondary corneal edema due to chronic corneal irritation seen pre-operatively.

Nictitans gland prolapse

Prolapse of the nictitans gland has been reported in several breeds including the Burmese, Persian and domestic shorthair cats. Whilst not strictly a congenital condition, the age at presentation varies and can include kittens and young cats up to six years of age (3). Surgical replacement of the nictitans gland using the Morgan Pocket technique has been shown to be effective without recurrence in three individual cases of the breeds mentioned above (7).

Epiphora

The nasolacrimal duct in brachycephalic cats follows a more acutely angled path when compared with meso- and dolichocephalic breeds, and this can potentially obstruct the normal drainage of tears (8,9). This anatomical malformation can result in persistent epiphora, however other pathological causes of epiphora such as inflammatory, infectious or traumatic disease should be ruled out before assuming a structural cause. Persistent tear staining around the medial canthus may be seen in brachycephalic cats, and practical advice to the owner includes frequent grooming around the medial canthus and nasal skin folds to prevent secondary maceration of the periocular skin.

Conjunctiva

Infectious conjunctivitis

Conjunctivitis in young cats is a very frequent condition — indeed, it is one of the most frequent presentations of ophthalmic disease — and should be approached in a logical manner considering the more common differential diagnoses. Swelling of the conjunctiva, blepharospasm and muco-purulent ocular discharge can be seen in many cases. Whilst treatment using broad-spectrum topical antimicrobials may not be inappropriate initially, specific diseases may often persist and require more targeted therapy, as discussed below.

Several infectious causes of conjunctivitis exist in kittens and young cats, including Feline Herpes Virus (FHV), *Chlamydophila felis* (*C. felis*), Calicivirus, *Mycoplasma* and other bacterial infections.

Feline herpes virus-1 (FHV)

FHV is characterized by recurrent episodes of rhinotracheitis, conjunctivitis, corneal ulceration and keratitis. The vast majority (reported exposure rates of up to 97%) of cats and kittens will be exposed to FHV at some stage in their lifetime and are infected by aerosol or by direct contact with infected animals (10). FHV can track along the trigeminal nerve endings and become resident in the trigeminal ganglion, which results in over 80% of infected cats developing a latent infection. Approximately 50% of these go on to show recrudescent "flare ups" of clinical signs secondary to stress, concurrent illness or corticosteroid administration (10). Initial infection can start from around 8 weeks of age and present with rhinotracheitis, conjunctivitis, keratitis and punctate or dendritic ulcers **(Figure 4)** (10,11).

A distinguishing sign of FHV infection is the development of dendritic corneal ulcers, which can be seen as linear, "branch-like" corneal defects (12). Dendritic ulcers can usually be detected under fluorescein staining, as seen in **Figure 5**; smaller lesions may be more easily seen with Rose Bengal corneal stain. As the course of the disease progresses, dendritic ulcers can coalesce to form larger areas of geographic corneal ulceration (12). Symblepharon can occur as inflamed conjunctival or corneal tissue forms local adhesions, and should be broken down with gentle manipulation whenever noticed to avoid more permanent adhesions forming (3). Recrudescence of FHV often presents with similar, milder clinical signs as an acute infection but can also develop into a chronic stromal keratitis (10).

Diagnosis by PCR testing and conjunctival/corneal cytology can be considered. However, since the majority of cats have been exposed to FHV, both false positive and false negative results can occur with FHV PCR, therefore caution should be taken when interpreting results, and should always be considered in light of the clinical presentation and history (10).

Conjunctival and corneal cytology can help rule out other conditions which can present similarly, such as *C. felis*. Response to treatment may also

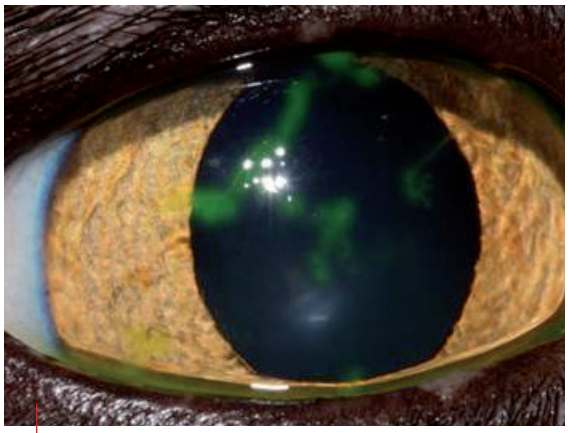


Figure 4. Herpetic keratitis in a 5-month-old Domestic shorthair with fluorescein-positive dendritic ulceration.

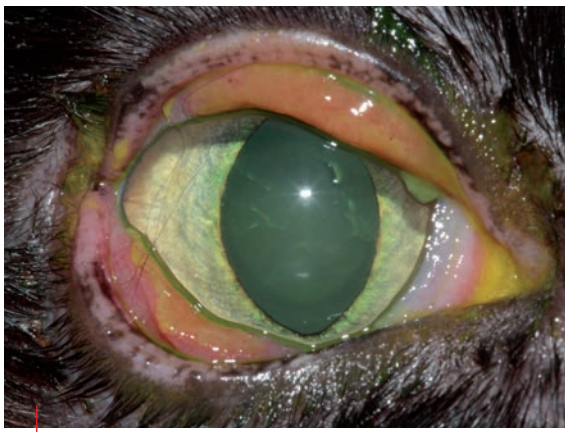


Figure 5. Chemosis and dendritic ulceration as seen in FHV infection. Note the fine linear areas of fluorescein uptake in the central cornea which are characteristic of dendritic ulceration as it tracts along the trigeminal sensory nerve endings.

be considered as an approach to diagnosis and treatment. Many mild cases of FHV recrudescence are self-limiting, and treatment may not be necessary, however when treatment is required systemic famciclovir at 90 mg/kg PO BID is recommended (13). The duration of treatment can vary depending on response, and in general should continue for a time beyond resolution of the clinical signs (13). Topical antibiotic preparations to treat possible secondary bacterial infections can also be used as an adjunctive treatment (14).

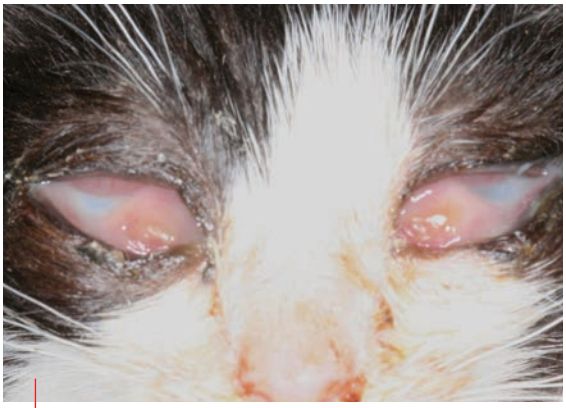
Chlamydophila felis

C. felis is an intracellular bacterial disease that can present with clinical signs of chronic unilateral or bilateral conjunctivitis and chemosis in young cats (3). It is transmitted by aerosol or contact from the environment with the pathogen. Diagnosis can be achieved via a commercial kit using special medical sampling devices[1] or standard

[1] *e.g.*, *Cytobrush® (Medscand®)

"Eyelid colobomas are a congenital maldevelopment of the eyelids, of unknown etiology. The condition can be unilateral or bilateral, and usually involves the upper temporal eyelid margins."

Ben T. Blacklock



© Taken with permission from *Feline Ophthalmology — The Manual* (18)

Figure 6. Neonatal ophthalmia in a 3-week-old kitten. Bilateral ankyloblepharon resulted in severe conjunctivitis and keratitis, which persisted after the eyelids had been opened.

conjunctival swab sampling of the conjunctiva for cytological examination, which can show inclusion bodies within epithelial cells (14). PCR testing of conjunctival swabs can also be a sensitive test to detect the *C. felis* organism in infected eyes, however sensitivity decreases with chronicity and therefore may be less reliable in achieving a diagnosis in chronic cases (15). Negative cytology and PCR results do not entirely rule out *C. felis*, therefore treatment may sometimes be decided on clinical suspicion alone based on presentation, clinical signs and a lower suspicion of other causes of conjunctivitis (especially if no corneal ulceration is seen). Treatment consists of systemic oral doxycycline at 10 mg/kg daily for at least 28 days (16). Note that it is recommended to give doxycycline with food or a small oral fluid bolus to reduce the risk of esophageal strictures. Signs can often resolve after several days, but treatment should continue for the full course.

Calicivirus

Calicivirus can occasionally cause conjunctivitis in cats but is mainly associated with upper respiratory tract disease and stomatitis (17). It is spread via contact with infected animals and the environment. Calicivirus can be diagnosed using PCR testing of conjunctival swabs, although caution is advised with interpreting a positive result as this can also occur in persistently infected shedders. Conjunctivitis associated with calicivirus tends to resolve spontaneously (3).

Neonatal ophthalmia

Neonatal ophthalmia is a term used to describe severe conjunctivitis in the neonatal kitten. If the eyelids are still fused by 14 days post-partum swelling of the orbit often develops, due to build-up of muco-purulent discharge **(Figure 6)** (3,18). Opening of the eyelids may be necessary, either by manual manipulation or sharp incision along the eyelid margin to drain mucopurulent discharge and to allow the application of topical antibiotic treatment.

Corneal disease

Dermoids

Corneal dermoids are an uncommon congenital abnormality seen in kittens. Dermoids have been reported in the Domestic Shorthair, Birman and Burmese breeds (19). They are characterized by an area of skin tissue inappropriately located on the ocular surface or closely associated structures. They have been reported to occur in several locations including the epibulbar region, lateral temporal cornea and dorsal cornea (19-21). Histological examination of ocular dermoids has shown them to be of a similar structure to skin, with an epidermal, subcuticular and dermal layer including sebaceous glands and hair follicles. The clinical signs associated with a dermoid can include epiphora, blepharospasm, conjunctivitis and blepharitis due to irritation of the associated ocular structures in contact with the hair shafts **(Figure 7)** (18).

© Taken with permission from *Feline Ophthalmology — The Manual* (18)

Figure 7. Conjunctival dermoid with a protruding tuft of hair causing conjunctivitis in a 3-month-old Birman.

© Taken with permission from *Feline Ophthalmology — The Manual* (23)

Figure 8. Persistent pupillary membrane remnants meeting centrally in the anterior chamber.

Surgical treatment is required to remove a corneal dermoid using a superficial keratectomy procedure to excise the abnormal tissue from normal underlying tissue. The prognosis following surgery is good providing all abnormal tissue is removed.

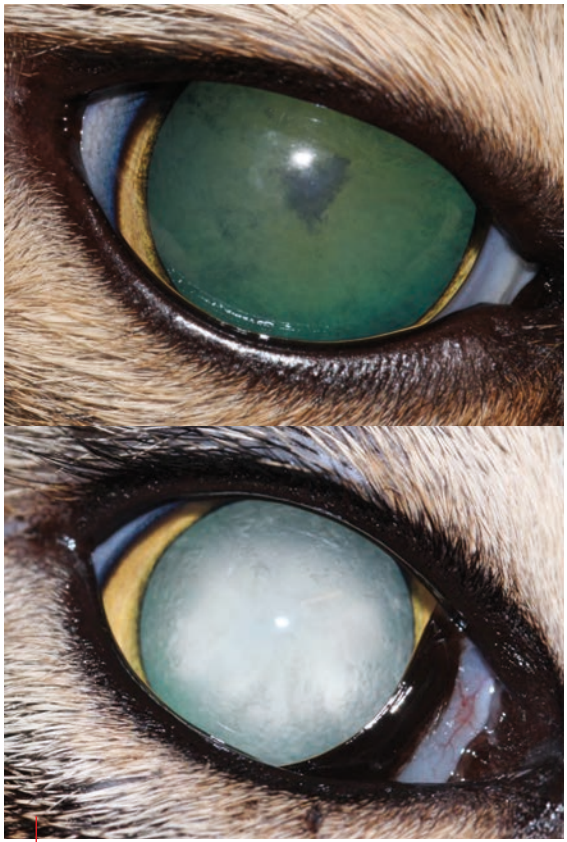
Uveal disease

Persistent pupillary membranes

Persistent pupillary membranes (PPMs) are an embryological remnant of the *tunica vaculosa lentis* (the embryological blood supply to the developing lens). They occur unilaterally or bilaterally in cats and appear as fine, filamentous, pigmented attachments originating from the iris collarette (the mid region of the iris) and can attach to other ocular structures such as corneal endothelium, lens and iris, or float free in the anterior chamber **(Figure 8)** (22,23). In some cases where a PPM attaches to the corneal endothelium, corneal opacities can occur secondary to the PPM causing traction on the endothelium, resulting in focal corneal edema (19). Diagnosis of a PPM is based on physical examination and the differentiation of a true PPM from a synechia that could be secondary to other ocular disease. The location of the origin of the pigmented strand at the iris collarette, and a lack of other ocular abnormalities suggestive of previous ocular disease, are suggestive of a true PPM. Treatment is not usually necessary, but the treatment options, if required, include topical mydriatics and surgical transection (3).

Uveal cysts

Anterior uveal cysts are an uncommon finding in cats and may occur as a congenital defect due to the embryological failure of adhesions between the layers of the optic cup. They may also occur spontaneously or secondary to ocular injury (24,25). Uveal cysts may be seen in one or both eyes; they are usually spherical, pigmented and can present as single or multiple cysts of varying sizes at any location along the posterior pupillary margin (24). Treatment is not usually necessary for most anterior uveal cysts, however if they are large and cause secondary issues (such as obstruction of vision or increased intraocular pressure) surgery with laser photocoagulation may be considered (26).



© Elena Fenollosa Romero CertVOphthal MRCVS, ECVO resident DWR, United Kingdom

Figure 9. Congenital/hereditary cataracts in a 2-year-old Domestic Shorthair cat (upper) and 4-year-old Domestic Shorthair cat (lower). Note the varied appearance of opacification of the lens and disruption of the fundic reflex.

Lens disease

Cataracts are focal or diffuse opacifications of the lens and in cats can be either congenital in origin or acquired. The cataract may be obvious on visual examination or may only be identified on careful ophthalmoscopic examination **(Figure 9)**. In a recent retrospective case series, 15% of cats presenting for referral to a veterinary ophthalmologist for cataract assessment were suspected to be congenital in origin (27). Although seen less frequently in cats than in dogs, congenital cataracts have been reported in the Birman, Himalayan, Persian and British shorthaired breeds, and may be associated with a mode of inheritance.

Developmental cataracts have been reported following kittens that were hand-reared with a commercial milk replacer in which the kittens developed incipient cataracts that were possibly related to low serum arginine concentrations during the feeding period (28). Thus environmental factors may also play a role in cataract development from a young age during development.

Chédiak-Higashi syndrome is a hereditary autosomal recessive condition that can present with congenital cataracts as well as pale irises, photophobia, hypopigmentation of the fundus and tapetal degeneration (29).

The treatment for cataracts in cats is dependent on the severity, and phacoemulsification can be considered if a cataract is causing secondary disease (3).

Retinal disease

Retinal dysplasia

Retinal dysplasia is a congenital malformation of the normal retinal tissues. The appearance of retinal dysplasia can be characterized by folding of the retina or rosette formation. Causes of retinal dysplasia have been reported to include Feline Leukemia Virus and Feline Panleukopenia Virus, and can also be seen with other congenital ocular conditions such as eyelid colobomas and Chédiak-Higashi syndrome (3).

CONCLUSION

Presentations of congenital ocular disease in cats, whilst infrequent and often breed-specific, are important for small animal veterinarians to be familiar with. Familiarization with the appearance of different congenital ocular conditions and good ocular examination technique can greatly aid the practitioner to advise owners on prognosis and treatment options for each individual case. Good knowledge of the differentiating clinical signs of specific diseases, the specific diagnostic tests available and individual treatment options means the majority of cases are able to be managed effectively in general practice. Further information on the topics discussed in this article, including surgical procedures, can be found in the references.

REFERENCES

1. Martin CL, Stiles J, Willis M. Feline colobomatous syndrome. *Vet Comp Ophthalmol* 1997;7:39-43.
2. Berkowski W, Langohr I, Pease A, *et al*. Microphthalmia, corneal dermoids, and congenital anomalies resembling Goldenhar syndrome in a cat. *J Am Vet Med Assoc* 2018;252(3):324-329.
3. Stiles J. Feline ophthalmology. In: Gelatt KN, Gilger BC, Kern TJ (eds). *Veterinary Ophthalmology 5th ed.* Oxford, Wiley-Blackwell; 2013;1477-1559.
4. Gelatt KN, Whitley RD. Surgery of the eyelids. In: Gelatt KN, Gelatt JP (eds). *Veterinary Ophthalmic Surgery 1st ed.* Philadelphia, Saunders Ltd; 2011;89-140.
5. Whittaker CJG, Wilkie DA, Simpson DJ, *et al*. Lip commissure to eyelid transposition for repair of feline eyelid agenesis. *Vet Ophthalmol* 2010;13(3):173-178.
6. White JS, Grundon RA, Hardman C, *et al*. Surgical management and outcome of lower eyelid entropion in 124 cats. *Vet Ophthalmol* 2012;15(4):231-235.
7. Chahory S, Crasta M, Trio S, *et al*. Three cases of prolapse of the nictitans gland in cats. *Vet Ophthalmol* 2004;7(6):417-419.
8. Breit S, Künzel W, Oppel M. The course of the nasolacrimal duct in brachycephalic cats. *Anat Histol Embryol* 2003;32(4):224-227.
9. Schlueter C, Budras KD, Ludewig E, *et al*. Brachycephalic feline noses: CT and anatomical study of the relationship between head conformation and the nasolacrimal drainage system. *J Feline Med Surg* 2009;11(11):891-900.
10. Gould D. Feline herpesvirus-1. *J Feline Med Surg* 2011;13(5):333-346.
11. Mitchell N, Oliver J. *Feline Ophthalmology – The Manual,* Grupo Asis Biomedica, S L, Zaragoza, Spain, 2015, p. 107.
12. Nasisse MP, Guy JS, Davidson MG, *et al*. Experimental ocular herpesvirus infection in the cat. Sites of virus replication, clinical features and effects of corticosteroid administration. *Invest Ophthalmol Vis Sci* 1989;30(8):1758-1768.
13. Thomasy SM, Maggs DJ. A review of antiviral drugs and other compounds with activity against feline herpesvirus type 1. *Vet Ophthalmol* 2016;19:119-130.
14. Thomasy SM, Lim CC, Reilly CM, *et al*. Evaluation of orally administered famciclovir in cats experimentally infected with feline herpesvirus type-1. *Am J Vet Res* 2011;72(1):85-95.
15. Sykes JE, Studdert VP, Browning GF. Comparison of the polymerase chain reaction and culture for the detection of feline *Chlamydia psittaci* in untreated and doxycycline-treated experimentally infected cats. *J Vet Intern Med* 1999;13(3):146-152.
16. Dean R, Harley R, Helps C, *et al*. Use of quantitative real-time PCR to monitor the response of *Chlamydophila felis* infection to doxycycline treatment. *J Clin Microbiol* 2005;43(4):1858-1864.
17. Fernandez M, Manzanilla EG, Lloret A, *et al*. Prevalence of feline herpesvirus-1, feline calicivirus, *Chlamydophila felis* and *Mycoplasma felis* DNA and associated risk factors in cats in Spain with upper respiratory tract disease, conjunctivitis and/or gingivostomatitis. *J Feline Med Surg* 2017;19(4):461-469.
18. Mitchell N, Oliver J. *Feline Ophthalmology – The Manual,* Grupo Asis Biomedica, S L, Zaragoza, Spain, 2015, p. 91-93.
19. Glaze MB, Acvo D. Congenital and hereditary ocular abnormalities in cats. *Clin Tech Small Anim Pr* 2005;20(2):74-82.
20. Labuc RH, Jones BR, Johnstone AC. Congenital dermoid in a cat. *N Z Vet J* 1985;33(9):154-155.
21. LoPinto AJ, Pirie CG, Huynh T, *et al*. Dorsally located corneal dermoid in a cat. *J Feline Med Surg* 2016;2(1):1-4.
22. Esson DW. Persistent pupillary membranes (PPM). In: *Clinical Atlas of Canine and Feline Ophthalmic Disease.* Chichester, John Wiley & Sons, Inc; 2015;171-173.
23. Mitchell N, Oliver J. *Feline Ophthalmology – The Manual,* Grupo Asis Biomedica, S L, Zaragoza, Spain, 2015, p. 134.
24. Blacklock BT, Grundon RA, Meehan M, *et al*. Uveal cysts in domestic cats: a retrospective evaluation of thirty-six cases. *Vet Ophthalmol* 2016;19:56-60.
25. Cook CS. Ocular embryology and congenital malformations. In: Gelatt KN, Gilger BC, Kern TJ, (eds). *Veterinary Ophthalmology 5th ed.* Oxford, Wiley-Blackwell; 2013;3-38.
26. Gemensky-Metzler AJ, Wilkie DA, Cook CS. The use of semiconductor diode laser for deflation and coagulation of anterior uveal cysts in dogs, cats and horses: a report of 20 cases. *Vet Ophthalmol* 2004;7(5):360-368.
27. Guyonnet A, Donzel E, Bourguet A, *et al*. Epidemiology and clinical presentation of feline cataracts in France: A retrospective study of 268 cases. *Vet Ophthalmol* 2018;00:1-9.
28. Remillard RL, Pickett JP, Thatcher CD, *et al*. Comparison of kittens fed queen's milk with those fed milk replacers. *Am J Vet Res* 1993; 54(6):901-907.
29. Collier LL, Bryan GM, Prieur DJ. Ocular manifestations of the Chédiak-Higashi syndrome in four species of animals. *J Am Vet Med Assoc* 1979;175(6):587-590.

TRITRICHOMONAS FOETUS IN YOUNG CATS

Large intestinal diarrhea is a common complaint in young cats presenting to primary care veterinary practices, and *Tritrichomonas foetus* is an important differential diagnosis for this condition, as Dan Thompson describes.

Dan Thompson,

MA, VetMB, PgCert VPS, CertAVP, MRCVS, Queen's Veterinary School Hospital, Cambridge, UK

Dr. Thompson graduated from the University of Cambridge in 2013 and initially worked in a first opinion small animal practice. He then returned to Cambridge to complete a small animal rotating internship before subsequently working for a year at a private veterinary hospital. In 2016 he took up a Small Animal Medicine Residency, funded by Royal Canin, at the Queen's Veterinary School Hospital in Cambridge. His clinical interests are in small animal nutrition, endocrinology and hematology.

KEY POINTS

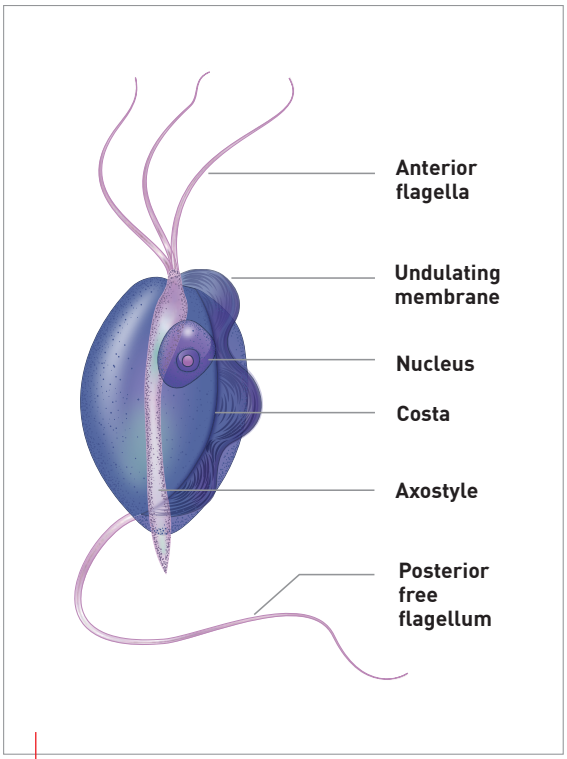
1. ***Tritrichomonas foetus*** **is a protozoal organism responsible for causing chronic large intestinal disease in young cats.**
2. **Diagnosis should be based on direct microscopy of fecal smears, fecal PCR and fecal culture.**
3. **The highest prevalence of *T. foetus* appears to be in purebred cats and animals kept in colonies. An increased risk of infection has also been associated with the use of shared litter trays and with social grooming.**
4. **Treatment with empirical anti-parasitic medications is not recommended if *T. foetus* is suspected without further investigation.**

Introduction

Diarrhea is a common reason for young cats to be presented to their primary care veterinarian. Practitioners are generally acutely aware of intestinal parasitic disease as a differential diagnosis for diarrhea, and many such patients will be treated empirically with anti-parasitic medications without further investigation. In many cases this appears to be effective, with relatively rapid improvement and cessation of clinical signs. Whilst the likes of *Giardia* and various helminths are likely to respond completely to such medications, the less-often considered *Tritrichomonas foetus*, a protozoan similar in appearance to *Giardia* species, cannot be cleared by such empirical treatments. This parasite can be a source of profound frustration for both cat owners and their veterinary surgeons, as clinical signs may initially appear to respond to therapy with standard anti-parasitic medications, but often return quickly after treatment is discontinued. Furthermore, the parasite can be challenging to diagnose unless sought specifically. It is therefore likely that increased awareness of this pathogen could lead to faster recognition and more effective treatment in young cats with apparently unresponsive or recurrent diarrhea.

Incidence, prevalence and predispositions

Tritrichomonas foetus (T. foetus) has a worldwide distribution, with an estimated prevalence of between 10-59% (1). Relatively limited data exists on specific geographic prevalences; however one study in a population of UK cats estimated that roughly 20% of healthy cats may be carriers of the protozoa, and a separate study looking at the



© Sandrine Fontègne

Figure 1. *T. foetus* is approximately 10-26 μm long and roughly 3-5 μm wide, and is often described as "pear-shaped" or "spindle-shaped" in form. Each organism has three anterior flagellae for motility.

prevalence of *T. foetus* in diarrheic fecal samples submitted to a UK lab identified the parasite in 14.4% of samples (2). In the USA, on the other hand, a population of show cats was found to have a higher prevalence of *T. foetus,* at 31% (3).

The highest prevalence of *T. foetus* appears to be in purebred cats and cats kept as part of colonies. It has been demonstrated that individuals housed with a smaller number of square feet of housing space per cat were also more likely to be carriers of the disease, suggesting that population density plays a significant part in infection risk. Similarly, an increased risk of infection has been associated with the use of shared litter trays and with social grooming (2,3).

Diarrhea caused by *T. foetus* is most commonly a disease of young cats, with a mean age of 8 months, and with greater than 75% of affected individuals being less than one year of age. However, cats of any age have the potential to carry the disease, and a proportion of these may develop clinical signs (1,4).

Etiology and pathogenesis

T. foetus is a flagellate protozoal organism that exists only in the trophozoite form. As such, there is no cyst formation (unlike the situation with giardiasis), and reproduction is achieved by simple binary fission. Visually the organisms are approximately 10-26 μm long and roughly 3-5 μm wide, and are often described to be "pear-shaped" or "spindle-shaped" in form. Each organism has three anterior flagellae (as compared to *Pentatrichomonas*, which has five), which allow the protozoa to be motile **(Figure 1)** (1,5).

In cats, *T. foetus* is primarily a parasite of the gastrointestinal tract, and localizes predominantly to the large intestine and, to a lesser extent, the distal ileum (6). This causes a mucosal inflammation manifesting as lymphoplasmacytic or neutrophilic colitis (7). Other clinical signs that have been documented repeatedly include anal irritation and occasional fecal incontinence. When present within the large intestine, the protozoa exist in close proximity to the intestinal mucosal surface and can often be found in association with colonic epithelial cells and crypts. Once in contact with the colonic wall, the organisms bind by specific receptor-ligand interactions, for which the binding is both competitive and saturable. Binding is to various cell surface molecules, including sialic acid lectins, lipophosphoglycans, cysteine proteases and adhesion proteins. Once bound, the organisms appear capable of breaking down both immunoglobulins and lactoferrins, allowing evasion of the immune system (8).

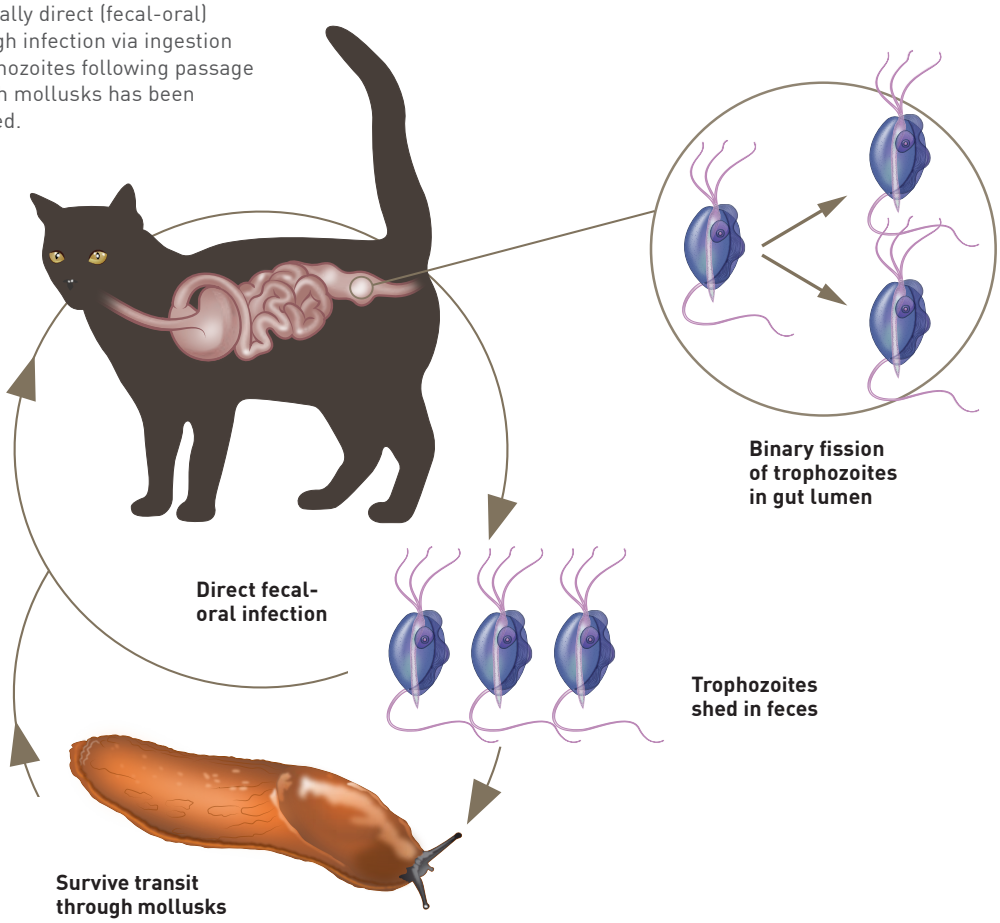
Transmission of the parasite is almost exclusively by the fecal-oral route. Trophozoites are shed in the feces of colonized cats, and are infectious in this form if consumed by another cat. There are currently no proven intermediate hosts, however it has been demonstrated that *T. foetus* trophozoites can survive ingestion and transit by terrestrial gastropod mollusks such as slugs, remaining infectious if subsequently eaten by a susceptible cat **(Figure 2)** (9). In the environment, the trophozoites can survive for several days if they remain in moist feces, however desiccation and death occurs in dry and aerobic environments (10).

Clinical presentation

Any age, breed or sex of cat can be affected. The commonly reported clinical presentation is one of chronic, waxing and waning large intestinal diarrhea. The diarrhea is often of a semi-formed consistency ("cow-pat") as oppose to watery, and in some cases may contain frank blood and/or mucous. Tenesmus is not infrequently reported, and some individuals may become intermittently partially fecally incontinent. The feces can also be profoundly malodourous in many cases. The consequence of the diarrhea and secondary regular grooming **(Figure 3)** is often the development of significant erythema and edema of the perineal region and anus that can be seemingly painful for the cat; less frequently rectal prolapse may occur secondary to inflammation and tenesmus (1,5).

Aside from the diarrhea and inflammation of the perineal region, most affected patients otherwise appear generally healthy. Some have been reported to be a little unthrifty, and occasionally patients are seen who have dropped below an ideal body condition score. Other described abnormalities include general non-specific findings such as poor coat quality, but no other specific clinical abnormalities are to be expected (1,5).

Figure 2. The life cycle of *T. foetus* is typically direct (fecal-oral) although infection via ingestion of trophozoites following passage through mollusks has been reported.



Diagnosis

A compatible signalment and history should raise suspicion for *Tritrichomonas foetus*. Differential diagnoses are presented in **Table 1**, and a thorough clinical work-up should be performed with a view to differentiating *T. foetus* from these other conditions.

Findings on routine blood testing in cases of *T. foetus* are generally non-specific, and parameters are often all within the reference intervals. However, bearing in mind the young nature of the patient population most at risk for *T. foetus*, it is important not to overinterpret parameters that are altered in young animals (for example, increased alkaline phosphatase and phosphate) when abnormalities on blood testing are present. Some changes may also be seen secondary to chronic clinical signs. The most common examples of this are alterations in electrolyte levels as a result of ongoing diarrhea, especially hypokalemia, hyponatremia and hypochloremia. These are generally mild and subclinical in nature, however more profound changes can occur in more severe disease (1,5).

While there are no changes on blood samples specific to *T. foetus*, it still remains a valuable part of the diagnostic work-up to exclude differential

Figure 3. Diarrhea in an affected cat can lead to excessive grooming and subsequent development of significant erythema and edema of the perineal region.

Table 1. Differential diagnoses for large intestinal diarrhea in cats.

- Parasitic, *e.g.*, *Cystoisospora*, *Cryptosporidia*, helminths
- Bacterial, *e.g.*, *C. perfringens*, *E. coli*, *Salmonella spp.*
- Dietary intolerance/hypersensitivity
- Inflammatory bowel disease (IBD)
- Drugs/toxins
- Neoplasia
- Renal disease
- Pancreatitis
- Toxoplasmosis
- Viral, *e.g.*, FIV, FeLV, FIP, FCoV
- Stricture
- Stress

diagnoses, identify co-morbidities and assess for electrolyte changes that need to be addressed as part of the treatment plan.

Similarly to blood testing, diagnostic imaging offers relatively little in the way of specific findings in cats with *T. foetus* (5). In severe cases, where there is profound colitis, there may be evidence of thickening of the colonic mucosa (either locally or diffusely) on abdominal ultrasound scanning, although the absence of such findings does not exclude the parasite as a cause. In cases where increased wall thickness is observed, no loss of intestinal wall layering would be expected — if present, this would increase suspicion of an infiltrative neoplastic disease rather than *T. foetus*.

As with blood testing, there is still good reason to perform diagnostic imaging in these cases. The absence of other clinical findings is indirectly supportive of *T. foetus* being the causal agent, and the imaging is a valuable tool for investigation of differential diagnoses.

Definitive diagnosis

Definitive diagnosis of *T. foetus* can be achieved either by direct visualization of the organism or by polymerase chain reaction (PCR) testing of the feces. Fecal culture can also be performed prior to smear preparation or PCR to increase the number of organisms present, and therefore increase the sensitivity of the tests.

Direct visualization is achieved using light microscopy to assess a fecal smear. This is a relatively simple examination and requires only a light microscope and slides, and is an ideal first-line test for *T. foetus.* It should therefore be performed in all cases of feline large-intestinal diarrhea at first presentation. It is important to note when performing a fecal smear assessment that both *Giardia* and *Pentatrichomonas hominis* can look very similar to *T. foetus* on light microscopy, and therefore care should be taken to accurately identify any parasites that are visualized (3,11). The importance of this relates mainly to treatment decisions, as *P. hominis* is a non-pathological protozoan requiring no treatment (1), whilst giardiasis is generally substantially more responsive than *T. foetus* to treatment and typically can be cleared using routine anti-parasitic drugs (*e.g.,* fenbendazole), unlike *T. foetus*.

Smears can be prepared from multiple sample types. Collection of samples from voluntarily passed fecal material is the simplest method, however if the patient is refusing to defecate within the hospital environment then alternative methods are reported to be successful. It is important to note that samples acquired from normal, non-diarrheic stools will rarely produce positive results, and therefore testing of such samples is not recommended (1).

Use of a rectal loop to acquire fecal material from within the colon has been found to be an adequate means by which to retrieve a sample, as has colonic flushing (1). Colonic flushing is a technique similar to that of a tracheal wash, whereby fluid is instilled into the rectum and colon with the cat under sedation. After instillation, gentle trans-abdominal palpation of the large intestine can be performed to facilitate mixing, before withdrawal of the fluid. This mechanism can generate two sample types: the first being a suspension that can be dripped onto a slide to create a wet preparation for direct light microscopy; the second being a larger sample for centrifugation to create a pellet on which PCR can be later performed.

A fecal smear for analysis is produced using the wet preparation. From colonic flush samples, a drop of the suspended material can be placed immediately on a slide and allowed to air dry. For samples collected from voided diarrhea or rectal loop, the sample should first be suspended in sterile saline before following the sample procedure. Once dry, the sample can be fixed and stained in-house using a Romanowsky stain to assist visualization. After application of a cover slip the sample can then be viewed under a light microscope using 20x or 40x magnification. Lowering the condenser can help improve identification.

Samples for fecal smear need to be examined fresh (within six hours of collection) (10), and therefore transportation to an external laboratory is suboptimal. After six hours the sensitivity of fecal smears as a diagnostic test for *T. foetus* begins to decrease, and therefore performance of the

"Increased awareness of *Tritrichomonas foetus* may lead to faster recognition and more effective treatment in young cats with apparently unresponsive or recurrent diarrhea."

Dan Thompson

examination in-house, immediately after the smear is prepared, is recommended (12). Fecal smear assessment is a very simple and inexpensive method for diagnosis, and the test has a very high specificity (*i.e.*, apparent identification of the parasite means it is very likely present); however, it suffers from a low sensitivity. A study to quantify this found that a single fecal smear can have a sensitivity of only 14%, and therefore it is strongly recommended that multiple smears from multiple samples are assessed to improve the chances of identifying the organism (3). Sensitivity is further worsened by the presence of sample contaminants such as cat litter, and therefore in cases where samples are being sent to external laboratories it is imperative that such contaminants are separated from the sample prior to postage (12). Sensitivity of testing is also reduced by antimicrobial treatment such as metronidazole, and therefore all antimicrobial therapy should be discontinued for at least several days prior to testing to mitigate the effects of this (1).

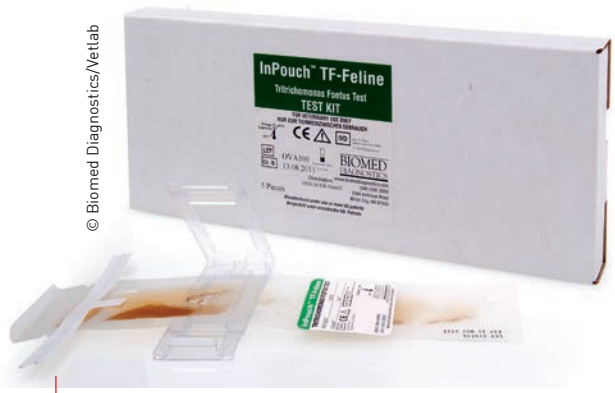
The alternative means of diagnosis of *T. foetus* is by fecal PCR. This can be performed as a first line test, but it is more expensive and takes longer than fecal smear assessment, and so is often performed after a negative smear result. In view of the low sensitivity of the fecal smear, all cases where there is a suspicion of *T. foetus* but where nothing is identified on microscopy should have fecal PCR performed. The test can also be used for confirmation of a diagnosis made on smear if there is doubt about the accurate identification of the parasite.

The PCR works by detection of one of a number of highly conserved portions of the *T. foetus* genome, and these most commonly utilize primers for the ITS1 and ITS2 genes (13). PCR is capable of detecting both living and dead parasites, and it has been reported that as few as 10 organisms are required within a sample for detection (14). The sensitivity of PCR has not been reported, however it is likely to be considerably higher than that of the fecal smear. It is also likely to be variable depending on the density of organisms within the sample, with more individual parasites leading to a greater sensitivity.

An important characteristic of the PCR test is its high specificity for *Tritrichomonas*. This means that where a cat is carrying *Giardia* or *Pentatrichomonas* that may be misinterpreted as *T. foetus* on smear, the PCR will not detect these other parasites and will be negative unless there is co-infection along with *T. foetus* (11). This makes PCR a valuable confirmatory test after identification on smear, and thus it is strongly recommended that PCR is performed alongside a fecal smear analysis in all cases (15).

Samples for PCR can be acquired similarly to those used for fecal smear. Again it is recommended that multiple samples from multiple days are pooled and submitted to increase sensitivity, as intermittent shedding has been reported (7). Samples of diarrhea can be submitted fresh, or colonic flush samples can be centrifuged to produce a pellet which can be submitted for analysis.

Although the sensitivity of PCR is thought to be greater than that of a fecal smear, this test also suffers from false negative results due to small numbers of organisms within samples. In order to improve the sensitivity of the test, a greater number of organisms is required, and one solution to this is to culture the organism prior to testing.



© Biomed Diagnostics/Vetlab

Figure 4. A commercial kit for culturing *T. foetus* from fecal samples is available in many countries.

A commercial kit **(Figure 4)** for culturing *T. foetus* from fecal samples is available[1]. This kit is a closed unit which requires inoculation with a very small fecal pellet (roughly rice-grain sized). The culture takes around 72 hours to perform if the pouch is incubated at 37°C, although at room temperature it can take as long as 12 days (16). The disadvantage of this test is therefore the potential to markedly increase the length of time before diagnosis, however there are also advantages. The first is that an increased number of organisms will improve the sensitivity of both a fecal smear and a PCR test. The second advantage is that the kit also contains a number of growth inhibitors that prevent co-culture of *Giardia* or *Pentatrichomonas*. These inhibitors prevent growth of both parasites, so any detected protozoa on fecal smear after culture has been performed are very likely to be *T. foetus* rather than an alternative parasite (16).

In view of the above information, the "gold standard" testing for *Tritrichomonas foetus* should be considered to be fecal culture followed by both direct fecal smear assessment and fecal PCR.

Treatment

Treatment and clearance of *T. foetus* can be a challenging and frustrating process. Patients often appear to respond clinically to courses of metronidazole, but this drug is not capable of clearing the infection and therefore, despite initial improvements in clinical signs, discontinuation of the drug will result in recurrence of the diarrhea (12). Treatment with metronidazole is actually thought to potentially increase the overall length of time an animal shows clinical signs, and it is not recommended for confirmed cases (1). Similarly, a treatment trial with metronidazole is not considered an appropriate method to differentiate *Giardia* (which may sometimes be cleared by metronidazole) from *T. foetus* (which is never cleared by metronidazole).

[1] "InPouch TF" (Biomed Diagnostics, White City, OR)

Unfortunately, *T. foetus* appears to be relatively resistant to conventional anti-microbial and anti-parasitic treatment. Currently only one drug has been reported to be effective at clearing infections. This is another drug from the nitroimidazole family, ronidazole (17). Ronidazole is not licensed or otherwise approved for use in cats in any country at the time of writing but is available from some veterinary compounding pharmacies for use off-license in the absence of an effective licensed treatment. This form of the drug is relatively expensive, but is recommended due to the reliable dose and formulation provided by a compounding pharmacy. If this option is not available, or if costs are prohibitive, the drug may also be acquired in powdered form as it is used to treat parasitic disease in pigeons. This formulation cannot be recommended as a first-choice drug due to the unknown quality and potentially variable formulation, but anecdotally it has been effective at clearing feline infections.

The reported dose for ronidazole is 30 mg/kg q24H PO for 14 days (18). The drug is well tolerated in many cats, however various side effects have been reported. These tend to be similar in nature to those seen with high doses of metronidazole, the majority of which relate to neurotoxicity. The most commonly seen side effects include lethargy, reduced appetite, ataxia and, if not discontinued, seizures (19). Most side effects will resolve quickly once medication is stopped, but substantial supportive care may be required if treatment is not discontinued as soon as side effects are noted (1). Side effects are considerably more common than those seen with metronidazole treatment, and this is thought to be related to the comparatively long half-life of ronidazole compared to metronidazole.

If the diarrhea recurs following treatment, in principle it would seem reasonable for the course to be repeated, particularly if a marked improvement is seen on medication followed by a sharp decline once finished. However, if there is a period of good health after the initial course followed by a deterioration weeks to months later, then it would be prudent to reconfirm the presence of *T. foetus* in case the clinical signs are caused by an alternative disease process.

Aside from ronidazole treatment, there is limited evidence for other management strategies. The author is not aware of any publication regarding dietary recommendation for this specific disease, but general rules for the management of enteropathies may be considered; any dietary alteration should be given careful consideration, as this can occasionally lead to large intestinal diarrhea, especially if a poor quality or unbalanced diet is employed. Supplementary antimicrobials are not appropriate. There is no evidence to support or refute the use of nutraceuticals and probiotics, therefore no recommendation can be made with respect to these.

CONCLUSION

Large intestinal diarrhea is a relatively common condition in young cats seen at primary care veterinary practices. *Tritrichomonas foetus* is an important differential diagnosis for this presentation and should therefore be tested for early in the diagnostic work-up. Gold standard testing involves fecal culture followed by both assessment of a fecal smear and fecal PCR. Treatment should be pursued once a diagnosis has been made, and ronidazole is currently the only known effective treatment.

Prognosis

Treatment with ronidazole usually results in relatively rapid improvement in both fecal consistency and fecal quality within the initial 14 day treatment period. However, in more severe cases, the time to improvement can take somewhat longer, and this is thought to reflect the level of colonic inflammation due to the higher parasite burden (1). In cats that are not treated for *T. foetus*, the diarrhea will eventually self-resolve in roughly 88% of cases, but this can take up to two years to occur (20). 55% of cats that self-resolve will remain infected and therefore may continue to shed trophozoites, making them a continuing infection risk for other cats. This management strategy is therefore not recommended.

REFERENCES

1. Gookin JL. Trichomoniasis. In: Greene CE, ed. *Infectious diseases of the dog and cat.* 4th Ed. St Louis: Saunders 2012;797-801.
2. Gunn-Moore DA, McCann TM, Reed N, *et al*. Prevalence of *Tritrichomonas foetus* infection in cats with diarrhea in the UK. *J Feline Med Surg* 2007;9:214-218.
3. Gookin JL, Stebbins ME, Hunt E, *et al*. Prevalence of and risk factors for feline *Tritrichomonas foetus* and *Giardia* infection. *J Clin Microbiol* 2004;42:2707-2710.
4. Gookin JL, Breitschwerdt EB, Levy MG, *et al*. Diarrhea associated with trichomonosis in cats. *J Am Vet Med Assoc* 2009;215:1450-1455.
5. Lappin MR. Trichomoniasis. In: Sykes JE, ed. *Canine and Feline Infectious Diseases.* St Louis: Saunders 2014;779-783.
6. Gookin JL, Levy MG, Law JM, *et al*. Experimental infection of cats with *Tritrichomonas foetus*. *Am J Vet Res* 2001;62:1690-1697.
7. Yaeger M, Gookin JL. Histologic features of *Tritrichomonas foetus* colitis in domestic cats. *Vet Pathol* 2005;42:797-804.
8. Tolbert MK, Gookin JL. Mechanisms of *Tritrichomonas foetus* pathogenicity in cats with insights from venereal trichomonosis. *J Vet Intern Med* 2016;30:516-552.
9. Van der Saag M, McDonell D, Slapeta J. Cat genotype *Tritrichomonas foetus* survives passage through the alimentary tract of two common slug species. *Vet Parasitol* 2011;177:262-266.
10. Hale S, Norris JM, Slapeta J. Prolonged resilience of *Tritrichomonas foetus* in cat feces at ambient temperature. *Vet Parasitol* 2009;166:60-65.
11. Gookin JL, Stauffer SH, Levy MG. Identification of *Pentatrichomonas hominis* in feline fecal samples by polymerase chain reaction assay. *Vet Parasitol* 2007;145:11-15.
12. Foster DM, Gookin JL, Poore MF, *et al*. Outcome of cats with diarrhea and *Tritrichomonas foetus*. *J Vet Intern Med* 2003;17:380.
13. Gookin JL, Birkenheuer AJ, Breitschwerdt EB, *et al*. Single-tube nested PCR for diagnosis of *Tritrichomonas foetus* in feline feces. *J Clin Microbiol* 2002;40:4126-4130.
14. Stauffer SH, Birkenheuer AJ, Levy MG, *et al*. Evaluation of four DNA extraction methods for the detection of *Tritrichomonas foetus* in feline stool specimens by polymerase chain reaction. *J Vet Diagn Invest* 2008;20:639-641.
15. Gookin JL, Birkenheuer AJ, St. John V, *et al*. Molecular characterization of trichomonads from feces of dogs with diarrhea. *J Parasitol* 2005; 91:939-943.
16. Gookin JL, Foster DM, Poore MF, *et al*. Use of a commercially available culture system for diagnosis of *Tritrichomonas foetus* infection in cats. *J Am Vet Med Assoc* 2003;222:1376-1379.
17. Gookin JL, Copple CN, Papich MG, *et al*. Efficacy of ronidazole for treatment of feline *Tritrichomonas foetus* infection. *J Vet Intern Med* 2006;20:536-543.
18. LeVine DN, Papich MG, Gookin JL, *et al*. Ronidazole pharmacokinetics after intravenous and oral immediate-release capsule administration in healthy cats. *J Feline Med Surg* 2011;13:244-250.
19. Rosado TW, Specht A, Marks SL. Neurotoxicosis in 4 cats receiving ronidazole. *J Vet Intern Med* 2007;21:328-331.
20. Foster DM, Gookin JL, Poore MF, *et al*. Outcome of cats with diarrhea and *Tritrichomonas foetus*. *J Am Vet Med Assoc* 2004;225:888-892.

FELINE FEEDING TOYS

Ingrid Johnson,

CCBC, Fundamentally Feline, Atlanta, GA, USA

Ingrid Johnson is a Certified Cat Behavior Consultant (CCBC) who owns and operates a business dedicated to providing in-home and phone consultations for clients experiencing behavior challenges with their cats. She and her husband also run their own company supplying feline foraging toys and other cat-related products. She has a keen interest in food puzzles and how they can be used to stimulate physical and emotional well-being for cats.

KEY POINTS

- Cats are hunters by nature, and foraging toys can both offer environmental enrichment and mimic natural feeding patterns.
- There are many different sorts of foraging puzzle available, but a cat should be introduced gradually to the concept of "feeding toys".

Many cats are subjected to their owner's choice of feeding times and methods, which is a very artificial situation. Foraging toys can be used in almost any home environment and offer cats both mental and physical stimulation, as Ingrid Johnson describes.

Introduction

Offering cats the opportunity to work for their food, just as they would hunt outdoors, is an often overlooked form of enrichment. This is especially true for the indoor-only cat. Giving cats a bowl full of dry food, as so many owners do, or feeding them only twice a day to keep them trim, is frustrating for cats and often results in behavioral problems. Foraging is the middle ground solution between free feeding and strict meal feeding. Boredom, frustration, and environmental stress are some of the most common reasons for feline behavior problems. Foraging provides cats with something to do with their time, offering "positive frustration" by giving them a problem to solve (1). The behavior becomes self-fulfilling as the cat is rewarded with food as it figures out the puzzle.

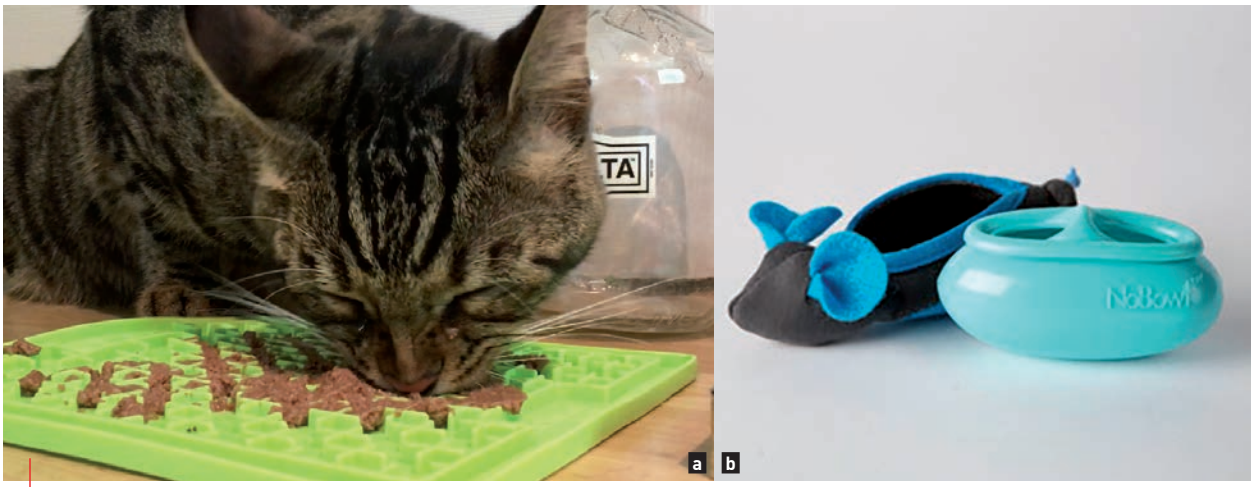
Dietary needs and eating style

Before foraging toys are offered, it is necessary to understand what and how cats eat. Cats are obligate carnivores, and naturally nibble and pick, eating nine to sixteen small, evenly sized meals throughout the day (2). In fact, there is evidence that meal-fed cats may be more aggressive and less cooperative than cats fed by free choice (2).

Cats are not family-style eaters. They are a social species that live in groups, but they hunt and eat alone (2). Unlike the big cats, our domestic cats prey on small animals which are not suitable for sharing. Cats also prefer — and take great comfort in — controlling their resources and basic needs. When control is taken away, often unintentionally by the owners, this creates stress. Free access to food, water, toileting areas and safe resting places are key to a cat's wellbeing and mental health. So we need to allow our cats to eat... but make them work for it. This is where foraging toys come into play.

Getting started

A cat's first foraging toy should be easy. The cat needs to learn the "game" and be rewarded for the behavior. There are basically two types of foraging toys or food puzzles, rolling and stationary. The toys can either be purchased or homemade, and may be designed to be used with wet or dry food **(Figure 1)**, or a combination of both, although wet food puzzles require a bit more creativity to implement. As a whole, and in the author's experience, rolling puzzles are more challenging than stationary puzzles, but every cat is different. If weight loss is a desired goal, rolling puzzles will make the cat work harder. Encouraging cats to forage from both types of toy will increased their versatility and add mental stimulation and enrichment.



© Ingrid Johnson

© Liz Bales

Figure 1. Two simple feeding puzzles. **(a)** A commercially produced stationary puzzle that can be used for wet or dry cat food. **(b)** A commercially produced toy designed to hold a small amount of kibble with a fake mouse outer "skin". This type of toy allows the cat to see the food but requires a degree of manual dexterity to manipulate the toy to enable the kibble to drop out.

Stationary puzzles are probably the easiest option for beginners. They can be as simple as an old ice cube tray or muffin tin, where the cat simply needs to reach in and scoop the food out with a paw **(Figure 2)**. It is especially important to offer a stationary puzzle if a cat finds a rolling puzzle too challenging.

For rolling puzzles, start with objects that are translucent so that the cat can see, smell, and hear the food rattling around inside the toy **(Figure 3)**. Spherical toys are easiest for beginners because they roll easily and are less frustrating. The object should have multiple holes where the food can dispense; three-holed objects are sufficient for almost all beginners (3). Some cats who have been strictly meal-fed may take to foraging so quickly that they can almost immediately transition to one- or two-hole puzzles.

Rolling puzzles should be filled at least one-half to three-quarters full, as an almost-empty puzzle can be too challenging and lead to frustration. Initially it can help if the owner sprinkles some dry food around the toy; as the cat eats these pieces it will probably nudge the toy and dispense more kibble. For slow starters the rolling puzzle may be left open in two halves and the cat can pull the food out with a paw. Then, having noted a positive experience with the object, the owner can reassemble the toy loaded with food, again with extra kibble sprinkled around it; most cats will push the toy with their muzzle or paw, knowing that just yesterday the device provided a meal.

Toys can be introduced at almost any point in a cat's lifetime; it is possible to start feeding toys with kittens as young as 8-10 weeks of age, although they often do not have the attention span for foraging at this stage. Whilst they may show little interest at first, given time they will start to engage more fully.

Motivating cats to forage

There may be little motivation for a cat to work for what has been readily available in a bowl for years. In this situation it is worthwhile putting a unique food in the toy to spark some interest. This will encourage a cat to think it is foraging for treats, even though it is just a different type of food.

© Ingrid Johnson

Figure 2. An ice-cube tray can be used as a very simple "stationary" puzzle for beginners.

Some cats do well if the foraging toy is placed in their normal feeding area; for others, putting it in a new and interesting location seems to spark more interest. It is worth trying both options — the ultimate goal is to scatter the puzzles throughout the home, especially in a multi-cat household, although initially it may be necessary to try different tactics to encourage their use.

If a cat is still struggling to use a puzzle it is worth spiking the toy with treats mixed with the normal food. This can be sufficient to stimulate interest. For a very slow starter simply try hiding small handfuls of food around the house for the cat to discover. This will at least get the pet into the habit of starting to search for its food.

It is also helpful to mimic a cat's natural habitat and feeding practices. So for example a textured toy can mimic what a cat would experience if it was rooting through grass searching for food **(Figure 4)**, and using a dental diet can mimic the masticatory action of a cat eating natural prey — although the choice of diet will in part be dictated by the animal's health status. Owners can be encouraged to incorporate such foods when introducing

© Ingrid Johnson

Figure 3. A commercially produced semi-transparent rolling puzzle. The cat can visualize the food, which is dispensed through three holes. Oval-shaped toys will roll eccentrically and can be more challenging for a cat to master. Further complexity can be introduced by using one toy inside another.

© Ingrid Johnson

Figure 5. A commercial stationary "tunnel feeder" puzzle with a ping-pong ball, filled with food, placed inside to increase the challenge. If used without the ball as an obstacle a cat should find it much easier, and it would be suitable as a beginner's toy.

the concept of foraging; most will want to use something unique in the toy that is also good for the cat, rather than just filling the toy with treats.

It is never appropriate to starve a cat into eating a new food or to adopt an "if they are hungry enough, they will eat it" attitude. This will not work, and could make a cat unwell. Cats are excellent hunters and, when outdoors, would generally not go nearly as long without eating as a dog would. It is imperative that cats eat every day.

Staging the difficulty level

Once a cat gets the hang of foraging toys, gradually begin increasing the challenge. Decrease the number of openings in the object, so it becomes more difficult to dispense food. Start by offering objects that do not roll as predictably as a ball, or objects that are opaque so that the cat has to be motivated by scent and previous learned experiences. Larger heavier objects present yet another challenge: these are generally more difficult to push, and although such puzzles can be more challenging for some kittens, such toys are great for multi-cat households.

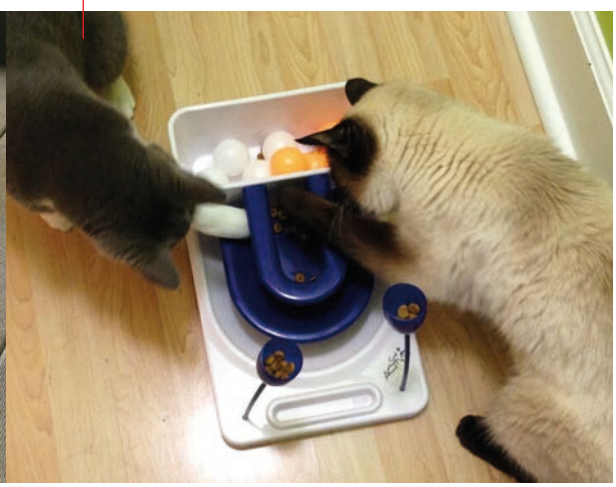
Combining toys is another way to increase the challenge. Take a smaller object that the cat has mastered and place it inside another object so they have to manipulate it twice to achieve a reward **(Figure 5)**. Most cats can learn to cope with this level of foraging sooner or later (4).

As mentioned above, stationary puzzles serve as great beginner toys for many cats, helping them learn the concept of foraging if they do not grasp

Figure 4. A textured feeding puzzle that can mimic what a cat would experience if it was rooting through grass searching for food.

© Ingrid Johnson

Figure 6. A challenging stationary puzzle that can be used by more than one cat at a time. Here a cat has to use its paws to reach into the object and extract the kibble.



© Ingrid Johnson

© Ingrid Johnson

© Ingrid Johnson

Figure 7. Home-made puzzles can be constructed with a bit of ingenuity and imagination. **(a)** A puzzle made from an old seat with multiple holes cut in it to allow a cat to forage for food and toys. A sisal mat is also secured to one side of the seat for use as a scratch post. **(b)** A very simple puzzle made from cardboard tubes, weighted with a stone to keep it stationary.

how to use rolling puzzles. Stationary foraging toys can also be made more complex (5), so that a cat has to use its paws to reach into the object and extract the kibble rather than rolling a loose object with their paws or muzzles **(Figure 6)**. To make things more difficult a rolling, food-filled toy can be inserted inside the stationary puzzle.

Home-made devices can be very effective **(Figure 7)** and are often easily made utilizing everyday items; for example, an old shoebox with holes cut in the top and sides of the box, filled with toys and food and with the lid taped securely shut — most cats are smart enough to flip off the lid otherwise. If used with rolling toys inside, the holes should be a little larger than the toys so that the cat can pull the toy out if desired.

Cube-shaped objects are one of the most difficult objects for cats to manipulate. Start by offering transparent cubes, as this allows cats to see the kibble as well as using scent and sound. Introduce cube-shaped toys on carpets or rugs where the pile makes it easier for the cat to learn how to flip the object. On hardwood floors, cats tend to simply push the toy around and become frustrated, but eventually they will usually learn to use the cube on any surface, and at this stage opaque cubes can be introduced as the next level of challenge.

The ultimate goal is to employ the most difficult toy that an individual cat can learn to use. Owners should not have unrealistic expectations or be disappointed; just as individual people vary in their abilities, so do cats. However, almost every cat can acquire the ability to use food puzzles. The author has had three-legged cats, blind cats, geriatric cats, and cats with hindlimb paralysis who have learnt how to forage. Do not underestimate a cat's ability!

Setting up for success

So how do owners comply with feeding cats long term using puzzles? It may be necessary to encourage reluctant owners by reminding them that such puzzles are not just a feeding protocol but also offer environmental enrichment. Time-poor owners can be advised to acquire lots of foraging toys and pre-fill a week's supply, storing them in an airtight container until required. This also allows a new toy to be offered to a cat each day. Note that, while no clinical studies have been undertaken, the author believes that cats need a selection of puzzles; it would seem to be less rewarding for a cat to tackle the same puzzle every day.

CONCLUSION

Foraging offers cats something to do all day and allows for a variation of free feeding, which can in particular be very helpful in a home with multiple cats who are being meal-fed, a practice that can cause fighting or aggression due to increased competition and lack of environmental control. Foraging also allows cats to eat when and where they choose and creates much less stress by eliminating "meal time" — and can also potentially be an effective dieting aid for overweight cats.

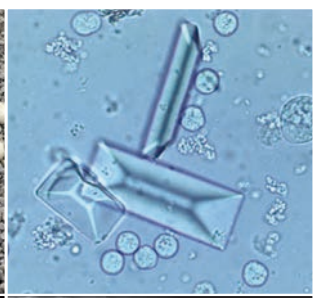
REFERENCES

1. Neville P. An ethical viewpoint: the role of veterinarians and behaviourists in ensuring good husbandry for cats. In *Proceedings*. AAFP American Association of Feline Practitioners Congress 2002; 156-157.
2. Beaver BVG. Feline behavior: A guide for veterinarians. 2nd ed. St. Louis: Saunders; 2003:219-221.
3. www.fundamentallyfeline.com/implementing-foraging-as-a-feeding-protocol. Accessed September 25th 2018.
4. www.fundamentallyfeline.com/so-you-think-you-have-a-master-forager. Accessed September 25th 2018.
5. Johnson I, Delgado M. Food puzzles for cats. http://foodpuzzlesforcats.com. Accessed 12th January 2019.

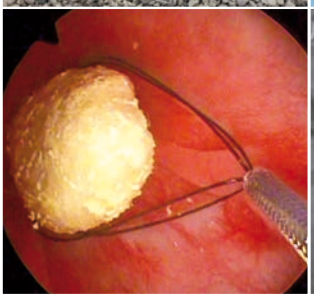
veterinary focus #29.2

The worldwide journal for the companion animal veterinarian

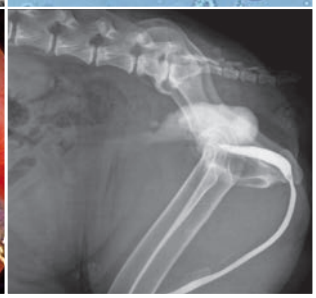
© Blücare Lab



© Paola Scarpa



© Marilyn Dunn



© Rafael Nickel

COMING UP...

In our next issue, we will look at various aspects of urinary disease in cats and dogs.

- Common mistakes in urinalysis
  Paola Scarpa, Italy
- Specific gravity and urinary calculi in cats
  Cecilia Villaverde, Spain
- How I approach... the dog with urinary incontinence
  Rafael Nickel, Germany
- Early detection of hematuria in cats
  Elodie Khenifar, France
- Canine urinary tract infections
  J. Scott Weese, Canada
- Imaging of emergency bladder problems
  Greg Lisciandro, USA
- Minimally invasive techniques for urolith removal
  Marilyn Dunn, Canada
- How I approach... The cat with idiopathic cystitis
  Isabelle Demontigny-Bedard, Canada

ROYAL CANIN

ROYAL CANIN®

TAKE A COMPLETE NUTRITIONAL APPROACH TO ALLERGIC DERMATITIS

Only the ROYAL CANIN® Dermatological range offers the choice of extensively-hydrolysed and partially-hydrolysed protein-based diets for cats and dogs, allowing you to choose the level of hypoallergenicity. From diagnosis to long-term management, now there is a diet for every stage of your clinical approach.

Our ANALLERGENIC product is your first choice for elimination diet trials for Adverse Food Reaction (AFR) or diagnosing Atopy by exclusion.

INCREDIBLE IN EVERY DETAIL