Thoracic Trauma: Tubes and Trachs

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Thoracic trauma in horses can results from either a blunt force injury or a penetrating wound.[1] A thorough physical exam is the first step in evaluation to ensure a patent airway, adequate ventilation and to stabilize the cardiovascular system. The respiratory cycle should be assessed for evidence of splinting, paradoxical chest wall movement, and/or obvious boney deformation of the ribcage. Palpation may sometimes identify fractures and subcutaneous emphysema, and auscultation and percussion can suggest the presence of pleural fluid or a pneumothorax. Additional diagnostics include ultrasound examination of the chest and abdomen, which can easily be performed in the field. If needed, the horse can be referred for radiographs, to further delineate pulmonary damage, fluid or air accumulations which could be consistent with hemothorax, pneumothorax or pneumomediastinum. More extensive diagnostics to consider include an arterial blood gas, blood lactate, central venous oxygen tension and central venous pressure in horses with abnormal physical exam findings.

Appropriate volume resuscitation should be included in initial management of horses in shock. Clinical signs of circulatory shock would include cold extremities, muddy mucous membranes with a delayed capillary refill time, poor peripheral pulses and depression. The “shock dose” of fluids is 60 ml/kg, however, the calculated volume is the divided into 4 equal boluses. Each dose is administered rapidly, and the patient reassessed for a response before administering the next. Successful resolution of circulatory shock can be identified clinically by improved mentation, peripheral pulses and production of urine. Alternatives to this large volume of crystalloid solutions include hypertonic saline (2-4 ml/kg) or colloids (5-10 ml/kg, 6% Hetastarch) followed by crystalloids to replace deficits, losses and maintenance fluid needs. In adults, as well as foals, additional supportive care including supplemental oxygen, nutritional support and adequate analgesia will assist in the recovery from thoracic trauma.

Lacerations and penetrating wounds

Lacerations to the thorax may occur due to sharp or blunt force trauma. Despite the fact that these wounds are often sizable, most lacerations to this area heal well, due to the extensive intrinsic blood supply in this region. On initial exam, the injury should be clipped, aseptically prepared, and explored to determine the involvement of deeper structures including the parietal space and musculoskeletal structures such as the cubital or shoulder joints. It would be advised to avoid cleansing the exposed tissues with anything other than normal saline, to prevent further tissue injury. Investigation of the wound should also proceed with caution, to avoid extending the laceration further into the thorax, or damaging blood vessels or nerves. Foreign objects are often noted within thoracic wounds, and advanced diagnostics to consider include ultrasound and contrast fistulograms. Surgical exploration using thoracoscopy and thoracotomy may be required for definitive identification and treatment, however, in the field, an endoscope is a useful substitute to identify debris.[2, 3]

Primary closure of most thoracic wounds is rarely possible, due to the extensive degree of tissue damage, skin loss, and contamination with debris. Second intention healing will also be required in areas of significant degree of motion or skin tension. Therefore, closed suction drains, stent bandages and/or sterile packing can be used until infection has been brought under control.[2] Debridement to remove foreign contaminants can be performed first using low pressure lavage to prevent dissemination of debris into deeper structures. A 60 cc syringe with an 18 g needle or a saline bottle with holes punctured in the lid are sterile options; for severely contaminated wounds, gentle rinsing with a hose and tap water are adequate. As with any wound, broad spectrum antibiotics and tetanus prophylaxis should be administered.

Complications of thoracic wounds include chronic draining tracts if foreign material is missed, and boney sequestration of the rib or sternum secondary to a fracture and bacterial infection. These fistulae will require injection of contrast (radiopaque for radiographs or new methylene blue at surgery) or ultrasound to help to identify the extent of the tract, followed by aggressive surgical debridement for resolution.

Subcutaneous emphysema

Subcutaneous emphysema is a common complication secondary to deep axillary or pectoral wounds, which result from collision with objects, impalement or kicks by other horses. The pathogenesis is secondary to the movement of air into the subcutaneous tissues due to advancement of the forelimb opening the wound, followed by trapping and forceful compression of the air into the subcutaneous tissues, as the horse advances through the stride. Emphysema can also occur secondary to tracheal or esophageal rupture.[4] Diagnosis of subcutaneous emphysema is by palpation of crepitus in the skin, and severe cases may show changes in contour of the body. While mild emphysema is benign, in severe cases the air may dissect through fascial planes to the head, disrupting airflow through the nasal

passages, and causing dyspnea and eventually asphyxia if untreated. Subcutaneous emphysema may also track into the mediastinum and pleural cavities, resulting in tachypnea or hypoxemia.

Prevention is imperative, and is accomplished by packing and sealing the axillary wound with occlusive dressings, and limiting movement of the horse by strict stall rest or cross ties. In cases where subcutaneous emphysema cannot be controlled or has already developed, it is important to monitor for edema of the nasal passages, which may require a tracheostomy. In addition, swelling of the facial musculature may prevent normal intake of food and water, requiring an indwelling feeding tube. The corneas should also be monitored to ensure that ulceration has not developed due to interference by the emphysema with blinking. Serial monitoring should be performed in all cases of subcutaneous emphysema to identify the development of a secondary pneumothorax or pneumomediastinum, which may occur days or weeks after the injury.[3]

Pneumothorax and pneumomediastinum

Pneumothorax is defined as the communication of the pleural space with the environment from an open wound (open pneumothorax), or internal defect in the bronchial tree or lungs (closed pneumothorax). A tension pneumothorax is defined by a flap over this defect, allowing air to gain access on inspiration that is then unable to escape on expiration. This valve can cause a rapid increase in intra-thoracic pressure, resulting in collapse of the lungs, compression of the thoracic tissues and a reduction in venous return to the heart. Most cases of pneumothorax are bilateral, but if the normal fenestrations between the pleural cavities are absent or occluded due to pleural effusion, the pneumothorax may be unilateral.[5]

Similarly, pneumomediastinum may occur secondary to an existing pneumothorax, subcutaneous emphysema, rupture of pulmonary bullae, perforation of the thoracic esophagus or trachea, or from direct penetration into the mediastinum by a foreign object.[2, 6-7] Pneumomediastinum is often a complication of axillary wounds, and air that enters the mediastinum may eventually progress to cause a pneumothorax.[3, 6] Any axillary wound should be monitored for progression to a pneumothorax until the wound has fully healed.

On examination, horses with pneumothorax and pneumomediastinum may display dyspnea, cyanosis, tachycardia, depression or anxiety.[5, 8] With tension pneumothorax, respiratory distress, tachycardia and hypotension may be observed. On auscultation, breath sounds may be dull or absent dorsally in pneumothorax, consistent with compression and collapse of the affected lung. Diagnosis of pneumothorax and pneumomediastinum can be assisted by thoracic radiographs, however ultrasound is often more sensitive in identifying free air in a pneumothorax. For pneumomediastinum, diagnosis is difficult; visualization of the outlines of the aorta, trachea and esophagus on radiographs is pathognomonic for this condition.

Treatment should be pursued for horses exhibiting clinical signs, including dyspnea or hypoxia. For all external chest wounds, an airtight packing should be applied immediately to prevent further air movement into the thorax. If vital parameters are within normal limits, the pneumothorax often will resolve without further treatment. However, clinical signs of respiratory distress or hypoxia require thoracic drainage and oxygen supplementation. A 24-36 French chest tube or a 14 gauge intravenous catheter placed high in the 13^{th}-14^{th} rib space will allow for both diagnosis and removal of air in a pneumothorax.[2] Occlusion of the site of chest tube entry with a finger-trap suture and air-tight bandage is recommended, and a Heimlich valve or continuous mechanical suction may be applied. While barotrauma has not been reported in the adult horse, it would be prudent to use low pressure suction in small horses, foals, and in horses with chronic pneumothorax that may have pulmonary fibrosis. Broad spectrum antibiotics should be provided, and the horse monitored closely for recurrence or decompensation. Nasal oxygen insufflation at 15 L/min would be indicated for sign of tachypnea, hypoventilation and hypoxemia (PaO_2 <80 mmHg).

Hemothorax

Hemorrhage into the chest may occur after blunt force trauma or penetrating wounds, resulting in intercostal artery disruption or lacerations to the heart, great vessels or pulmonary parenchyma. With severe hemorrhage, physical examination may reveal pale mucous membranes, cool extremities, signs of colic, or altered mentation. Horses in the late phases of hypovolemic shock may exhibit tachycardia, renal insufficiency and alterations in PCV. Mild bleeding, however, may only be recognized by thoracic ultrasound, where free fluid will appear hypoechoic.

Thoracic hemorrhage should be addressed by fluid therapy (plus or minus transfusion based on clinical signs of hypoxemia); but conservative fluid therapy is recommended for active and uncontrolled bleeding to prevent an increase in hemorrhage due to disruption of clots and further dilution of clotting factors. In cases of uncontrollable hemorrhage, crystalloid fluids are titrated to a maintenance rate, and the acute resuscitation is complete when the horse either urinates, or has a mean blood pressure of 60 mmHg. Additional medications to promote clot formation or stasis are aminocaproic acid (an anti-fibrinolytic) or a 0.37% formalin solution IV. If active hemorrhage is controlled (by ligating the hemorrhaging vessel or packing off the wound), fluid therapy can be administered at shock rates (20 ml/kg boluses up to 60 ml/kg) as indicated. If hypoxia or dyspnea is noted on clinical exam, drainage of the thorax using a chest tube at the 6-8^{th} intercostal space will improve ventilation. In addition, if the hemothorax was caused by a penetrating wound, drainage and thoracic lavage will allow treatment of infection to prevent secondary pleuritis and constrictive

fibrothorax due to fibrinous adhesions.[3] Risks of thoracocentesis include recurrence of hemorrhage due to disruption of the thrombus, or pleuritic caused by introduction of bacteria into the thoracic cavity. Because of these side effects, drainage of a hemothorax is only indicated if the horse is showing clinical signs of hypoxia suspected to be due to the fluid accumulation.

Rib fractures

Rib fractures may occur subsequent to both penetrating and blunt force trauma, and are commonly caused by dystocia in foals.[9] On physical exam, splinting and tachypnea may be noted, as well as pain on palpation, obvious boney abnormalities and crepitus. Identification of rib fractures in the horse is more difficult than in smaller animals, due to the insensitive nature of both radiographs and external palpation. Ultrasound has been recognized as the most sensitive diagnostic in both adults and foals for positive identification of the fractures, as well as diagnosis of complications including pneumothorax, hemothorax and pleuropneumonia.[9-10]

Treatment of rib fractures includes wound management, broad spectrum antibiotics, analgesia, supplemental oxygen to improve saturation to >90%, as well as addressing concurrent pneumothorax or hemothorax. The discomfort caused by rib fractures must be alleviated to ensure normal chest excursion and expectoration to reduce the risk of pleuropneumonia. Recommendations for pain management horses include non-steroidal anti-inflammatory medications, and local nerve blocks along the caudal surfaces of the affected ribs. Opioids are advantageous, but should be used with caution at higher doses due to the risk of respiratory depression and colic.

In adults, primary repair of rib fractures is typically not required, due to the stability resulting from the non-compliant nature of the chest wall.[3] However, in neonates fractures are typically at the costrochondral junction of ribs numbered 3-8. Fractures in this area are directly over the heart and great vessels, increasing the risk of hemothorax, pneumothorax, hemopericardium, diaphragmatic herniation, and hemoabdomen.[11] Surgical stabilization can be accomplished in neonates by internal plating, sutures, plastic zip ties or external fixation with a splint.[12]

Flail chest

A flail chest is a specific type of rib fracture defined as 2 or more ribs fractured in 3 or more places, creating a free floating segment of the thoracic wall. This creates a paradoxical respiratory pattern, where the flail segment moves in on inspiration, and out with expiration, opposite the normal respiratory cycle. Diagnosis is based on palpation and observation of the paradoxical movement of the flail segment. Morbidity and mortality with flail chest typically results from the pulmonary contusions caused by the injury, rather than directly from the fractures themselves. Although therapy is similar to that of a simple rib fracture, the impact that causes a flail segment in the adult horse is usually fatal due to concurrent cardiac and pulmonary contusions, and additional injuries to the limbs or gastrointestinal organs.

Diaphragmatic hernia

Diaphragmatic hernias may result from any condition that results in increased intra-abdominal or intra-thoracic pressures, including falls, dystocia, or blunt force trauma.[13] Clinical signs include acute or chronic intermittent episodes of colic, exercise intolerance, or tachypnea, but may be variable or even asymptomatic depending on the degree of visceral herniation.[14-18] Diagnosis may be suggestive of a hernia based on rectal palpation (noting an empty caudal abdomen), or imaging including ultrasound or radiographs showing abdominal contents in the lung field. However, diagnostics are often equivocal and surgery is required for a definitive answer.[18-19] Less invasive methods may include thoracoscopy or laparoscopy, and may facilitate the repair of dorsal tears.[20-22] Treatment involves either direct suturing or a mesh repair of the defect, and this can be difficult due to limited access by either surgical approach.[16, 18, 22] While immediate recovery from surgery is guarded due to suture breakdown or anesthetic complications from reperfusion injury and barotrauma, survival after recovery from anesthesia is good, with reports of horses returning to high level performance or breeding programs.[18, 23-25]

Conclusions

Thoracic injuries in the horse can have a successful outcome, provided the clinician promptly addresses the complications of penetrating injuries and blunt force trauma. For most thoracic injuries, long term wound management and follow-up is required. Tetanus prophylaxis and appropriate antibiotics are indicated with both internal and external wounds, and serial evaluations will permit early recognition of complications. A common sequela of thoracic trauma is pleuropneumonia, which may require diagnostic cultures and long-term antibiotics. All horses with thoracic trauma should be provided adequate analgesia, and multimodal pain management is preferred.

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All Choked Up:
Esophageal Obstructions

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Esophageal obstruction is the most common abnormality of the equine esophagus.[1] Causes can include ingestion of bedding, such as straw or wood shavings, poorly masticated feeds including apples, carrots or hay, as well as processed dry feeds such as beet pulp, pellets or hay cubes. Predisposing factors may include poor dentition, improperly moistened feeds (ie beet pulp), dehydration, or sedation, among others. Choke can also occur in horses that are inclined to bolting their feed, as well as in horses that have had esophageal impaction previously which caused an esophageal stricture or diverticulum. While the diagnosis of an intraluminal obstruction is relatively straightforward, resolution can be frustrating, and complications are often devastating for the future function of the horse.

Clinical findings in esophageal obstruction

While the classic signalment of a horse with an esophageal obstruction is the older horse with dental disease, the average age is actually quite lower in the literature, around 10.5 years on average.[1] There is no one breed that is predisposed to choke, however, Friesians have been noted to have esophageal pathology caused by a distal hypertrophy that may lead to similar clinical findings.[2] On examination, horses with an obstruction will often have saliva or feed-tinged mucous exiting both nostrils, and sometimes the mouth. Tachypnea and tachycardia may be present of the obstruction is chronic, due to dehydration, electrolyte abnormalities, and pulmonary inflammation from aspiration of feedstuffs. Horses may appear anxious, and may repeatedly stretch their neck, gulp, cough or retch.

Identification of esophageal obstructions

The first step in treatment of esophageal obstructions is to sedate the horse to lower the head for both diagnosis and treatment of the obstruction. Diagnosis is often confirmed by passing a nasotracheal tube down the esophagus to the obstruction, which will prevent the tube from passing into the stomach. If the obstruction is in the cervical esophagus, it may be palpable externally. If an endoscope is available, it would be preferable to pass it before passing a nasogastric tube, to assess the degree of trachea contamination prior to lavage, and to determine where the food is lodged and what type of feed stuff it appears to be. An endoscope will also allow the clinician to identify mucosal damage or lacerations that may complicate therapy. Obstructions are most commonly found in the proximal esophagus or at the thoracic inlet.[1]

Advanced diagnostics, such as radiographs, are not necessary to diagnose a simple esophageal obstruction, and barium should not be administered to horses with esophageal obstruction due to the risk of aspiration and the development of barium pneumonitis. However, horses with recurrent episodes of choke should be evaluated thoroughly for morphologic or functional disturbances, including megaesophagus, esophageal stricture or diverticulum. Endoscopy can be cheaper and more informative than other diagnostics for the identification of esophageal strictures, and it can also be helpful in evaluating the severity of the damage after the obstruction has resolved.

Treatment of esophageal obstructions

Simple esophageal obstructions may pass into the stomach due to normal peristaltic waves on their own after a single dose of sedation, or may easily pass into the stomach with gentle pressure from the nasogastric tube. However, if the choke has not resolved on its own in 15-20 minutes, or with manual pressure from the nasogastric tube, esophageal lavage should be used to break down the impaction. The typical large bore nasogastric tube may be used for retrograde lavage. Alternatively, a cuffed endotracheal tube may be passed first into the esophagus, followed by the nasogastric tube inside its lumen, to reduce the aspiration of water and feed. Lavage should be performed only in a well-sedated animal to encourage fluid to drain from the nose, rather than down the trachea. Alternative, the horse may be anesthetized to allow for better control of the airway. If the obstruction is a solid foreign body (ie. apples, carrots), use of the endoscope and a small biopsy instrument has allowed for piece-meal dissection of the obstruction where lavage alone was not successful. Finally, if progress is slow or difficult, the horse may be allowed time to rehydrate with intravenous fluids prior to a second attempt, to allow for softening of the impaction.

Sedation is used not only to make the horse more tractable for treatment, but also to promote relaxation of the esophageal musculature. Depending on the site of obstruction, sedation can be tailored to help dilate the musculature at the site of the impaction. Acepromazine (0.07 mg/kg, IV) is a phenothiazine tranquilizer that causes sedation by acting as a dopamine antagonist, as well as smooth muscle relaxation through antagonism of the alpha-1 receptor. It has been shown to work on the musculature of the distal esophagus, causing esophageal dilation and decreasing spontaneous swallowing reflex.[3] While it could be useful to treat a distal esophageal obstruction, acepromazine should be used with caution in hypovolemic animals, due to the side effect of peripheral vasodilation. Alpha-2 adrenergic receptor agonists, alternatively, work on the skeletal muscle of the proximal esophagus by reducing

normal peristalsis, presumed to be caused by effects on the central nervous system. These effects have been demonstrated with both xylazine (0.5 mg/kg, IV) and detomidine (0.04 mg/kg), while detomidine may cause distention of the esophagus at the thoracic inlet as well. [3] When combined with butorphanol (0.02 mg/kg), xylazine was effective in reducing the number of swallowing events, which could also reduce peristaltic waves. Guaifenesin (25 mg/kg IV) can decrease spontaneous swallowing, but may cause significant ataxia in standing horses, even at this low dose. Of these medications, the alpha-2 agonists alone, and combined with butorphanol, produced the most dramatic effects on the esophagus.[3] While oxytocin was once reported to possibly reduce esophageal tone, it has no effect on esophageal pressures in vivo.[3] Smooth muscle relaxants, such as n-butylscopolammonium bromide (0.3 mg/kg, IV), have been purported to improve smooth muscle relaxation, and have been used anecdotally for esophageal obstruction in the lower esophagus. In experimental studies, this medication has been shown to eliminate the swallowing reflex in the distal third of the esophagus.[4]

Due to the accompanying dysphagia, all horses with esophageal obstruction aspirate feed and saliva to some degree, and the costs to a horse from aspiration pneumonia far outweigh the costs of prophylactic use of antimicrobials and their side effects. In all horses with choke, broad spectrum antibiotics (ie. potassium penicillin 22,000 U/kg, IV, QID and gentamicin 6.6 mg/kg, IV, SID, or trimethoprim sulfadiazine 22 mg/kg, PO, BID), including metronidazole for anaerobic bacteria (15 mg/kg, PO, TID) should be prescribed for a minimum of 5 days, and up to 2-8 weeks for confirmed aspiration pneumonia. While it would be tempting to associate the degree of feed contamination in the trachea noted on endoscopy with the risk of aspiration pneumonia, it has shown no diagnostic sensitivity for this complication.[1] However, the duration of the obstruction was more likely to correlate with an increase the risk of aspiration pneumonia. Non-steroidal anti-inflammatory medications should be provided, while monitoring hydration status, and clenbuterol (0.08 μg/kg, IV, BID) may be administered to improve mucociliary function and bronchodilation. Sucralfate (20 mg/kg, PO, QID) can also be used to treat esophagitis and minor mucosal irritation.

Horses should remain off feed for at least 24 hours for minor chokes, and up to 3-4 days for horse with severe injury to the esophageal mucosa. The horse may need to be muzzled during this time, and bedding should be removed from the stall to prevent ingestion. Fluids can be provided PO, or IV if severely dehydrated. Feed should be introduced gradually, and softened mashes of pelleted feed supplemented with mineral oil are recommended for 1-3 weeks based on the duration of the obstruction and the appearance of the esophagus on endoscopy. After this time, the normal diet can be gradually re-introduced. If the cause of the obstruction can be determined, dietary and management changes may help prevent re-obstruction. Prognosis is best for horses presented for the first time with an esophageal obstruction and for horses that resolve quickly with lavage.[1]

Complications of esophageal obstruction

Esophageal stricture

Esophageal strictures can be a consequence of circumferential damage or extensive linear tears of the esophagus. The damage can be assessed by endoscopy after relieving the obstruction, and horses that may be predisposed should be reevaluated in 2-4 weeks to determine the duration of feed restriction, and need for further treatments including antibiotic and anti-inflammatory medications. If a stricture develops, the contracture that results from normal wound remodeling will cause the lumen to constrict to a minimal diameter at 30 days after the injury.[5] However, remodeling of this scar tissue will continue for up to 60 days. Therefore, medical and dietary management of a stricture can be recommended, and can be successful, if extended for at least 2 months after the choke. If the horse has not resolved the stricture at this time, the modified diet may be maintained indefinitely, or surgical management, including bougienage, esophagomyotomy or esophagopexy may be considered for horses that continue to re-obstruct.[6]

Esophageal diverticula

There are two types of esophageal diverticula, traction and pulsion, and both are caused by esophageal trauma. Traction diverticula typically have a shallow body and wide neck. These characteristics, and the fact that peristalsis is not affected, mean that a traction diverticulum rarely causes clinical problems. Pulsion diverticula, however, appear as a protrusion of esophageal mucosa through a defect in the muscular wall. The narrow neck through the musculature predisposes it to impaction of feed, and can lead to esophageal rupture. Clinical signs of a diverticula will be similar to esophageal obstruction, in addition to the presence of diffuse swelling and possibly an external wound communicating with the diverticula. Most diverticula occur in the cervical neck, but pulsion diverticula have been reported in the thoracic esophagus.[7] Diagnosis of esophageal diverticula is similar to that for esophageal obstruction, with the use of plain and contrast radiographs and endoscopy. Surgical repair should be recommended, especially for a pulsion diverticula.

Esophageal rupture

Esophageal rupture may occur secondary to pressure necrosis caused by the obstruction itself, hypovolemia, and the peristaltic waves of the esophagus attempting to move the obstruction aborally. It may also occur as a result of attempts to relieve the obstruction with the nasogastric tube and lavage. Clinical signs would be consistent with cellulitis, noted by a painful swelling and crepitus in the ventral neck, along with signs of endotoxemia. If the feed and air dissect caudally or if the rupture is intrathoracic, a pneumomediastinum or pneumothorax may result.[8] Treatment involves establishing ventral drainage and bypassing the rent with an indwelling feeding tube placed through the defect or below it.

Idiopathic megaesophagus

Megaesophagus is a recently recognized disorder noted mainly in Friesian horses, with a possible X linked mechanism of transmission.[2,9] Although it has been documented in Dutch Warmbloods and Welsh ponies,[10] the incidence in Friesians in one report was 70 times that of other breeds, making it an important disorder to consider for a Friesian presenting with esophageal obstruction. Affected horses may show clinical signs of esophageal dysfunction and chronic dysphagia, including coughing, gagging, ptyalism, nasal discharge, weight loss, anorexia, fever, pleural effusion, and recurrent bouts of esophageal obstruction. However, muscular hypertrophy of the esophagus may be silent and only identified on necropsy as an incidental finding.[10]

Diagnosis can be made with endoscopy, where a dilation of the esophagus will be visible, along with retrograde reflux of feed, and an abnormal appearance to the mucosal lining.[9] Both plain and contrast radiography may also be helpful. On histopathology, megaesophagus can be confirmed by identification of gross hypertrophy of the tunica muscularis of the caudal esophagus.[10] Many horses were also diagnosed with mucosa ulceration and fibrinous pleuritis consistent with chronic aspiration pneumonia. Esophageal tears can be concurrent with megaesophagus. While the cause of equine megaesophagus has not been determined, it was morphologically similar to esophageal leiomyomatosis (Alport Syndrome) seen in humans.[2] This condition is associated with a mutation in the gene encoding type IV collagen, resulting in hypertrophy of smooth muscle cells of the distal esophagus. Unlike neoplastic lesions, there is low cellularity, and no evidence of mitosis or cellular atypia. There is no treatment in humans, and in horses supportive care is recommended. To reduce the risk of obstruction, soft feeds, such as a mash or grazing, are recommended, as well as offering feed at chest height.[11]

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Equine Castration:
Techniques and Managing Complications

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The veterinarian's objective when castrating a horse is to make what may be the only surgical procedure a horse experiences in its life as safe and successful as possible.

Horses are castrated for various reasons, but for the most part to create geldings. Geldings are safer, nicer, and easier to handle than stallions. Castrations create horses that can safely be used and enjoyed for a lifetime.

Because castration is so common, because we all do it, because we equine veterinarians are creative – there are a lot of ways to 'cut' a horse. It is good to have a favorite technique and get proficient at it. It is also good to know your options and be flexible given different situations. It can be done standing, in lateral recumbency, in dorsal recumbency, open, closed, semi-open.

In reality, castration can take place at any age as long as both testicles are descended within the scrotum. Some colts are castrated around weaning because of early onset of unwanted male behavior (mounting or aggression). Others are left until older in order to allow the development of masculine physical characteristics. Most castrations take place between 6 months and 2 years of age.

When the client calls to schedule, is a great time for you or your staff to get some basic but important information

- Confirm in current good health. Consider a pre-operative exam and blood work if any concerns.
- Age and size estimate.
- Level of training or handling.
- Vaccination history, especially tetanus prophylaxis.
- Deworming history.
- Do they know if both the testicles are descended?
- Any history of or suspicion of hernia (scrotal or inguinal)?
- Has the client ever witnessed a castration and do they have any questions about the procedure?

Know the pertinent anatomy

- Take care to avoid the penis. Take care to avoid the external pudendal vessels.
- Scrotum, median raphe.
- Spermatic fascia.
- Vaginal tunic.
- Scrotal ligament, ligament of the tail of the epididymis.
- Testicle and epididymis.
- Spermatic cord; vasculature and vas deferens.
- Cremaster muscle.

Equipment / supplies

- Halter and lead rope.
- Restraint ropes and towels for under the head and to cover the eyes.
- Gloves, bucket, water, soft roll-cotton, scrub (betadine or chlorhexidine).
- General anesthetic agents and local anesthetic.
- Sterile gloves and surgery pack: scalpel, mayo scissors, towel clamp, hemostats, and gauze sponges.
- Emasculators: Modified White's, Reimer, Serra.

Pick a spot that is flat, with good footing, and free of obstacles for the procedure. Take time to ensure that all who are helping know their roles. If possible use assistants rather than the client. Explain the plan and what the client can expect to witness and instruct them to stand back, away from the action.

Physical exam

- Confirm proper vaccination program.
- Assess general health and body condition.
- Temperature, pulse, respiration; auscultation.
- Estimate weight (tape) and figure doses of anesthetic agents.
- Confirm that there are two descended testicles and assess for herniation. Sedate if needed. In some cases it is necessary to anesthetize the patient to completely palpate for testicles. If both testicles are not evident the surgery should be

postponed for a cryptorchidectomy (at the least, the one not evident should be removed first and the surgery cancelled if it cannot be found).

Drug administration

- Anti-inflammatory medication: phenylbutazone or flunixin meglumine.
- Peri-operative antibiotic (+/-).
- Sedative / analgesic: alpha-2 agonist, xylazine or detomidine. At this time I usually tie a loop of rope around the patient's neck.
- Additional analgesic: butorphanol.
- Muscle relaxant (+/-): diazepam.
- Induction agent: Ketamine.
- Consider having additional doses of sedative and Ketamine ready if needed (typically ½ of the original induction doses).

Procedure

- Guide the patient down into the desired recumbency and place the towels to protect the patient's eyes. Usually left lateral for a right-handed surgeon (reverses for left-handed). Hay bales or shavings bags are helpful to position in dorsal recumbency.
- Use a soft cotton rope to carefully tie the elevated hindlimb cranially to the previously placed loop of rope around the neck (quick release knot). Do not tie to the halter.
- The surgeon or assistant scrubs the scrotum and inguinal region to prepare for surgery.
- After an initial cleaning, local anesthetic (10 to 20 mls of lidocaine) is injected into each testicle and allowed to diffuse into the spermatic cords while the rest of the prep is performed. Local anesthetic can also be deposited subcutaneously along the proposed incision lines in the scrotum.
- The surgeon stands behind the horse and reaches over to the operative field. If in dorsal recumbency, the surgeon is between the hind limbs or to the side.
- Approach: parallel scrotal incisions on either side of the median raphe, tent the scrotum and remove a portion, or use a large carmalt to isolate (and provide hemorrhage control) a portion of the scrotum to remove.
- The dependent testicle is removed first. Closed, open, or modified closed technique.
    - Closed technique: The testicle is grasped from below and elevated. Careful sharp dissection with the blade or blunt dissection with a hemostat is performed to expose the testicle within the parietal tunic. The spermatic fascia is stripped to isolate the spermatic cord for emasculation. It can be helpful to secure the testicle with a towel clamp and use gauze sponges to facilitate the stripping. The Cremaster can then be digitally isolated from the spermatic cord and bluntly separated. This reduces the "tug" on the cord and allows for more discrete ligation and emasculation of the cord. A hemostat is used to secure a small piece of the vaginal tunic proximal to the emasculation site and any ligatures. This serves as an "insurance policy" – allowing you to retrieve the cord stump if hemorrhage is present.
- Ligatures may be placed in the spermatic cord proximal to the proposed emasculation site.
- The emasculator is then placed on the entire cord as far proximal as is practical, using a hand underneath to push the body wall away and ensure scrotum is not included in the emasculator. Remember to place the emasculator "nut-to-nut" (crushing side to the horse, cutting side to the testicle). Apply the emasculator and leave in place for around 2 minutes. During emasculation I expose the removed testicle from the tunic and show the client that I have successfully removed all the needed tissue: testicle (sperm factory), epididymis (sperm maturation tank), and the vas deferens (sperm delivery system).
- Gently remove the emasculator and examine the cord stump for proper hemostasis. This is facilitated by the previously placed hemostat on the proximal cord. Let go of the hemostat and release tension on the cord and check once again for hemorrhage. If no worries, then remove the hemostat and allow the cord to retract.
- Remove the opposite testicle. Show the client that the horse is officially gelded.
- Any protruding tissue should be spread out to avoid large vessels and then removed. If not previously performed, the medial raphe can be removed between the incisions.
- The incisions should be stretched to help with hemostasis and provide for adequate drainage. They are left open to heal by second intention.
- Untie the elevated hind limb and allow the horse to recover. It is usually prudent to hold the patient's head and neck down to prevent early and unsuccessful attempts at standing.

- Once the horse is recovered and standing, examine the scrotal region for any dangling tissue or excessive hemorrhage. Now is the time to address it before the horse is fully aware.

Aftercare

Some bleeding and swelling is expected. Bleeding should initially be no more than dripping (if you can see between drops you are generally OK) and should not last long. Some scrotal swelling is inevitable and will probably be greatest at day 3 to 5 post surgery. Aftercare is aimed at keeping these from becoming problematic. The incisions should be mostly healed within 3 weeks.

- Stall rest for 24 hours to allow proper clot formation.
- Then daily forced exercise (trotting) twice a day for 2 weeks. This helps to ensure that swelling is kept to a minimum and drainage is effective. Turnout in a pasture does not ensure proper exercise as some individuals will choose to stand rather than move around due to post-operative discomfort.
- Phenylbutazone: administer 2.2 to 4.4 mg/kg orally every 12 hours for 1-3 days after surgery. This will help control swelling and provide comfort which supports proper movement and exercise.
- Tetanus toxoid booster if indicated (6-12 months since the last vaccination). Tetanus toxoid and tetanus antitoxin if not properly immunized prior to the procedure.
- Systemic antibiotics may be given for an appropriate regimen if excessive contamination of the surgical field occurred, or in the case of ligature placement.
- Isolate the newly gelded horse from females for at least 2 days (potential for residual viable sperm in the reproductive tract). I suggest 2 weeks – I don't like the gelding to be tempted to mount anything during the healing period.
- Congratulate your client on creating a better companion.

Potential complications

Castration is a common procedure, so complications will take place.

- Excessive bleeding. Normal dripping should stop within a couple hours of castration. Any report of ongoing or voluminous bleeding must be investigated and addressed.
- Excessive swelling. These horses should be examined and the incisions re-opened if necessary. In most cases, administration of NSAIDs and increased exercise will be adequate. While hydrotherapy can be helpful, it also can lead to ascending contamination – avoid if possible.
- Infection. If the problem is confined to the superficial tissues then drainage and systemic antibiotics should be adequate. Involvement of deeper tissues requires surgical isolation and removal of the affected tissues.
- Others include: hydrocele, intestinal eventration or omental prolapse, peritonitis, colic, penile damage, and ongoing stallion-like behavior.

Field Colic Management: When Referral is Not an Option

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Care of the colic begins on the phone. How you handle the first contact from the client has impact. Are you available to examine the horse and fully assess the situation, or is it "give a dose of Banamine and call me in the morning"? We should be encouraging our clients to call us at the first abnormal signs, and visiting each horse showing signs of colic.

Signalment
Age, breed, sex

History
General, recent, disease-related

- Housing and husbandry
- Feeding
- Deworming and vaccinations
- Previous medical or surgical issues
- Medications
- Any change in management practices
- Any exposure to toxic substances
- Current colic signs: intensity, duration, response to medications

Physical examination
Veterinarians should develop a systematic approach to the physical exam as most decisions regarding treatment, prognosis, and need for advance care are based upon the results of a thorough physical exam.

- Observe the horse
  - Body condition
  - Magnitude of pain: presence of abrasions or wounds signifies severe pain
  - Mentation / attitude
  - Abdominal distension
- Vital parameters – if possible, these should be attained before the administration of any drugs or medications. In some cases sedation and analgesics must be given in order to perform a safe exam – but the affects of these drugs must then be taken into account.
  - Temperature
    - Elevation can signify infection: enteritis, colitis, peritonitis.
    - Lowered temperature can signify hypovolemia, dehydration, cardiovascular compromise.
  - Heart rate and pulse rate
    - One of the most important parameters of the exam. Heart rate is an excellent marker of pain, response (or failure to respond) to treatment, progression of the disease, and prognosis.
    - Elevated rates over 60 beats per minute are associated with poor prognosis for survival.
  - Respiratory rate
- Assess hydration / body fluid content
  - Oral mucous membranes (gums)
    - Color, moisture and capillary refill time all provide information regarding hydration and tissue perfusion.
      - Pink, moist, CRT < 2 seconds are normal.
      - Pale, dry, dark red and purple gums with refill times over 2 seconds are markers for perfusion, hydration, and endotoxic complications.
  - Pinch the skin of the eyelids or over the shoulder to see how quickly it rebounds. If it stays tented this is a gross sign of dehydration, as is a sunken appearance of the eyes.
- Complete auscultation of the thoracic and abdominal regions (with a stethoscope) to assess heart sounds / rhythm, lung sounds, and gastrointestinal sounds.
- Palpation of limbs to determine digital pulse amplitude and temperature of the extremities.

- Rectal examination: should be performed on all horses with colic.
    - Important to arrive at a definitive diagnosis or to help guide the treatment plan (including the need to refer for advanced care) and prognosis.
    - Proper restraint is important: stocks, twitch, sedation.
    - Hyoscine N-butylbromide: 3cc dose to relax rectal wall for examination.
    - Structures in the caudal 1/3 of the abdomen can be palpated.
        - Reasons for alarm are palpation of displaced contents, impactions, gas or fluid distended bowel, twists / torsions, or the inability to access normally palpable structures.
    - If no abnormalities are found, yet pain persists, serial rectal exams should be performed to monitor progression of the condition.
    - Fecal sample can be collected for parasite egg counts (FEC).
- Oral examination
    - Any dentition abnormalities or the need for dental equilibration (floating) should be noted and plans for correction made.
- Nasogastric Intubation: passing a tube to the stomach via the nasal passage and esophagus.
    - Provides diagnostic information, decompresses gas and ingesta to prevent stomach rupture, and allows for administration of water, electrolytes, and laxatives.
    - Normal equine stomach should have no more than 1-2 liters of fluid present.

These procedures comprise the basic colic exam that is essential in order to determine the cause of the colic or to make educated decisions on the course of treatment including the need for advanced care. While the majority of colic cases will respond successfully to basic care (whether or not a definitive diagnosis or cause has been identified), it is difficult to impossible to successfully identify those that require advanced care without a thorough and systematic examination. When a systematic approach is followed this examination can be completed in a short period of time (30-45 minutes), and repeated as needed given the condition of the horse.

What follows are ancillary diagnostic tests that can be added to the basic exam when more information is needed depending on the horse's condition and response or lack of response to normal care. These tests can be performed on site (residence, farm, stable) and completed with laboratory equipment found at most veterinary practices or delivered to commercial laboratories for completion. If the lack of response to therapy dictates that these tests must be performed and the primary veterinarian is unable to provide these services – referral to an equipped practice should be offered.

Ancillary diagnostic tests

Can help to arrive at a diagnosis, direct treatment, and establish a prognosis.

- Routine blood work
    - Packed cell volume and total plasma protein to gauge the degree of dehydration.
    - Complete blood count, serum chemistry, fibrinogen and venous blood gas will provide information on:
        - Inflammation / infection
        - Dehydration or hypovolemia, toxemia
        - Electrolyte, acid/base, and metabolic disorders
- Lactate levels
- Transabdominal ultrasound
- Abdominal fluid analysis
- Radiography (X-rays) Use may be limited to foals or minis given the power of the equipment and the size of the horse.

Management of the horse with colic can vary significantly based on the cause of the colic and what was found on the various diagnostic tests. In cases where referral is not an option, the practitioner has the freedom to perform more aggressive treatment options and use higher doses of medications, without the fear of treating or masking a horse's condition past a good surgical outcome.

Basic colic care with no major diagnostic findings

- Initial pain control with xylazine, detomidine, butorphanol
- Full dose of Flunixine Meglumine every 12 hours IV or PO
- Spasmolytic: hyoscine N-butylbromide
- Nasogastric intubation with fluids and electrolytes for re-hydration
- IV fluids administration
- Gastroguard if history warrants it
- Monitoring and follow up examinations

Gas colic

- Walking horse to facilitate passage of gas
- Tubing the horse with water and mineral oil
- Loading a horse in a trailer and driving around
- Monitor lactate levels
- Enterocentesis – decompress gas from colon or cecum
- Intermittent administration of pain medication

Impaction colic

- Nasogastric intubation with stool softeners
    - Epson salts
    - Mineral oil
    - DSS
- Continuous or intermittent administration of gastric fluids
- Walking the horse to facilitate manure passage
- IV fluids administration
- Intermittent administration of pain medication

Displacement / torsion of the large colon

- Can carry a poor prognosis
- Can be challenging to manage without surgery
- Intermittent administration of pain medication
- IV Fluids
- Walking the horse to facilitate displaced viscus to move
- Euthanasia if pain control becomes ineffective or Lactate levels are rising

Left dorsal displacement of the large colon (Nephrosplenic entrapment)

- Rectal and ultrasound findings to confirm diagnosis
- Administration of Phenylephrine followed by lunging the horse
- Administration of Phenylephrine followed by triple drip anesthesia and rolling the horse
- Follow up rectal and ultrasound to confirm reduction of the displacement

Small intestine conditions

- Presence of reflux followed by frequent decompression
- Distention easily determined with rectal and ultrasound findings
- Enteritis (fever?) vs entrapment / incarceration / impaction
- Lactate levels on blood and belly tap helpful
- Enteritis requires medical managements with fluids and possibly antibiotics
- Surgical lesion unlikely to resolve medically

Cecal impaction

- Similar management to large colon impactions
- Spontaneous rupture always a concern
- Frustrating condition to treat medically

Gastric impaction

- IV Fluids
- Attempt to get nasogastric tube at least partially in the stomach to administer fluids
- Diet Coke??
- Can take several days to resolve
- Endoscopic monitoring of the condition / resolution
- Ulcer medication administration

Penile Cancer and Dysfunction: Treatments for a Hidden Problem

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The horse's prepuce or sheath, is a folded sleeve of integument covering the mobile portion of the penis. The equine prepuce is different than most species as it's made of a double fold of preputial skin. Most preputial abnormalities are easily diagnosed from the horse's history and a physical exam.

The equine penis is the male organ of copulation. It's divided into 3 parts: the root, the body or shaft and the glans penis. Two erectile bodies are present in the penis, the dorsally located corpus cavernosum penis (CCP) which is responsible for erection and the ventrally located corpus spongiosum penis (CSP).

Clinical examination of the penis and the prepuce include

- Urination: It's important to see a horse urinate as part of the examination process. If a horse struggles or is painful during urination, some form of urethral obstruction should be suspected. In that case, the bladder should be palpated to determine if it's distended.
- Erection and Ejaculation: This is an important component of a complete examination of a stallion with servicing problems. If pain, failure to achieve erection, or failure to ejaculate is noticed, further investigation, including a semen sample is recommended.
- Palpation: This is best done with the horse sedated and complete palpation of the penis and sheath should be performed. Make sure the penis can easily be exteriorized from the sheath. The urethral recess should also be inspected for the presence of a bean.
- Visual inspection: Look for any abnormalities, which include lesions, lacerations, scar tissue, cancerous masses, and habronemiasis. Based on the findings of the visual inspection, further diagnostic tests can be performed.
- Endoscopy: Great diagnostic to determine the presence of a urethral stone, obstruction, and source for possible bleeding origination from the urethra. Discharge coming from the opening of the accessory sex glands can also be identified.
- Ultrasonography: Helpful in assessing carvenosal tissue problems, urethral problems, and the location or urethral calculi.
- Cavernosography: Contrast medium can be injected into the CCP followed by radiographs to determine the presence of shunts, and rupture or lacerations of the tunica albuginea.
- Miscellaneous: urethral catheterization, cytology, histopathology and cultures.

Conditions

- Open wounds: Horses can lacerate the penis while jumping barriers, while breeding a mare, or by falling on a sharp object. During breeding a loosely placed breeding stitch can also cause injury. It's important to determine if lacerations are superficial, or if they include deeper tissues, such as the cavernosal cavities or the urethra. If possible, it's preferable to debride and suture fresh wounds.
- Hematomas: This constitutes a true emergency, and treatment aiming at decreasing hemorrhage should be instituted as soon as possible. Compressing the penis with a tight bandage to relieve edema and minimize further hemorrhage. An elastic bandage can be used to decrease penile swelling as much as possible, and the penis can then be either supported against the abdomen, or replaced within the sheath with a purse string suture. It's important to allow enough of an opening in the purse string so that horses urine can evacuate the sheath.
- Paraphimosis: This condition is defined by the inability of a horse to retract the penis back into the prepuce. It commonly occurs secondary to trauma, which leads to edema or a hematoma. It can also be seen in horses that are severely debilitated. Other causes include nerve damage, spinal disease, herpesvirus 1, rabies, and following administration of phenothiazine-derivative tranquilizers. Treatment is aimed at controlling edema and preventing further trauma. If possible, the penis should be retracted back into the prepuce and retained there with towels clamps or a purse string suture. If the penis is too enlarged to be replaced into the prepuce, it should be bandaged against the abdomen. The penis should be kept lubricated with either glycerin or a topical antibiotic ointment. Systemic anti-inflammatory drugs should be administered to reduce inflammation and provide analgesia. If medical management fails to resolve the condition, surgical intervention may be required.
- Phimosis: This condition is defined by the horse's inability to exteriorize the penis from the prepuce; this is likely caused by a congenital or acquired stricture of the preputial opening or ring. It can also be caused due to cancerous or

cicatrizing lesions. If phimosis is caused by constriction of the preputial orifice, surgical removal of a wedge of the external preputial lamina is removed.

- Priapism: This condition is defined by persistent erection without sexual excitement. In horses, the condition is usually caused by the use of phenothiazine-derivative tranquilizers, but can occasionally also by caused be general anesthesia, parasitism of the spinal cord, and neoplasia of the pelvic canal. Medical treatment of this condition includes massaging the penis with an emollient dressing and compressing the penis against the body wall with a sling. Benztropine mesylate can be administered soon after onset of the condition to re-establish impaired venous drainage. The usual dose is 8mg (per horse) IV slowly. Other treatments include instillation of phenylephrine in saline injected into the CCP, surgical lavage of the CCP, and as a last resort, creation of a surgical shunt between the CCP and the CSP to facilitate drainage of blood. Partial phallectomy has also been reported as a treatment option for priapism.
- Neoplasia: This is a common condition in the horse, as external genitalia is the second most common location for neoplasia in the horse. Neoplasms include squamous papillomas, squamous cell carcinoma (most common), sarcoids, melanomas, mastocytomas, and hemangiomas. Diagnosis is usually made based on history, palpation and visual inspection of the penis and prepuce. Treatment for this condition includes surgical excision, cryotherapy, chemotherapy and hyperthermia. Early detection and treatment is usually associated with a favorable prognosis.
- Habronemiasis: Also know as “summer sores”, is caused by the larvae of the stomach worm Habronema. The Parasite is usually deposited on the horse by flies. Wounds are usually present during the spring and summer. Most common locations for the lesions are on the preputial ring and the urethral process. Diagnosis is usually made by appearance, but cytology of the exudate can confirm the diagnosis. Treatment of smaller lesions usually entails systemic Ivermectin and topical application of steroid ointment. If lesionsare excessively large, surgical debulking of the lesions may be required.

Surgical procedures

- Segmental Posthectomy: This surgical procedure consists of the removal of a circumferential segment of the internal preputial lamina. Indications for this procedure include removal of neoplasms, granulomas or scars.
- Bolz Technique of Phallopexy: Surgical procedure aimed at permanently retracting a paralyzed penis into the preputial cavity thus avoiding a partial phallectomy.
- Amputation of the urethral process: Intended for removal of granulomatous or neoplastic lesions of the urethral process.
- Partial phallectomy: Removal of the distal segment of the penis where permanent penile paralysis is present in addition to irreparable trauma, or if significant neoplasia of distal penis is present. Various techniques have been described including the Vinsot’s technique, Williams Technique, and the Scott Technique.
- En-bloc penile resection: Surgical option when there is significant neoplasia present on the free portion of the penis and the sheath. This surgical option removes the free portion of the penis as well as the sheath and regional lymphnodes. A perineal urethrostomy is performed just distal to the anus as the new means for urination for the horse.
- Partial perineal urethrostomy: Surgical procedure aimed at healing “blow out” type lesions from the CSP into the urethral lumen causing hemospermia and post urination bleeding.
- Perineal urethrostomy: Surgical approach to remove a urethral or bladder calculus. Usually left open to heal by second intention.

Oxytet Deficiencies: Practical Management of Potomac Horse Fever, Lyme Disease, and Anaplasmosis

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Oxytetracycline is a commonly used antibiotic in Veterinary Medicine. It was the second broad-spectrum antibiotic to be discovered. It works by interfering with the ability of bacteria to produce essential proteins, which categorizes this antibiotic as bacteriostatic. The use of oxytetracycline in Equine Medicine has increased over the past years with the increased prevalence of Potomac Horse Fever, Lyme disease and Anaplasmosis in different parts of the country.

Potomac Horse Fever (PHF), also known as Equine Monocytic Ehrlichiosis is caused by the organism Neorickettsia risticii. Clinical signs of the disease include fever, mild to severe diarrhea, laminitis, mild colic, and decrease abdominal gut sounds. When PHF is confirmed on a farm or certain geographic area, future cases are likely to occur. Diagnosis of PHF still remains problematic. Testing can be done by IFA, Elisa and a PCR test. Paired titer samples can be helpful in confirming infection, but can take a long time and treatment decisions need to be made prior to results. The main treatment for PHF is oxytetracycline at 6.6 mg/kg a day for 3-5 days IV, which is given in addition to supportive care that includes fluids, NSAID's and gastro protectants. Outcome prognosis is very dependent on how soon treatment is initiated after onset of clinical signs.

Lyme disease is caused by a bacterial spirochete named Borrelia burgdorferi. The bacteria is carried by black-legged deer ticks. Infections occur when an infected tick has bitten a horse and remains attached for at least 24-36 hours. Clinical signs of the disease include generalized stiffness, hyperesthesia, grumpiness, lameness, low-grade fever, and poor performance. In rare cases, there is also a neurologic form of the disease referred to as Neuroborreliosis. Diagnosis of the condition remains difficult because testing relies on antibody levels in the blood. Many horses can carry a titer and differentiating presence of antibodies and active infections is very difficult. Treatment usually involves the use of Doxycycline and oxytetracycline or a combination of both. Milder cases are usually treated with 6 weeks of BID oral doxycycline, and more severe cases can be treated with 7-14 days of IV Oxytetracycline followed by 6 weeks of oral doxycycline. There are no approved vaccines for Lyme disease in horses, so the best prevention for this disease remains active tick control.

Anaplasmosis, also known as Equine Granulocytic Ehrlichiosis is caused by the organism Anaplasma phagocytophilum, a gram-negative bacterial organism. The organism is spread by deer tick bites. Clinical sings usually develop 1-12 days post infection and include fever, depression, lethargy, partial anorexia, and limb edema. In more severe cases the presence of ataxia and reluctance to move can also be present. Clinical diagnosis is based on presence of some clinical signs described above in endemic areas, in addition to leukopenia and thrombocytopenia. Laboratory testing to confirm diagnosis include IFA, paired-titer testing and PCR. Cases are usually treated based on clinical signs, as response to treatment is usually evident prior to results being available. Treatment usually involves the use 3-5 days of Oxytetracycline at 6.6 mg/kg a day, in addition to supportive care with Flunixin meglumine and IV or PO fluids in more severe cases. Prognosis for recovery is excellent, especially in horses treated early, and resolution of clinical signs can usually be seen within 24 hours.

Horses presenting with lethargy and fever are very common in daily equine practice. Rule outs include various conditions ranging from bacterial, viral and Rickettsial organisms. Since so many of cases of equine fever include conditions that respond to Oxytetracycline, we recommend instituting treatment as soon as clinical signs are present. Once laboratory testing confirms a diagnosis the use of oxytetracycline can be discontinued if necessary. We have found in clinical practice that the use of flunixin meglumine and oxytetracycline can be nephrotoxic in horses, and concurrent administration of either IV or PO fluids is recommended. Monitoring creatinine levels closely is also indicated, especially on horses with more severe clinical sings, as they tend to dehydrate more easily.

Equine Field Anesthesia: Practical Guide

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Standing equine sedation

Xylazine

- Reaches maximum effect in 5-8 minutes IV
- Can be given IV or IM (IM dose can be close to double)
- Avoid giving to horses with a fever (hyperventilation)
- Duration 15-20 minutes
- Causes decreased GI motility, 2nd degree block
- Very good for short term analgesia in equine colic
- Deeply sedated horses can still respond to stimulation, especially touch

Detomidine

- 10 times the strength of Xylazine
- Can be given IV or IM (IM dose can be close to double)
- Avoid giving to horses with a fever (hyperventilation)
- Duration 40-50 minutes
- Good for longer term analgesia in equine colic
- Good sedative for dental procedures

Butorphanol

- Rarely used alone for sedation, other than foals
- Can be given IV or IM
- Can be used for analgesia to break pain cycle
- Can cause head shakes – affects x-rays and dental procedures

Xylazine or detomidine with butorphanol

- Very good combination for standing procedures
- Duration up to 60 minutes
- Can produce obvious ataxia
- Marked decrease in GI motility
- Often combination of choice for joint injections

Acepromazine

- Produces a calming effect on the horse
- Not a potent tranquilizer
- Causes vasodilation
- Useful in agitated post partum mares to allow foal to nurse
- Useful in laminitis and tying up cases
- Be aware in males and stallions: can lead to priapism

Intravenous general anesthesia

For recumbent procedures up to 1 hour

Xylazine / ketamine

- 10-20 minutes of surgical anesthesia
- Good induction and recovery
- Xylazine administered first, followed 3 minutes later by Ketamine
- Often requires additional dose (1/3 original dose)
- Popular combination for castrations
- Increase induction dose by 20% in more agitated animals

Xylazine / ketamine / diazepam

- Less movement
- Added muscle relaxation
- Smoother recovery

Xylazine / ketamine / guaifenesin drip

- Induce with xylazine / diazepam / ketamine
- Continuous infusion at 2 ml/kg/hr
- 1 Liter 5% GG + 500 mg xylazine + 1000 mg ketamine
- Excellent form of anesthesia
- GREAT muscle relaxation
- MUST use a catheter / not to be given off the needle
- Ideal for field settings
- Do not exceed 1 hour of anesthesia
- Recommended for castration of stallions

Epidural anesthesia – caudal

- Recommended for standing procedures
- Different choices:
    - Lidocaine
    - Carbocaine
    - Xylazine
    - Detomidine
- 19-g 1.5 inch needle
- First movable space after the sacrum
- Decrease systemic sedation to avoid excessive ataxia
- Indications:
    - Tail procedures – mass removals
    - Perineal surgery (urethrotomy)
    - Recto vaginal tears
    - Rectal tears (repair and / or stabilizing a patient)

Equine Hernias:
Overview of Diagnosis and Treatments

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Classifications of hernias

By opening or defect

- Direct: Through an abnormal defect in a normal anatomical structure
  - Diaphragmatic
  - Body wall
- Indirect: Through a normal or potential defect in another anatomical structure
  - Inguinal
  - Umbilical

Epidemiology

- Congenital: hernia defect that is present at birth (protrusion might not be evident till later)
- Acquired: defect occurs after birth
  - Blunt trauma
  - Surgical trauma
  - Degeneration (pre pubic tendon)
  - Increased diameter of normal body opening (inguinal)

Presentation

- Reducible
- Non reducible (incarcerated)
- Strangulated (vascular compromise of herniated tissue)

Components of a hernia

- The ring: actual defect in the limiting wall
- The hernia sac: made up of tissues that cover the contents
- The contents: intestine, omentum

Types

Umbilical

- At the umbilical remnant
- Females > males
- Quarter Horses?
- Acquired vs. heritable
- Reducible vs non reducible
- Treatment: medical vs surgical

Richter's hernia

- Entrapped anti-mesenteric wall of intestine

Direct hernias

- Usually traumatic
- Open abdomen vs. closed
- Decisions for emergency treatment: entrapped viscera? Open body cavity?
- Delay repair if possible
- Treat similar to RV tears
- Diagnosis: exam, ultrasonography
- Treatment:
  - Intact skin and SQ : wrap or herniorraphy (delay for fibrosis – weeks to months)
  - Mesh vs sutured repairs
- Open body cavity: emergency, goal is to get cavity closed

Prepubic tendon rupture

- Prepartum mares
- Predisposed by:
  - Hydrops allantois

    - Hydrops amnios
    - Trauma
    - Twins

Inguinal hernia

- Congenital and Acquired
- Indirect vs Direct
- Inguinal rupture
- Scrotal
- Foals:
    - Diagnosis: exam, ultrasound
    - Usually no colic
    - Observe for peritoneal rupture: fluid in SQ, discolored skin
    - Treatment: conservative vs surgical
    - Surgical: castration when possible, close external inguinal ring
- Adults:
    - Severe colic
    - Enlarged scrotum: firm, cool
    - History of work or breeding
    - Treatment: address colic, surgical emergency

Internal hernias

- Colic:
    - Mesenteric rent
    - Gastrosplenic rent
    - Epiploic foramen entrapment
    - Diaphragmatic hernia

Ultraviolet B Radiation for Exotic Pets: The Good, the Bad, and the Photokeratitis

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Because the majority of exotic pets are being housed indoors, it is important that they are provided lighting that mimics natural light. In addition to the provision of light, the amount of light provided in captivity should also mimic natural patterns. Photoperiods in the wild are generally between 12-15 hours a day, depending on season. To have success with exotic pets in captivity, it is important that we make recommendations to our clients that can ensure their long term success with their pets/breeding animals. The purpose of this presentation is to provide attendees an overview of the different types of lighting available for exotic pets held indoors, and how we can best use these lighting systems to provide the best captive environment for our patients.

Artificial lighting is provided in two different forms: incandescent and fluorescent lighting. Many of us are familiar with the standard forms of these lighting types, although there are some exceptions we may be less familiar with. One of the confusing aspects of lighting comes when manufacturers make claims about their light bulbs that are not true. The following review is meant to help clarify any misconceptions regarding the different types of lights.

Incandescent lighting is represented by the standard screw-in light bulb. This type of light has dominated the lighting scene for the provision of light in standard lighting fixtures in human domiciles. This type of light can generate a great deal of heat, especially at higher wattages, and requires a large amount of energy to run. There is a current movement to replace these bulbs for the more energy conserving fluorescent coli bulbs. The primary benefits associated with the incandescent bulbs are that they are inexpensive, can be used to generate heat, and can be made in different colors (e.g., red, black green, clear) and lighting spectrums (e.g., black light). To the author, incandescent lighting remains the best method for providing and regulating the environmental temperature within an exotic pet's enclosure. Incandescent lighting, with few exceptions, functions to provide visible light and infrared light (or heat). Although many manufacturers make a claim that their infrared lights are "full-spectrum" and can provide ultraviolet B radiation, it is not true. Two exceptions are the black lights and mercury vapor bulbs. Black lights do produce ultraviolet radiation, but it is not in the spectrum considered important for the photochemical stimulation of vitamin D. Some mercury vapor bulbs do provide ultraviolet B radiation within this spectrum, as well as heat. Actually, many of the mercury vapor bulbs can produce a significant amount of heat, making them only ideal for large vivariums.

Fluorescent light bulbs are sold in two forms, the original tube style and the more recent coiled screw-in type. Historically, when people discussed "full spectrum" light bulbs they were talking about the fluorescent tube light bulbs. The first to be sold as "full-spectrum", the Vita-light, was popular among hobbyists. It wasn't until later that research showed that this bulb did not produce an appreciable amount of ultraviolet B radiation in the appropriate range. This is an important point to consider, as there are a number of different manufacturers offering these bulbs and making claims regarding their value. It is important to research the bulbs prior to making the recommendations. The more recent coiled fluorescent bulbs appear to have the potential to produce even higher amounts of ultraviolet B radiation (in the appropriate range) than the tube bulbs. Again, the bulbs that can do this are specifically manufactured to do so. A fluorescent coli bulb from the local hardware store is not the same bulb as one produced specifically for reptile enclosures. The primary advantages associated with these bulbs is that they can provide ultraviolet B radiation in the appropriate range (290-310 nanometers) and provide high quality visible light. The primary disadvantages are that these bulbs produce little heat, requiring an additional bulb to generate infrared light heat, and can be expensive.

Ultraviolet light is produced by electromagnetic radiation. The wavelengths for ultraviolet radiation are shorter than those for visible and infrared light. Ultraviolet radiation is generally discussed in relation to those categories important to vertebrates: Ultraviolet A, B, and C. Ultraviolet C radiation represents the shortest wavelengths of the three classes (<280 nanometers). This range of ultraviolet radiation is germicidal, and is commonly used to control pathogens in aquatic systems. Ultraviolet B radiation provides the medium range ultraviolet radiation (280-315 nanometers). Ultraviolet A radiation represents the longest rays of the group and is characterized as "black light" (> 315-380 nanometers). Ultraviolet B radiation represents the range considered important in the synthesis of vitamin D3. Vitamin D3 is an essential hormone that plays many different important physiologic roles. Its role in calcium metabolism is probably its most recognized function, where it helps to ensure the development and maintenance of healthy bones. In some exotic pets, maintaining appropriate levels of vitamin D3 has also been found to be associated with increased reproductive success. Ultraviolet C is not generally discussed at any great extent, although it is considered important in regulating behavior in vertebrates.

There are two primary methods for obtaining vitamin D3: synthesizing it from exposure to ultraviolet B radiation or consuming a vertebrate that has synthesized the hormone through exposure to the sun. The production of vitamin D occurs as a result of the photosynthetic conversion of 7-dehydrocholesterol to pre-vitamin D3. Pre-vitamin D3 is converted to vitamin D3 via a temperature

dependent process. At this stage the hormone is transported to the liver where it is hydroxylated to 25-hydroxyvitamin D3. The kidneys serve as the site for the final conversion of the hormone to 1, 25-hydroxyvitamin D3, which represents the active form.

Vitamin D is considered important in vertebrates because it plays many different roles in the body. Because captive exotic pets are generally maintained indoors and derive no unobstructed sunlight, the use of "full spectrum" lighting has become an important consideration for ensuring that captive, non-carnivorous species can obtain vitamin D3. Until recently, studies evaluating the importance of full spectrum lighting in exotic pets have been limited to species of lizards. However, recently published original research from the author's laboratory has shown that 25-hydroxyvitamin D levels in a snake, Elaphe guttata, and chelonian, Trachemys scripta elegans, could be significantly increased after exposure to appropriate full spectrum lighting. Similarly, research evaluating these lights in rabbits and rodents has shown similar results. It has generally been accepted that these animals obtain their vitamin D through their diet; however, the results of these studies suggest that in these species, they can generate endogenous vitamin D, like humans, from direct stimulation to appropriate artificial lighting. Coiled fluorescent screw-in light bulbs were used for the study. The bulbs were placed within 6-9 inches of the study animal's basking spot. The findings of these studies confirm the importance of using full spectrum lighting for captive exotic pets.

When making recommendations regarding lighting that provides good quality ultraviolet B radiation it is important to recognize that not all bulbs are created equal. Although "full-spectrum" lights may appear similar, they can produce vastly different quantities of ultraviolet B radiation. To confirm the quantity of ultraviolet B radiation being produced by a bulb, it is important to measure the intensity of the radiation using an appropriate radiometer/photometer. The distance the bulb is placed to a basking reptile can also have an effect on the quantity and intensity of light reaching an animal. "Full-spectrum" lights should not be shown through glass, as it can defract the ultraviolet B radiation away from the pet. Historically, only fluorescent tube light bulbs produced any significant quantity of ultraviolet B radiation; however, some coiled fluorescent bulbs and mercury vapor bulbs can also produce appropriate to high levels of ultraviolet B radiation.

Visible light

Visible light is provided in the mid-light spectrum. The quality of visible light provided by different bulbs can vary. Some light bulbs provide poor-quality visible light across the color spectrum. In these cases, the light within the enclosure may have a "yellow" quality and the vibrant colors of the pet won't be apparent. Many exotic pets require high-quality visible light to identify the colors of foods, predators, and potential mates, among other things. Color rendering index is an important parameter to evaluate in the light bulbs. Fluorescent bulbs generally provide the best visible light. Most of the high quality "full spectrum" fluorescent tube and coil bulbs available through the pet trade provide good quality visible light.

Infrared light

Infrared radiation is in the upper end of the light spectrum, and the area in which heat is generated. Although there are a variety of different heating elements for exotic pet enclosures, the author prefers to use radiant heat sources in the form of light. This is the most natural method of providing heat to exotic pets, and mimics the primary method they absorb heat in the wild. It is possible to use variable wattage incandescent bulbs to provide a gradient of temperature for a pet's enclosure. The wattage for the bulbs will vary depending on the size and depth of the enclosure.

Conclusions

Artificial light is an important consideration for captive exotic pets being held indoors. It is important to use high quality light bulbs that meet the animal's needs across all three forms of the light spectrum, including ultraviolet, visible and infrared radiation. The provision of high quality light will help to ensure our client's success with their pet.

Opening Pandora's Shell:
Medical and Surgical Considerations for Chelonians

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Chelonians are commonly presented to veterinarians for a variety of health concerns. The purpose of this presentation is to provide a review of important biologic, husbandry, and disease information as it relates to these animals

Chelonians are long-lived reptiles that have always been of interest to humans, originally as a source of food, and more recently as pets. Chelonians are found on all of the inhabited continents. Since the 1980's the popularity of chelonians has increased dramatically. The primary reason for this has been the successful reproduction of these animals in captivity. As the popularity of these reptiles continues to rise, veterinarians can expect to encounter them more frequently in their practices.

Chelonians represent a diverse group of animals that can be found in different ecological niches, including aquatic, temperate, semi-arid and desert habitats. Characterizing the specific habitat required by a chelonian can be useful when designing a vivarium. These diurnal species prefer to bask in the morning and late afternoon hours in to avoid the excessive heat of the day. Because chelonians are ectotherms, it is important to provide them an appropriate environmental temperature range. In general, a diurnal range from 80-90^{o}F is appropriate; while a nighttime drop to 70-80^{o}F will suffice. Chelonians not provided an appropriate environmental temperature may have a decreased metabolic rate and immune response, resulting in limited growth and chronic infections.

For years there has been very little research focused at identifying the specific nutritional requirements of chelonians. Chelonians are generally classified as herbivorous, omnivorous or carnivorous. Herbivorous tortoises generally feed on a high degree of succulents and grasses within their native environments. The grasses are important sources of fiber, and provide essential cellulose for microbes in the colon of these reptiles. These microbes utilize these plant sources to generate volatile fatty acids (e.g., energy) for the tortoise. Captive tortoises should be provided a diverse diet comprised of vegetables, fruits, and grasses. The author prefers to use timothy or Bermuda grass hay, mustard and collard greens, and romaine lettuce as the basis for the diet. Fruits generally comprise 10-15% of the diet. Other green leafy vegetables, beans, and squash can be used to round out the diet. When offered a diverse diet, nutritional supplements are not generally required.

Omnivorous chelonians should be provided a diet comprised of both animal and plant materials. As juveniles, omnivorous chelonians tend to prefer animal proteins, while adult animals tend to consume more plant protein in their diet. Omnivorous chelonians should be provided the same plant based diet as described previously for herbivorous reptiles. In the United States, there are six invertebrates sold commercially, including the commercial cricket (*Acheta domesticus*), mealworm (*Tenebrio molitor*), superworm (*Zoophobia*s *morio*), waxworm larva (*Galleria mellonella*), fruit fly (*Drosophila* spp.), and earthworm (*Lumbricus terrestris*). The primary advantage to using these invertebrates is that they are readily available through most pet distributors year round. Unfortunately, these prey items do not provide a complete and balanced diet for an omnivorous chelonian. Most of these invertebrates are deficient in calcium, the exception being earthworms maintained in high calcium soils. Feeding or "gut-loading" commercial invertebrates prior to offering them to a chelonian can help to increase the mineral content of the prey items. Dusting the prey item with a calcium carbonate powder may also help to increase the calcium content of the prey items.

Some pet owners elect to capture wild invertebrates to feed their chelonians. It is important to only collect invertebrates from areas that are free of insecticides. There are a number of invertebrates that produce toxins that can prove fatal to a reptile. The same considerations should be followed when allowing tortoises to free-graze in a yard. Pesticides or insecticides used to treat grass can also be toxic to tortoises.

Chelonians not provided a balanced diet might develop hypovitaminosis A. Hypovitaminosis A is a common finding in tortoises that are offered a vitamin A deficient diet. Affected tortoises may present with blepharoedema, nasal and ocular discharge, dermatitis, diarrhea, and pneumonia. In severe cases, affected animals can die from hypovitaminosis A. Fast-growing juveniles and reproductively active females are most commonly affected. Affected chelonians develop squamous metaplasia, which results in the loss of tight cell junctions and increases the risk of opportunistic infections. Diagnosis is generally made based on history, physical examination, and measuring vitamin A levels. Hematologic samples and radiographs should also be performed to determine the extent of the disease. Treatment should include correcting dietary and environmental deficiencies. Parenteral vitamin A (1,500-2,500 IU/kg) can be used to initiate treatment. Over dosing an affected chelonian with vitamin A can cause an iatrogenic hypervitaminosis A, which can lead to the sloughing of the integument. Special care should be taken to only use the parenteral vitamin A in cases where the veterinarian is confident in their diagnosis.

Obesity is a common problem identified in captive chelonians that are offered ad lib food and not provided any exercise. Obesity can lead to other health issues, including dystocia and hepatic disease, and clients should be provided dietary recommendations to reduce the weight of their chelonians.

In the past decade, there has been a rise in the number of “new” or emerging infectious diseases reported in reptiles. Emerging infectious diseases include both newly identified pathogens and those pathogens that may have been previously characterized and are being reported with increased frequency. Veterinarians play an important role in the diagnosis of infectious diseases in herpetological collections and should closely monitor the literature to keep abreast of new findings and current research.

The rise in emerging infectious diseases in reptiles may be attributed to several factors, including the increased number of reptiles being imported into the United States and Europe, poor quarantine and sanitation programs, and improved diagnostic assays. The popularity of reptiles in the United States remains high, with millions of reptiles being imported annually. The popularity of reptiles has led to the growth of reptile swap meets, where herpetoculturists have the opportunity to select from a large number of different reptile species. At these swap meets large numbers of reptiles are maintained in relatively small areas with minimal/no biosecurity. Herpetoculturists routinely handle different specimens without washing their hands, possibly introducing and disseminating pathogens through the reptiles. The sanitation methods used to control or eliminate pathogens in reptile collections may also be suspect. Inappropriate use of disinfectants may lead to the development of resistant strains of microbes.

The number of diagnostic tests available to the clinician treating reptiles has increased dramatically over the past ten years. Historically, clinicians treated all “infections” in reptiles as bacterial diseases. However, over the past ten years, there have been an increased number of reports of viruses and fungi being isolated from diseased reptiles. The advent of molecular diagnostic testing has led to the development of highly sensitive and specific enzyme-linked immunosorbent assays, polymerase chain reaction (PCR), and reverse-transcriptase PCR.

The incidence of herpesvirus infections in chelonians has been on the rise since originally being isolated from sea turtles in 1975. Herpesvirus infections have been identified in freshwater, marine, and terrestrial species of chelonians. Transmission of the herpesvirus is believed to be via the horizontal route, although it has been suggested that a vertical route of transmission is also possible. Affected animals may present with rhinitis, conjunctivitis, necrotizing stomatitis, enteritis, pneumonia, and neurological disease. Molecular diagnostics, electron microscopy, and viral isolation have been used to diagnose herpes infections in chelonians. Affected animals should be provided appropriate supportive care (e.g., fluids, enterals, and antibiotics) to control clinical signs. Acyclovir has been used with some success by reducing viral replication. However, there is no effective treatment for this virus. Affected animals should not be released into the wild to prevent translocation of the virus to naïve chelonians.

Mycoplasmosis is a bacterial infection that has been associated with severe disease in chelonians. Affected animals may present with nasal and ocular discharge, conjunctivitis, palpebral edema and pneumonia. There are several diagnostic tests available to confirm mycoplasmosis in reptiles, including culture, an ELISA and a PCR assay. Microbiologic culture can be used to confirm an infection, but it is difficult to isolate this bacteria and time consuming. Currently, parallel testing using both the ELISA and PCR assays provides the highest degree of sensitivity. Treatment may be attempted using tetracyclines and flouroquinolones. Mycoplasmosis has been associated with declines in native tortoise populations in the United States and treatment of wild specimens is not recommended.

Chelonians are routinely presented to veterinarians for traumatic injuries. The majority of these injuries generally result in the fracture of the shell. Shell fractures should be managed as an emergency. Fractures to the shell can result in the loss of body heat, fluids, and the natural barrier against pathogens. A thorough examination is performed to assess the extent of the animal’s injuries, with shell fragments stabilized to minimize pain. Analgesics should be given prior to reducing the shell fractures. To determine the chelonian’s general health condition, diagnostic tests including a packed cell volume, complete blood count, and plasma biochemistries analysis are needed. Survey radiographs should be taken to assess the extent of skeletal and soft tissue injuries. Shell fractures greater than six hours old are managed as a contaminated injury, and samples from within the wound collected for microbial culture. The author has isolated both Gram-positive and Gram-negative bacteria from these injuries and broad-spectrum systemic antimicrobials are warranted in these cases depending on the antimicrobial sensitivity pattern.

The first step is to managing a shell fracture is to remove any debris by liberally flushing the injury with sterile warm physiologic saline. Care should be taken not to introduce excessive amounts of saline into the coelomic cavity. Wet-to-dry bandages can be applied to the shell surface to facilitate removal of debris. I generally use physiologic saline or dilute chlorhexidine for the wet bandage. Wet-to-dry bandages should only be used until the exudate associated with the wound is under control, as long-term use of these bandages can result in the desiccation of the viable tissues.

There are a number of opinions on the best method to correct a shell fracture. The author generally uses surgical hardware to reduce the fractures or manage the injury as an open wound and allow it to heal completely by second intention. Surgical correction is necessary for shell fractures that are not stable or involve greater than 20% of the shell surface area. Cerclage wire, plates or metal braces have all been used to reduce shell fractures. These devices are generally not removed from the shell fracture unless the animal remains in captivity until the shell fracture is completely healed. Once the fractures are reduced, the injury can be allowed to heal by secondary intention healing or covered with an acrylic polymer. Wounds that are not covered should be irrigated daily and kept free of debris until a protective epithelial barrier is observed. Commercial epoxy resins are also routinely used to repair shell injuries. However, these compounds are exothermic, and leakage into an injury could cause osteomyelitis or coelomitis. If the acrylic polymer

is used to protect the fracture site, than the epoxy can be used to cover the acrylic and form a watertight seal for aquatic chelonians. The convalescence period for a chelonian shell fracture can range from 6-30 months, depending on environmental and physical variables (e.g., environmental temperature and age).

Understanding the Bowel Wrapped in Fur: Rabbit and Rodent GI Disease

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The gastrointestinal tract of rabbits and rodents is unique in comparison to other domestic mammals. Veterinarians should become familiar with the anatomic and physiologic differences of the gastrointestinal tract of these animals in order to improve their management of diseases associated with this organ system. Diseases of the gastrointestinal system are a common finding in captive rodents and lagomorphs and have been associated with infectious diseases, parasites, toxins, and neoplasia. The purpose of this presentation is to provide attendees with a review of important anatomical features of the gastrointestinal system of rabbits and rodents and to discuss common diseases associated with the gastrointestinal system.

History and physical examination

A thorough history is essential to identifying any potential etiology(ies) responsible for gastrointestinal disease in rabbits and rodents. In many cases, there will be deficiencies in the animal's husbandry. Inappropriate diet is a common problem encountered in the author's practice. The physical examination should be thorough and complete. The ears, nares and eyes should be clear and free of discharge. The oral cavity should be examined closely. Because incisor and molar malocclusions are common in these animals, it is imperative that the teeth be closely inspected. The incisors can be evaluated by lifting the upper and lower lips, while examining the molars may require a more invasive approach, such as an oral speculum. The integument and furs should be evaluated for the presence of ectoparasites and injuries. The lungs and heart should be ausculted to determine in there are any problems with the cardiorespiratory systems. The extremities should be palpated. The plantar surfaces of rabbits should be closely inspected. Pododermatitis is a common problem in rabbits housed on wire bottom cages. The abdomen should be palpated. The kidneys, urinary bladder, stomach, and large intestine can generally be palpated during a routine examination. The anus and urogenital area should be examined, and these areas free of discharge. A rectal temperature should be taken. Rabbit body temperature is generally between 99-102^{o}F. The appearance of the droppings produced during the examination should be evaluated. Rabbit and rodent pellets should be well formed and moist. If the fecal component of the dropping is loose or watery, it is suggestive of a diarrhea. Changes in fecal color can also suggest a gastrointestinal abnormality.

Diagnostic testing

A complete blood count and plasma chemistry analysis should be done to assess the physiologic status of the rabbit or rodent patient. Inflammatory leukograms are frequent findings in animals with gastrointestinal disease, and are characterized by a heterophilia/neutrophilia and monocytosis. Anemia is also a frequent finding in chronic cases of gastrointestinal disease. Alterations in the enzymes, electrolytes, and proteins may be observed in animals with gastrointestinal disease. Survey radiographs can be used to assess the gastrointestinal tract. When the gastrointestinal tract of these animals becomes static, ileus will become evident. Microbiological culture should be done to isolate a specific pathogen, and an antimicrobial sensitivity assay performed to determine the most appropriate antibiotic for the case. A fecal examination should be done to rule-out parasitism and bacterial infections. Endoscopy can also be used to evaluate the gastrointestinal tract.

Bacterial diseases

Bacterial diseases are one of the most common causes of gastrointestinal disease in rabbits and rodents. The majority of the isolates recovered from animals with diarrhea are opportunistic Gram-negative bacteria, although certain Gram positive bacteria (*Clostridium* spp.) can also cause issues. Many of these isolates are typically found in the animal's environment. An antimicrobial sensitivity assay should be performed on the isolate to determine the most appropriate antibiotic. A fluroquinolone or potentiated sulfa may be used as a first order antibiotic while the sensitivity assay is pending. Penicillins and cephalosporins should never be given orally to rodents and rabbits.

Gastric stasis

Gastric stasis is a common finding in captive rodents and rabbits. Animals that develop gastric stasis may do so as a result of ingesting fur or another obstructive material (e.g., carpet) or as a result of some other medical gastrointestinal slow down. Fur ingestion may be accidental, which is thought to occur as a method to increase dietary fiber, or purposeful, as a result of nest building or barbering. Rabbits and rodents that present with trichobezoars may be anorectic, depressed and lethargic. Often these animals have a "doughy" abdomen. A firm mass can often be palpated in the stomach. Survey radiographs can be used to confirm the presence of hair in the stomach. In most cases the history will be that the animal has been anorectic, but their will be apparent ingesta (the fur) in the stomach. In many cases, ileus occurs secondarily to the trichobezoar. These cases can be treated medically or surgically. Medical management should consist of re-hydrating the animal and re-stimulating the gastrointestinal tract. Any fluid imbalances should be corrected first. Motility enhancers should not be used if an obstructive trichobezoar is suspected. Antimicrobials should be used if

enteritis develops. Mineral oil can also be used to assist in the passage of the trichobezoar. Surgical removal of a trichobezoar should be attempted if medical management is unsuccessful.

Parasites

Protozoal parasites (e.g., coccidian) are the most common endoparasites encountered in rodents and rabbits in the author's practice. Although coccidians are generally considered self-limiting in mammals, they do not appear to be in rabbits. *Eimeria* is the most common genera encountered. Diagnosis can be made from direct saline smears. Treatment can generally be accomplished using appropriate anti-coccidiocides such as ponazuril. The most common nematodes encountered in captive rabbits and rodents are pinworms. These parasites are considered by many to be commensals. The author generally recommends treating animals with pinworms when burdens appear heavy or it is a breeding operation.

Neoplastic diseases

Gastrointestinal neoplasia is an infrequent finding in rabbits and rodents. Neoplasia should always be considered in a differential diagnosis when an undetermined mass is associated with the gastrointestinal tract. Diagnosis is generally made using hematology, radiography, and biopsy/histopathology. Management of neoplasia in rabbits and rodents is dependent on the type of neoplasia.

Captive Reptile Diseases: What's Lurking under those Scales?

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In the past two decades, there has been a rise in the number of emerging and re-emerging infectious diseases reported in reptiles. Emerging infectious diseases include newly identified pathogens, while those characterized as re-emerging include those that may have been previously characterized but are being reported with increased frequency. Veterinarians play an important role in the diagnosis of infectious diseases in herpetological collections and should closely monitor the literature to keep abreast of new findings and current research.

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The number of diagnostic tests available to the clinician treating reptiles has increased dramatically over the past ten years. Historically, clinicians treated all "infections" in reptiles as bacterial diseases. However, over the past ten years, there have been an increased number of reports of viruses and fungi being isolated from diseased reptiles. The advent of molecular diagnostic testing has led to the development of highly sensitive and specific enzyme-linked immunosorbent assays, polymerase chain reaction (PCR), and reverse-transcriptase PCR.

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Mycoplasmosis is a bacterial infection that has been associated with severe disease in chelonians. Affected animals may present with nasal and ocular discharge, conjunctivitis, palpebral edema and pneumonia. Mycoplasmosis has also been identified in squamates and crocodilians. There are several diagnostic tests available to confirm mycoplasmosis in reptiles, including culture, an ELISA and a PCR assay. Microbiologic culture can be used to confirm an infection, but it is difficult to isolate this bacteria and time consuming. Currently, parallel testing using both the ELISA and PCR assays provides the highest degree of sensitivity. Treatment may be attempted using tetracyclines and flouroquinolones. Mycoplasmosis has been associated with declines in native tortoise populations in the United States and treatment of wild specimens is not recommended.

Cryptosporidium serpentis is considered a "plague" of captive snake collections. This apicomplexan parasite has been associated with both high morbidity and mortality in captive collections. Affected snakes commonly regurgitate their meals, have a mid-body swelling, and are dehydrated. A variety of methods may be used to diagnose cryptosporidiosis in snakes. Acid-fast cytology of a regurgitated meal or fecal sample is often diagnostic. Because there is currently no effective treatment, affected animals should be culled. *Cryptosporidium saurophilum* is a more recently diagnosed species associated with lizards. Whereas *C. serpentis* is associated with the stomach, *C. saurophilum* is associated with the intestine. Currently, no consistent treatment is available for *C. saurophilum* or *C. serpentis.*

Bearded dragon adenovirus was first reported in Australia in the early 1980's. The virus was not characterized in the United States until more than a decade later. Since that time, the virus has spread through the bearded dragon population in the USA and should be considered endemic. Transmission of the virus is primarily by the direct route (fecal-oral), although vertical transmission may also be possible. Affected animals may present with anorexia, weight loss, limb paresis, diarrhea and opisthotonous. Concurrent dependovirus and coccidial infections have also been observed in neonatal bearded dragons. Biopsies of the liver, stomach, esophagus, and kidney may be collected to confirm diagnosis (ante-mortem). On histopathology, basophilic intranuclear inclusion bodies are strongly suggestive of adenoviral infection. Currently, there is no non-invasive ante mortem diagnostic test to confirm adenovirus in the reptile; however, the author is currently working on a polymerase chain reaction (PCR) assay to detect adenovirus in the feces of affected

animals. There is no effective treatment for adenoviral infections, although supportive care (e.g., fluids, enterals, antibiotics) may be useful in stemming the secondary effects of the disease. Again, very little is known regarding the epidemiology of this virus; therefore, special precautions should be taken when working with affected animals. Because there is no effective treatment, affected bearded dragons should be culled from breeding populations.

Coccidiosis is a major cause of morbidity and mortality in reptiles. A species of special concern, Isospora *amphiboluri*, is found in bearded dragons. These endoparasites are especially problematic in neonatal dragons, often resulting in stunting, diarrhea, and death. Whereas most coccidial infections in higher vertebrates are self-limiting, these infections often persist in bearded dragon colonies. Historically, eliminating coccidia from bearded dragons was difficult because most of the therapeutics used to eliminate the parasites were coccidiostatic. Penazoril (30 mg/kg per os once with a second treatment 48 hours later) is coccidiocidal and has excellent therapeutic value against *I. amphiboluri*. Quarantine and environmental disinfection/sanitation should also be done to eliminate coccidia from dragon colonies.

Microsporidians are obligate intracellular parasites. The life cycle of these parasites includes both merogenic and sporogenic phases. These parasites are common in lower vertebrates (e.g., fish), but have also been implicated as a concern in humans with acquired immunodeficiency virus. Bearded dragons infected with these parasites can present with a similar clinical picture as adenovirus or coccidiosis. Affected dragons are anorectic, unthrifty, cachectic, and may die acutely. Diagnosis is generally made at post-mortem. Hepatic and renal necrosis is common, although other organ systems (e.g., intestine and gonads) may also be affected. There is no effective treatment. To limit the likelihood of introducing this parasite into a collection, herpetoculturists should only acquire animals from reputable breeders and quarantine any new arrivals for a minimum of 60-90 days.

Ranavirus is an emerging disease of chelonians. This virus has a high morbidity and mortality. It has been isolated from both captive and wild chelonians. Affected animals typically develop upper respiratory signs (e.g., palpebral edema, conjunctivitis), lower respiratory signs, oral ulcers, cervical edema, and gastrointestinal signs. Diagnosis can be done using PCR. There is currently no effective treatment for affected animals.

Ornamental Fish 101:
Managing Pet Fish without Getting All Wet

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There are two ways to approach a disease issue in fish: 1) ante-mortem tests and 2) post-mortem tests. Ante-mortem tests, or those done on live fish, are done when the aquarist is interested in saving a particular fish. The aquarist may pursue this route because of either personal (yes, the human-animal bond does occur with non-furry animals!) or financial (e.g., valuable breeding animal) reasons. Post-mortem tests, or those done on dead animals, are pursued when the aquarist is interested in saving a group of fish. A necropsy (animal form of an autopsy) can provide a great deal of insight into the disease condition of a particular fish, and therefore the population of animals that it originates from. The purpose of this presentation is to review the common diagnostic tests used to assess the disease status of a fish.

There are a number of different reasons that fish develop disease, including poor water quality, inappropriate husbandry, nutritional deficiencies, infectious disease (e.g., bacteria, viral, fungal), and parasitic disease. To determine which of these etiologies is responsible for disease in a particular fish (or fishes), diagnostic testing is required. Although the concept of performing these tests may appear overwhelming, with practice, diagnosing disease can become second nature.

The most common ante-mortem tests performed on fish are gill biopsies, skin scrapes, fin biopsies, complete blood counts, cultures, and fecal direct smears. Selecting which test to perform should be based on the clinical signs of the fish. Dyspnea (rapid breathing) in fish is suggestive of gill disease, and a gill biopsy would be appropriate. Lesions found on the skin (e.g., excessive mucous production) or fins (e.g., erosions) may be suggestive of infectious or parasitic disease, and a skin scrape or fin biopsy would be appropriate. Fish that are depressed, anorectic (not eating), or thin (muscle wasting) may have an internal disease (e.g., infectious or parasitic disease). A bacterial culture can be done to identify a specific bacterial pathogen. An antibiotic sensitivity profile can also be done to determine which antibiotic is best suited for eliminating the infection. A complete blood count can be used to interpret the animal's overall well-being or a fecal exam can be used to assess the potential for internal parasites. All of these tests can be done on alert or anesthetized animals, although the author prefers to anesthetize animals for the procedures. Tricaine methane sulfonate (MS-222; Argent Laboratories, Redmond, WA 98052)(100-200 mg/L) is the preferred anesthetic for anesthetizing fish.

Gill biopsies (clips) are an excellent method for assessing the quality of the gills. Teleosts, or bony fish, have 4 pairs of gills. The gills reside in the protective buccopharyngeal chamber under the operculum (gill cover). At the microscopic level, the gills can be divided into the primary and secondary lamellae. The primary lamellae represent the individual gill filaments that can be observed with the naked eye, while the secondary lamellae are comprised of a single layer of epithelial and endothelial cells and line the primary lamellae. The secondary lamellae are the site for gas exchange (e.g., oxygen absorption and carbon dioxide off-loading) and the excretion of wastes (e.g., ammonia). The surface area of the gills is vast, and allows for the rapid movement of water across the gill surface. Any damage to the gills can decrease the surface area associated with the secondary lamellae, and lead to dyspnea and death. Elevated levels of chlorine, ammonia, and nitrite, along with infectious and parasitic diseases, are the most common causes of gill disease in ornamental fish. To confirm which of these problems is associated with a specific case, diagnostic tests, such as a gill biopsy, should be done. If ammonia, nitrite or chlorine toxicity is suspected, than a water test should be done too. Elevated levels of any of these toxins, in combination with microscopic changes in the gills (e.g., excessive mucous production and a loss of respiratory surface area), are diagnostic. The presence of infectious (e.g., bacterial or fungal) or parasitic diseases with abnormal gills is also diagnostic. Once a diagnosis is made, an appropriate treatment plan can be devised. For example, water changes can be made to reduce the toxicity associated with ammonia or nitrite, sodium thiosulfate used to dechlorinate water, or an appropriate antibiotic or anti-parasitic given to treat infectious or parasitic agents.

A gill biopsy can be collected from an anesthetized or alert fish; however, the author performs this procedure on anesthetized patients. When handling fish it is best to wear latex exam gloves to minimize the likelihood of traumatizing the skin of the fish. The integument of fish is an important component of their innate (natural) immune system. Any damage to the skin can lead to an increased likelihood of opportunistic pathogens invading a fish. The gloves should also be moistened with the water from the animal's aquarium. The fish should be netted and removed from the aquarium. The thumb of your non-dominant hand should be inserted under the operculum, and the operculum raised slightly. Once elevated, a fine pair of scissors can be inserted under the operculum to collect the gill biopsy. A small cutting (4) of primary lamellae should be collected. A small amount of bleeding may occur, but generally ceases within seconds. The gill sample should be placed onto a glass microscope slide, a drop of water from the animal's aquarium placed on the sample, and a coverslip added to protect the sample. Water from the aquarium is preferred because it is isotonic (balanced) for any pathogens found on the gill. Adding water from another source that is not balanced can lead to the death of the organism and an inability to make a diagnosis. The sample should be reviewed immediately after collection to ensure best results.

A skin scrape should be done in cases where a fish has lesions on the skin. The skin scrape can be used to identify infectious or parasitic organisms. A glass microscope slide can be used to collect the sample. The slide should be held at a 45^{o} angle and drawn in a cranial to caudal direction (e.g., from head to tail). The sample should be placed on a second microscope slide, mixed with a drop of water from the aquarium, and covered with a coverslip. Again, the sample should be read immediately for best results. If bacteria are a concern, than a Gram stain or Diff-quik stain can be done to evaluate the types of bacteria present. To prepare these slides, the sample and drop of water are mixed, the sample heat fixed using a match or lighter, and the sample stained according to the manufacturer's recommendation.

A fin biopsy should be considered in cases where lesions are found on the fins. Many times these lesions are associated with a bacterial, fungal or parasitic infection. A fine pair of scissors should be used to collect the sample. If the sample can be collected between fin rays, that is preferred; however, this is not always possible, and the fin will regenerate. The sample should be handled in a similar fashion to the skin scrape, and either be placed on a slide with a coverslip or stained.

Fecal exams for parasites can be done on free-catch samples (e.g., found in the tank) or via enema. The samples should be placed on a slide with a drop of water and a coverslip and reviewed.

Post-mortem examinations should always be performed immediately after the fish has expired. Autolysis, or tissue disintegration, can occur rapidly in fish, and can severely limit the value of a necropsy. Fish that have been dead in the water for even a couple hours, depending on the water conditions and temperature, may have limited value. Therefore, it is important to perform the procedure as soon as possible after death. In cases where this is not possible, the animal should be stored in a refrigerator in an air tight bag. Freezing a fish can lead to tissue crystallization and eventual autolysis with thawing and is not recommended. Storing a fish in water is also not recommended, again, because of the potential for autolysis.

A fish post-mortem can be divided into two major parts: the gross examination and the microscopic examination. The gross examination will provide a significant amount of information; however, this is not generally diagnostic. The microscopic examination requires a review of the tissues under a light microscope. This aspect of the post-mortem examination generally requires the assistance of a veterinary pathologist. Veterinarians interested in submitting samples can find individuals capable of reviewing a case by searching the internet or local/state diagnostic laboratory. The author sends his samples to Dr. Michael Garner at Northwest ZooPath (www.zoopath.com).

When performing a necropsy on a fish, it is important to protect yourself against potential zoonotic diseases (e.g., those diseases that can be transmitted from animals to humans). The author highly recommends wearing latex exam gloves (or nitrile gloves for those with allergies to latex) when performing a necropsy. There are a number of bacterial and fungal fish diseases that can cause localized or even systemic diseases in humans. The cuts and scrapes we have on our hands can serve as excellent sites of entry for these pathogens, and thus the reason gloves are important.

The gross post-mortem examination will be the primary focus of this article, as the histologic examination is beyond the scope of this article. The post-mortem examination should start with an external examination of the fish. The general appearance of the fish should be closely inspected. How is the muscling? Is the animal thin? This can usually be determined by evaluating the large (epaxial) muscles along the spine. Animals with chronic disease typically lose muscle in an attempt to generate energy to defend against an infectious disease (e.g., mycobacteriosis). Are there erosions or ulcers on the skin? How large are they? Are they full thickness (e.g., can you see the underlying muscles)? These types of lesions may be indicative of aggressive bacterial infections that may be contagious to other fishes (e.g., *Aeromonas* spp.). A close external examination can provide a significant amount of insight into the health status of the animal. Not fully evaluating the fish can result in misdiagnosis. Once the external examination is completed, a thorough internal examination should be done.

Prior to opening the coelomic cavity (abdomen), it is important to evaluate the oral cavity and gills. The operculum should be removed and the gross appearance of the gills recorded. If the fish is only recently expired, they should remain moist and red. If the fish has been expired for an extended period of time, then they may appear deteriorated. Excessive mucous production or a loss of color is suggestive of disease. A clip of the gills can be taken and reviewed (unstained) under a light microscope to identify potential pathogens.

The author prefers to open the fish on the left side for the internal examination, as it provides better access to the spleen. The initial incision should be made on the ventral surface of the fish, cranial (in front of) to the anus. The incision should then be extended cranially to the level of the operculum. The incision should then be extended dorsally towards the spine. At this point, the incision can be extended caudally towards the tail, parallel to the spine. Finally, the incision can be extended ventrally back to the level of the initial incision. Once the incision is completed, the entire lateral aspect of the body wall can be removed. With the body wall removed, it will be possible to visualize the internal organs. With over 20,000 different teleosts, it is impossible to describe the variation in organ position, size, color, and texture in a single article. For the most part, these things are similar, but you can expect to be stumped on occasion. provide a review of the general locations of these organs in two different species of cichlids. For a more complete review of fish anatomy, the readers are directed to Michael Stosskopf's Fish Medicine (1992, W. B. Saunders Publishing). With time and practice, a veterinarian can become quite adept at identifying organs and knowing what looks normal and what looks abnormal.

The gross examination of the organs can certainly provide some insight into the health status of the animal, but is generally limited without histopathology (microscopic review of the tissues). Again, this is when submitting samples to a pathologist can prove invaluable. For example, the gills of a fish may appear grossly abnormal, but it would require histopathology to confirm the presence of a mycobacteriosis.

To truly characterize a specific cause of disease in a fish or a group of fish, diagnostic tests must be performed. For many veterinarians, the idea of performing these tests may be daunting; however, with practice any veterinarian can become proficient at performing and interpreting these tests.

Husbandry and Nutrition for Backyard Poultry: Making Lean, Mean, Egg-Producing Machines

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Backyard poultry are gaining in popularity. Much of this is related to people wanting to have a better understanding of where their food comes from, as well as developing a strong bond with the animals providing this food. For most veterinarians, poultry medicine in veterinary school is a distant memory. This is primarily because it was based on population medicine versus individual patient medicine, which is more common with backyard poultry. The good news is that veterinarians working with domestic pets already have a strong understanding of managing individual patients and can learn to do the same with poultry by gaining some knowledge regarding the specific husbandry and nutritional needs of these animals.

Housing

When considering housing for backyard poultry it is important to provide the birds protection against predators and inclement weather, as well as sufficient space for feed, water, laying, and exercise. Fortunately, chickens are highly adaptable to a variety of environments and conditions. A typical chicken coop should provide 1.5 to 2 ft2 of floor space per adult chicken. There are many different designs available on the internet for designing chicken coops (http://pubs.ext.vt.edu/). Ultimately, the structure itself should be easy to disinfect. Many clients like to design coops that are architecturally unique; however, it is important that is meets the needs of the birds first.

Ventilation is an important consideration for poultry. Poor ventilation can lead to stress which can affect performance (egg-laying) and predispose birds to disease (e.g., respiratory infections). Because warm air rises and cool air settles, it is important for clients to use fans or ventilation methods that ensure the air circulates rather than stagnates. Air circulation may also need to be varied based on season, depending on where the birds are housed. During the summer, it is important for warm air to be removed, while in the winter, it is important to limit the amount of cold air entering the coop to maintain a warm environment for the birds.

Perches can be provided in the roost to limit the time the birds are on the ground. This will help limit fecal contamination on the feet and the potential for pododermatitis. Perches should typically be 12-24 inches off the ground; it is important to leave room to clean under them. Perches can be constructed out of wood; however, they should be replaced if they become difficult to disinfect.

Nesting boxes should also be provided for hens in the coop. These houses provide a specific site for the hens to lay their eggs. The author recommends one nest box for every 3-4 birds. Nest boxes can be purchased from commercial sources or constructed from available building supplies. A good size for a nest box is 1 ft (tall) x 1.5 ft (wide) x 1 ft (deep); however, this may vary some depending on breed being chosen.

Nutrition and nutritional diseases

Chickens are omnivores and will gladly consume both animal (invertebrates such red worms) and plant products. Fortunately, there are commercial diets available to accommodate chickens from birth through laying. It is important for clients to utilize these special diets to provide the essential levels of macro- and micronutrients for their birds. This is especially important during the rapid growth of juvenile birds and egg producing years of hens. Nutritional diseases typically only occur in poultry fed unbalanced, non-commercial diets, such as table scraps. The most common nutritional diseases the author sees are related to low calcium diets (secondary nutritional hyperparathyroidism), especially in reproductively active hens, and hypovitaminosis A. Chickens presenting with secondary nutritional hyperparathyroidism typically have soft-shelled eggs, muscle fasiculations, and general weakness. If chicks are fed a poor diet, abnormal bone growth (e.g., pathologic fractures, splay legs) may also be common. Affected animals should be placed on an appropriate diet and supplements with oral calcium (calcium glubionate) until stabilized. Chickens presenting with hypovitaminosis A typically suffer from the effects of squamous metaplasia. Affected animals may have poor skin and feathers and abscesses within the oral cavity. Again, correcting the diet and supplementing the chicken with oral or parenteral vitamin A should correct the deficiency.

Examinations and Diagnostics for Backyard Poultry: You Can Perform Antemortem Workups on Chickens?

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Restraint

Chickens can often be restrained simply by holding their wings up against their body. A towel can also be wrapped around the body of the bird, like a burrito, to settle the animal and allow the examination of the head and neck. Some birds may peck, and in these cases, gently grasping the head at the level of the quadrate/mandible with one hand and supporting the animal's body with your second hand will suffice. Remember, chickens are a prey species and many predators kill them by wringing their neck; therefore, it is best to limit the amount of time you restrain their head. It is also important to avoid placing any excessive pressure over the keel, as these animals do not have a diaphragm and must move the keel to ventilate.

Physical examination

Always observe a chicken patient from a distance prior to restraining it for a physical examination. Special attention should be given to mentation, respiration, and locomotion. The physical examination should be performed in a thorough and consistent manner. The eyes should be clear with no discharge. A baseline ophthalmic exam should be performed to evaluate the conjunctiva, cornea, anterior chamber, and posterior chamber. Birds suffering from a traumatic injury may have hemorrhage in the eye or other significant lesions. The nares should be clear and free of discharge. The oral cavity should be inspected closely. The mucous membranes should be pale to pink and free of thick ropey mucous. The tongue should be identified and evaluated for function. The glottis should be free of discharge. The choanae should be free of discharge and have well-developed choanal papillae. The integument should be closely inspected for traumatic injuries and inflammatory responses (dermatitis, parasites). Feather parasites are a common problem with pet chickens. The muscling over the keel bone, spine and ribs should be palpated. The muscles over these structures should be well developed. The keel and spine will be prominent in birds with muscle wasting. The wings and limbs should be palpated for any traumatic injuries and to assess feather condition. Evaluating the muscles covering the limbs can also be helpful with assessing body condition. The coelomic cavity should be palpated for any abnormalities. A thumb or finger can be used to gently palpate the viscera. Any abnormal masses should be further evaluated using appropriate diagnostic tests. A stethoscope may be used to measure the heart and respiratory rates and listen for abnormalities in these systems.

Diagnostic sampling

Chickens are stoic animals and have evolved to mask their illness. A thorough physical examination may be helpful in characterizing certain disease problems, but its overall value may be limited. A veterinarian must use available diagnostic tests, such as hematology, plasma chemistry analysis, microbiological culture, cytologic examination and parasitologic examination, to aid in the diagnosis of disease.

Hematology

Hematologic samples may be collected and submitted to evaluate the red and white blood cells (complete blood count), plasma enzymes, minerals, proteins, and electrolytes. When collecting a blood sample, considering the sample volume is important. Approximately 1.0-ml blood / 100gr body weight can be safely collected from birds, although it is important to consider the animal's overall health status when estimating how much blood to collect.

Blood samples are routinely collected from the jugular vein, medial metatarsal vein, and basilic vein of birds. The jugular vein is located on the lateral aspect of the neck. Wiping alcohol over the lateral cervical region will cause the feathers to part over the apterium, enabling the venipuncturist to visualize the jugular vein. The author prefers to use a 25-26 gauge needle on a 3-ml syringe to collect the sample. Using a larger gauge needle may result in a hematoma forming. The medial metatarsal vein is another appropriate site for venipuncture in chickens. Wiping alcohol over the venipuncture site may help facilitate direct visualization of the vessel. Again, the author prefers to use a 25-26 gauge needle with a 3-ml syringe for sample collection. The basilic vein is located on the ventral surface of the wing at the level of the elbow. Care should be taken when sampling this site, as hematoma formation is

common. This is a site where the author always prefers a 26-gauge needle. Because the vessel is highly moveable, it is often helpful to stabilize the vessel against your thumb.

Blood samples should be immediately placed into an appropriate collection tube. Blood samples that are going to be used to perform a complete blood count (CBC) should be placed into an ethylenediaminetetraacetic acid (EDTA, purple-top) microtainer tube and samples for plasma chemistry analysis should be placed into a lithium heparin (green) microtainer tube.

Microbiological culture

Both Gram-positive and Gram-negative bacteria have been associated with infections in birds, although Gram-negative bacteria (e.g., *Salmonella, E coli*) are considered to be more important pathogens of chickens. Bacteria may be differentiated not only by their staining characteristics (Gram-positive or negative), but a battery of additional biochemical tests: aerobic or anaerobic, lactose fermenting or non-lactose-fermenting, etc. When a microbiologic sample is collected, it should be streaked onto appropriate agar plates and incubated. Most commercial microbiologic incubators are set at 98.6^{o}F because they were developed to grow pathogenic bacteria from humans. Because avian core body temperatures may vary from this standard (>104^{o}F), it has been suggested that different incubator temperatures may be needed to isolate bacteria from birds. However, research suggests that the pathogens are capable at growing at a range of temperatures.

Parasitology

Parasites are a common finding in backyard chickens. Birds may be infested with both internal (endoparasites) and external (ectoparasites) parasites. Therefore, a thorough parasitological examination should be performed. Birds may be infested with the same groups of endoparasites commonly identified in domestic species, including protozoa and nematodes. Although chickens and parasites have evolved to exist together, parasites can overburden their host in captivity. An avian endoparasite examination should include both a fecal direct saline smear and a fecal floatation. A direct saline smear will facilitate the examination of bacteria and some protozoa (ciliated and flagellated protozoa), while the fecal float is used to identify larger parasites (e.g., nematodes, flukes, cestodes).

Diagnostic imaging

Radiographs and ultrasound are important diagnostics for backyard poultry. Because cancer and foreign bodies are common in these birds, the author frequently uses radiographs to confirm the presence of a mass and ultrasound to identify a specific mass for a fine needle aspirate or biopsy.

Common Diseases of Backyard Poultry: Creepy-Crawlies to Cancer

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Backyard poultry are gaining in popularity. Much of this is related to people wanting to have a better understanding of where their food comes from, as well as developing a strong bond with the animals providing this food. For most veterinarians, poultry medicine in veterinary school is a distant memory. This is primarily because it was based on population medicine versus individual patient medicine, which is more common with backyard poultry. The good news is that veterinarians working with domestic pets already have a strong understanding of managing individual patients and can learn to do the same with poultry by gaining some knowledge regarding the specific diseases of these animals.

Reproductive diseases

Chickens have been bred for commercial purposes to produce eggs for 1-2 laying seasons. With backyard poultry, there is a desire to increase the laying season and longevity of the birds; however, this is typically because these animals are considered as pets rather than as a source of a product (eggs). With this increased longevity, it is not uncommon to have birds presented for reproductive diseases. In the author's experience, reproductive diseases are the most common reason backyard poultry are presented to his practice. Egg-yolk coelomitis commonly occurs in chickens greater than 2 years of age. Cases can be acute or chronic in nature. In many cases, birds present because of a swollen "abdomen" and decreased egg production. In mild cases, medical treatment including antibiotics, anti-inflammatories, analgesics, and supportive care can prove successful. In severe cases, surgery is required. Another common reproductive presentation is associated with ovarian cancer. Because of the similarities in cancer between chickens and humans, these animals are commonly used as translational models for human cancer. Again, the most common reason the birds are presented is for decreased egg production. In severe metastatic cases, which are common, birds may also show signs of general weakness, anorexia, and weight loss. Surgery is the only option for these birds; however, many cases have already metastasized by the time the birds are presented.

Infectious and parasitic diseases

The infectious diseases that tend to create the most problems for backyard poultry are Gram negative bacteria, including *Salmonella* spp., *E. coli*, and *Campylobacter* spp. Common reasons birds are presented are for infections of the reproductive tract (e.g., egg-yolk coelomitis), digestive tract (e.g., diarrhea), and respiratory tract (e.g., pneumonia). Gram stains may be used to guide the clinician, but microbiological culture and antimicrobial sensitivity testing are necessary to confirm the pathogen and antibiotic needed to treat the animal, respectively. It is important to remember that many of the antibiotics used for domestic pets are off limits for production species, such as backyard poultry. The following link provides a list of antibiotics that can be used for backyard poultry: http://www.extension.org/pages/66983/drugs-approved-for-use-in-conventional-poultry-production#.VYquibfbLcs

Marek's disease is associated with a herpesvirus. This virus is commonly spread between birds by dust and feather dander. This is typically a disease of very young birds, but can also show up in older flocks too. This virus can lead to tumor development, which can affect the bird's ability to ambulate. Birds being presented with Marek's disease are often anorexic, weak, and have delayed ambulation. There is a vaccine against this virus that can be given to young animals.

Ectoparasites and endoparasites are common in poultry kept in poor husbandry conditions. Mites, lice and ticks can be found on backyard poultry. The type of parasite can be determined by reviewing the organism under light microscopy. Fecal floats and direct saline smears should be used to screen chickens for endoparasites. Nematodes, cestodes, and protozoa may be found during these examinations. In most cases, birds with low burdens of parasites will show no signs of disease. In cases where birds are confined and husbandry is poor, burdens can rise and animals may show signs of decreased egg production, diarrhea, pneumonia, and general weakness. The following link provides a list of antiparasitics that can be used for backyard poultry: http://www.extension.org/pages/66983/drugs-approved-for-use-in-conventional-poultry-production#.VYquibfbLcs

Feline Urinalysis Update

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Urinalysis – the body fluid of choice for disorders of the urinary tract and more

Collection of urine without contamination (non-urinary chemicals, cells, environmental elements) and without trauma to the urinary tract (which introduces cells and protein into the urine) is critical to the proper interpretation of results. The method by which urine is collected influences the cell and chemical content that will be reported, and should be clearly noted on the urinalysis form. Urine may be collected by voiding, catheterization, or cystocentesis; each method has its own advantages and disadvantages. The single most important kidney function test from the urinalysis is the degree of urine concentration as evaluated by urinary specific gravity (USG). Less than maximal urine concentration may provide clues to underlying renal and endocrine disorders. A complete urinalysis should be submitted whenever serum biochemistry and CBC are submitted in order to allow a clearer analysis of the patient's condition. Two handbooks/manuals of veterinary urinalysis are available as references.[1,2]

Voided urine

Voided samples are acceptable for evaluation of urinary specific gravity (USG). It is almost never possible to collect mid-stream voided samples from cats. Urine should NOT be expressed from the bladder of cats as trauma from this procedure often adds blood and protein to the sample. Wide fluctuations in USG do not occur throughout the day in cats as occurs in dogs, so timing of sample collection is usually not important. Non-absorbable kitty litter (e.g., Nosorb ®) placed in a cleaned and rinsed litter box may allow the collection of a voided sample from cats. Make certain there is no bleach contamination to the sample as this can give an artificially positive reaction for blood on dipstrip chemical analysis. Contamination from the distal urethra, genital tract, skin, and environment can make interpretation of results from voided urine samples difficult. Voided samples are not acceptable for bacterial culture due to the potential for heavy bacterial contamination of the sample from the distal urethra and genital tracts, although the degree of this type of contamination is far less in cats than in dogs. Analysis of a voided urine sample is often needed to determine whether blood observed from a previous sample collected by cystocenteisis was caused by the cystocentesis needle.

Catheterized urine

It is rarely justified to obtain routine urinalysis by catheter, since the possibility of introducing bacteria is always a threat to create iatrogenic urinary tract infection (UTI). If a urinary catheter is being placed for other reasons, collection of urine through the catheter may be acceptable, but some changes in the urinalysis may be the result of trauma from passing of the catheter. Routine catheterization of male cats should be avoided due to the possibility of causing urethritis and urethral obstruction following the procedure. Culture of catheterized samples may help document urinary infection. Results of urinalysis taken from animals with indwelling urinary catheters are more likely to have blood and protein present, secondary to the presence of the catheter. The initial 1-3 mL of urine from the catheter should be discarded (called a mid-stream catheterized sample), since the first few mL are most likely to be contaminated from the urethra and genital tracts.

Cystocentesis samples

In general, it is best to evaluate urine collected by cystocentesis (vesicopuncture), since this method bypasses potential contamination of the specimen with cells, protein, or bacteria from the urethra, vagina, prepuce, and perineum. This is unquestionably the method of choice for urine culture and microscopic evaluation of bacteria in sediment, since normal urine directly from the bladder should not contain any bacteria. Some problems with interpretation of results can occur when the tip of the needle has traumatized the bladder or if the bladder wall has inadvertently been aspirated into the needle during sampling (adding RBC or epithelial cells). Cystocentesis should also be avoided if there has been recent major caudal abdominal trauma due to the possibility of bladder wall devitalization from the trauma.

Cystocentesis is readily performed when the urinary bladder is palpable in cats. If the bladder is not palpable, cystocentesis should not be attempted with blind techniques as used with some success in dogs. Urinary urgency and pollakiuria can make it difficult to keep enough urine in the bladder to obtain a sample from a palpable bladder. It may be necessary to give the cat an analgesic and mild tranquilizer to decrease urgency so that the bladder will fill over the next few hours. Removing the litter tray the night before a first morning appointment increases the chances to be able to palpate the bladder and obtain a cystocentesis sample. This method is useful for cats scheduled to be examined for wellness visits or elective pre-operative procedures.

Sudden collapse following/during cystocentesis has been very uncommonly encountered in cats, probably a result of a vagal-vagal response. Though sometimes dramatic, this effect is quite transient. We have observed this in some male cats with urethral obstruction in which decompressive cystocentesis was very rapidly accomplished. A 22 gauge needle or smaller should be used for puncture of a palpable bladder using dorsal or lateral recumbency. A one-inch needle should be used for thin animals; up to a two inch needle can be used for large or obese cats. The needle should be pointed toward the pelvic inlet to allow collection of a sample as the bladder collapses without needle trauma during aspiration. Although cystocentesis can be performed in cats using dorsal recumbency, it is safer and easier in most cases to perform the procedure with the cat restrained in lateral recumbency. The bladder can be palpated and

isolated using one hand to position the bladder away from the bowel. With four fingers under the cat pull up lightly on the abdomen, using the thumb to isolate the bladder within the abdomen in the ideal position. With the other hand, direct the syringe and needle perpendicular to the body wall, through the abdomen, and into the bladder. Ultrasound (ULS) guidance usually allows cystocentesis of enough urine from a small bladder that could not be sampled during bladder palpation. Even with ULS the bladder may be too small to successfully obtain a sample. In these instances, waiting for the bladder to fill with more urine is advised. In some practices, all urine samples are obtained with ULS guidance whether the bladder is palpable or not. The advantage to this method is that it allows a brief structural evaluation of the bladder to exclude the presence of cystic calculi or bladder masses.

Performing the urinalysis

A complete urinalysis that includes evaluation of physical properties, chemical properties, and urinary sediment microscopy should always be performed when possible, otherwise potentially meaningful clinical information will not be evaluated. Acquisition of a very small urine sample volume may not allow the performance of all 3 components of the complete urinalysis, but there is almost always enough volume to analyze the chemical dipstrip and the USG. In some instances all of the small volume will be prioritized to submit for urine culture instead of components of the UA.

Should the UA be performed in-house or shipped to a veterinary referral laboratory? One answer does not fit all practice situations especially depending on technical personnel available and their level of expertise with urinalysis. UA results from fresh urine can differ from those following storage and shipping depending upon time before analysis and temperature conditions of the sample. Samples that sit overnight in the refrigerator before analysis may suffer loss of cells, loss of cellular detail, degradation of casts, and precipitation of crystals that were not there at the time of collection. To lessen the impact of this, an unstained dry mount of urine sediment may be sent along with the urine specimen allowing cellular detail to be preserved (Dr. Maxey Wellman personal communication) but this will not preserve casts or crystals for observation.

A standard quantity of urine should be centrifuged to allow semiquantitative comparison of any abnormal findings between animals or from the same animal over time. Usually 6 to10 mL is recommended for routine urinalysis, but smaller volumes are often analyzed. The volume of urine subjected to analysis should be specifically noted as used in your practice or sent to a referral laboratory. Comparison of urinary sediment results between large and small urinary volumes that were centrifuged at either high or low speed suggested minimal differences in a recent veterinary abstract but differences in the number of reported of casts were found.[3]

Urinalysis should be performed as quickly as possible following collection of the sample (within 15 to 30 minutes). Prolonged exposure of urine to room temperature before analysis can result in dissolution or degradation of delicate casts, change in pH, growth of bacterial contaminants, and loss of cellular detail due to intracellular degeneration. Refrigeration of the specimen is necessary if examination within 15 to 30 minutes after collection is not possible. The diagnostic value of the urinalysis is greatly enhanced when the urine sample is obtained prior to initiation of diuretic or intravenous fluid therapy that may alter urine concentration. Fresh urine sediment evaluation is likely to be most valuable/revealing in cats that are systemically ill or in the hospital receiving treatment.

USG is the weight of urine compared to that of distilled water. Highly concentrated urine is expected in the urine of healthy cats. USG is the only indicator of renal function in the urinalysis and consequently is very important. USG is estimated by refractometric methods that depend on the bending of light in proportion to the number of molecules dissolved in solution. Refractometers designed for analysis of human urine are often used in veterinary practices, but these have a limited range for the upper scale (1.001 to 1.035). Refractometers designed for veterinary use are more appropriate to use since the scale is calibrated from 1.001 to 1.060. USG most often exceeds 1.035 in cats with normal renal tubular function.[4] It is not acceptable to report USG values as "Greater than 1.035" or "Off the Scale," as potentially valuable quantitative information is lost regarding renal function and risk for idiopathic cystitis or urolithiasis. The refractive index for urine differs between dogs, cats, and humans, so it is best to use a veterinary refractometer that displays different scales to record the refractive index (estimate of USG) for dogs and cats.[5] Both digital and optical refractometry correlate well to urine osmolality, but digital methods remove the variability of subjective interpretation.[6]

Dipstrip reactions for urine chemistry are graded on a subjective scale from 0 to 4 plus, with 1 plus being a trace reaction and 4 plus being the most intense reaction possible. It is important that urine be at room temperature for dipstrip testing as some color reactions are temperature-dependent. Urine should be well-mixed prior to exposure to the dipstrip to ensure that all constituents of the urine will contact the reagent pads. Color reactions should be read in good light, as some of the reactions have subtle color changes, particularly notable for protein content. Highly pigmented urine (obviously bloody or dark with bilirubin) can make it difficult or impossible to accurately determine the degree of color reaction in some instances. Human dipstrip testing for WBC is very unreliable in urine from cats (many false positives).[7] Similarly, dipstrip testing should not be used to determine USG.[8] Automated devices to read the colorimetric reactions from dipstrips are becoming increasingly available in private practice and can remove some of the inherent subjectivity to reading the color reactions with the naked eye.[9,10]

Evaluation of urinary sediment

The goal of centrifugation is to concentrate otherwise undetectable abnormal urinary elements for microscopic evaluation. A pellet at the bottom may or may not be macroscopically visible following centrifugation. Sedi-Stain® may be added to the sediment to enhance contrast of cellular elements; although this is optional, it is recommended. Sedi-stain sometimes causes mucus strands to look like casts or precipitates to look like bacteria. The microscopic slide is first examined under low power to count casts and to detect areas of interest that need examination under high power. At least 10 high-dry microscopic fields are then evaluated to quantitate white blood cells, red blood cells, epithelial cells, and bacteria, and to examine crystals that might be present. Casts are counted per low-dry power field. It is a good idea to bias the examination to include the coverslip margins as elements often accumulate there. It is now easy to capture digital images of urinary sediment using a smart phone and an inexpensive adapter to the microscope eyepiece.[11] This allows a more permanent record to be captured and stored for part of the patient's medical record and also provides a means to send images to specialists for further identification of abnormal elements.

Urinary sediment from healthy animals contains very few cells or casts and no bacteria, but can contain certain crystals. The ability to properly identify red blood cells, white blood cells, and bacteria is most important. Do not expect cells in urine to look like they do on a blood film due to the widely varying effects of urinary osmolaitiy on the cells as well as that from urinary pH and urinary toxins. Highly concentrated urine will cause cells to shrink and very dilute urine will cause cells to swell. The presence of up to 5 red and 5 white blood cells per high-dry microscopic field is considered normal when the sample is obtained atraumatically by catheterization or cystocentesis. Some labs include up to 10 RBC per HPF to be "normal". Slightly higher numbers of cells (up to 8 red or white cells per HPF) may still be considered normal when a voided sample is examined. The presence of clumps of white blood cells increases the probability that an organism is the cause of pyuria, and clumps should be so noted on the form. Lipiduria is normal in cats – lipid droplets are highly refractile and vary greatly in size. Lipid droplets are often confused with RBC (and sometimes with crystals) but can be differentiated with more certainty following staining with Sudan stain.

Epithelial cells

Zero to occasional transitional epithelial cells should be present in urine from healthy cats. Transitional epithelial cells vary widely in size, and are usually rounded, but only small ones (approximately 1.5 to 2 times the size of white cells) are derived from the kidney. Unfortunately, small transitional epithelial cells can also originate from the lower urinary tract. Small transitional epithelial cells with a tail-like configuration (caudate cells) are thought to arise from the renal pelvis and consequently their presence may suggest upper urinary tract localization of disease. The presence of sheets or clumps (rafts) of transitional epithelial cells strongly suggests neoplasia, but may also occur with severe inflammation. A dry mount cytological preparation of urine should be examined for morphology of these epithelial cells if rafts are consistently identified in the urinary sediment. Squamous epithelial cells can be observed in voided specimens. These cells are of no particular significance in urine as they arise from non-urinary tract tissue.

Bacteria

When urine samples from healthy animals are properly collected and examined in a timely manner, none or very few bacteria should be seen. Particles of debris, stain precipitates, and very tiny crystals may look like cocci when subjected to Brownian motion in urine sediment, resulting in a false positive for bacteria to be reported by the laboratory. It is easier to be confident that bacteria are present when rod-shaped organisms are seen. Specimens which are reported positive for bacteria should be Gram stained or stained with Diff-Quick® for confirmation,[12-14] and a quantitative urine culture should be performed. The absence of microscopically visible bacteria does not ensure that bacteria are absent; at least 10,000 rods/mL or 100,000 cocci/mL of urine must be present to be visible during wet-mount microscopy.

Casts

Casts are molds of proteins and cells that form within the lumen of the distal tubule and should be rarely encountered in urine from healthy animals. Cellular casts in urine are always considered pathologic regardless of their quantity. Cellular casts are easily disrupted and can undergo rapid cellular degeneration. So it is essential to examine fresh urinary sediment if cellular casts are to be identified. The presence of cellular casts localizes a pathological process to the kidneys.

Cellular casts may consist of red blood cells, white blood cells, or renal tubular epithelial cells. Red blood cell casts are occasionally observed in acute glomerulitis and following severe renal trauma or renal biopsy. Acute glomerular disease is not common in cats. White blood cell casts (pus casts) are indicative of renal inflammation and are often thought to be caused by bacterial infection. Epithelial cell casts result as the lining of the renal tubule sloughs following a variety of injuries to the kidney – indicating severe tubular injury.

It is easy to identify the type of cellular cast when the morphology of the cells within the cast is well preserved. When cellular degeneration has occurred it can be difficult to tell the difference between white blood cell and epithelial cell casts. Where cell type cannot be accurately determined, the cast is referred to as a degenerating cellular cast. Since even a single cellular cast is of great diagnostic significance, it is important to note their presence. Cellular casts are especially fragile and their presence is easily missed if urine is stored too long prior to examination.

Granular casts are more commonly encountered in animals with renal disease than cellular casts. According to the classic theory of Addis, granular casts develop from degenerating renal epithelial cells, white cells, and red cells that have remained within the renal tubular lumen. Granules can also originate from precipitation of filtered serum proteins into tubular fluid.

Waxy casts consequently require the longest intrarenal time for their development. Waxy casts are translucent and sometimes take up stain intensely. They tend to be brittle, often with visible fractures and sharp, broken off ends. They are not fragile casts, and are stable for some time in alkaline or acid urine. Since it takes more intrarenal time to form this cast, their presence implies local nephron obstruction and often indicates advanced renal disease.

Hyaline casts are pure precipitates of matrix (Tamm-Horsfall) mucoprotein. Hyaline casts are transparent and have low optical density. They can be missed during brightfield microscopy if lighting intensity is not reduced. The presence of persistent hyaline casts usually indicates increased filtration of serum proteins which does not happen in healthy animals. Increased filtered proteins can occur from glomerular disease, passive congestion, and fever. Increased concentration of THP favors its precipitation – this can occur in highly concentrated urine and from increased tubular secretion. Decreased tubular flow rate and the presence of myoglbin or hemoglobin in the tubular fluid favor precipitation of THP.

Crystals

The presence of crystals in urine is often more confusing than helpful in providing meaningful information. Many amorphous crystals cannot be definitively identified based on morphology alone. Urinary pH can suggest which types of crystals are more like to precipitate out of solution at a particular pH. Crystals can be identified in those without stones, in those with stones, and sometimes in those with stones of another crystal composition, so their clinical significance is questionable in many instances. It is VERY IMPORTANT to remember that crystals can come out of solution after collection of the sample, especially during storage and even more so during refrigeration. Crystals that are reported may not have been there at the time the sample was collected.[15,16]

Struvite crystals are common in both normal and abnormal small animals and their presence in urinary sediment does not mean by this finding alone that the animal has urolithiasis due to struvite. Struvite crystals are the most common type encountered in small animals. The presence of struvite crystals is commonly encountered in urinalysis from normal dogs and cats. Struvite is easily identified when they assume the “coffin-lid” appearance but they can also assume amorphous forms. Struvite crystals form more often in alkaline urine and are commonly encountered as an artifact following storage and refrigeration.

Calcium oxalate crystals can be helpful in establishing a diagnosis of ethylene glycol (radiator fluid) poisoning in the appropriate clinical setting, but they can also be seen in the urine of healthy animals. So-called "hippurate" crystals also help to support a diagnosis of ethylene glycol poisoning, but they are really not hippurates as was once thought.[17,18] There are many different morphological appearances for calcium oxalate crystalluria, some of which are not easy to identify. These crystals are more often found in acid urine. The dihydrate form of calcium oxalate is relatively easy to recognize due to its rhomboid shape with internal Maltese cross pattern. Oxalate crystals may be an artifact of storage and refrigeration or may be associated with urolithiasis, hypercalcemia, or ethylene glycol ingestion.

The presence of cystine crystals is abnormal and in animals with urolithiasis does help to confirm their chemical composition. They are usually noted in acid urine. These hexagonal crystals are never normal and are associated with cystinuria or cystine urolithiais. These crystals may be confused with struvite crystals, but cystine crystals are flat and display little internal architecture.

Urate crystalluria is never normal in the cat. In the presence of confirmed urolithiasis their presenece suggests the chemical composition of the urinary stone. The presence of ammonium biurate, leucine, or tyrosine crystals can be seen in animals with liver disease, but are not commonly observed.

Bilirbuin crystalluria is never normal in the cat and should prompt further evaluation of liver function.

Pseudocasts/artifacts

Sometimes elements within urinary sediment will resemble casts when they are really artifacts, called pseudocasts. The presence of mucus in urine can trap debris in such a way that the resulting structure appears very similar to a cast. The pseudocast can be quite long and its diameter quite variable. Sometimes packing of crystals or many bacteria during centrifugation can produce structures that resemble casts. In these instances, examine a fresh drop of unspun urine for comparison. Squamous epithelial cells have a tendency to roll on themselves and can look like casts, but they are much larger than casts. Degenerated lower urinary tract epithelial cells can produce pseudocasts that resemble granular casts; however, usually these pseudocasts, unlike true casts, have rounded ends and walls which are not parallel.

Vegetative matter such as straw and fiber is observed frequently in specimens collected by voiding. Ova of Capillaria plica can occasionally be encountered in urine sediment of cats with and without signs of lower urinary tract disease.

Special tips - urinalysis

- Evaluate fresh sediment- everything is easier to identify
- Crystals from refrigerated urine may be artifacts– note if refrigerated
- Describe if WBC are clumped

- Look closely at clumped WBC for possible organisms
- Describe “bacteria” as cocci or rods
- Don’t rely on dipstrip pads for WBC in dogs or cats
- Don’t rely on dipstrip pads for USG
- If you see things that look like fungal elements, make sure they are not elongate bacteria.
- If fungal elements are seen, make sure they are not in the stain
- Consider Gram-stain of urine when “bacteria” are noted in the urinary sediment.
- Get pH by meter if it is important to know precise values
- Make sure you have the “real” specific gravity – not “off scale”
- Perform dispsticks on urine that has been warmed to room temperature if samples have been stored in the refrigerator
- Be careful to distinguish lipid droplets from RBC in urine from cats
- Quantitate the number of crystals, note if they are aggregating or not, and make sure to report if they were discovered in refrigerated urine

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Diagnosing and Treating Urinary Tract Infection in Cats

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Urinary tract infection (UTI) exists when bacteria colonize portions of the urinary tract that are normally sterile (i.e., kidney, ureter, bladder, proximal urethra). UTI most commonly affects the bladder. Bacterial colonization may be superficial along the mucosa, or deeper within the mucosa or submucosa. Bacterial UTI is far less commonly diagnosed in cats compared to dogs and is estimated to affect 1-3% of cats in their lifetime. Dogs with no identifiable anatomical, metabolic, or urinary functional problems of the urethra or bladder can acquire UTI, which is quite different for UTI that develops in most cats. Cats that develop UTI are by definition considered "complicated" since healthy cats have exquisite urinary tract defense systems that simply do not allow a "casual" development of UTI. Cats with bacterial UTI will most often be discovered to have anatomical, metabolic, or functional problems of the bladder or urethra, or have undergone urinary tract instrumentation (e.g. urinary catheterization) that facilitate bacterial ascent and colonization of the urinary tract.

Diagnosis

Various combinations of hematuria, pyuria, and bacteriuria are observed in urinary sediment from cats with LUT signs associated with a positive quantitative urine culture (clinical UTI). In cats without LUT signs evaluated for other reasons, a positive urine culture in substantial quantity can be documented (occult or asymptomatic UTI – discussed later). The isolation of bacteria in large quantities does not determine whether the UTI is located in the upper or lower urinary tract, if the UTI is chronic or acute, or if the infection is deep within tissue or superficial along the mucosa.

It is important to remember that many particles in urinary sediment from cats, more so than dogs, resemble bacteria – lipid droplets, small crystals, cellular fragments, mucus, stain precipitates. Dry-mount examination of urinary sediment following either Wright's-Giemsa or Gram stain to further identify bacteria in urinary sediment from cats increases the certainty that UTI really exists or it does not.[1] Urinalysis and aerobic quantitative urine culture reported in colony-forming units per milliliter (cfu/mL) should be conducted in all cats suspected of having a UTI. Isolation of organisms in large quantitative growth (cfu/mL) from a properly collected and handled sample is the gold standard for definitive diagnosis. The number of cfu/mL needed to definitively confirm the existence of UTI varies depending on how the urine is collected and whether clinical signs are present. Lower cfu/ml are often considered clinically significant in patients with increased voiding frequency in which organisms may be eliminated from the bladder before they have time to replicate to higher numbers.

Do not submit sterile swabs soaked or dipped in urine since quantitative culture methods cannot be performed on this type of sample. Culture of urine following cystocentesis is the method of choice to most easily establish a definitive diagnosis of UTI as this bypasses potential contamination with organisms from the distal urethra or genital tract.[2,3] Far less contamination with bacterial organisms occurs during collection of voided or catheterized urine samples from cats compared to dogs. In one study, 24 samples from healthy cats of both sexes, no growth occurred when urine was collected by cystocentesis. Minimal cfu/ml of bacterial growth occurred from samples collected by urinary catheter. In 9 of 12 samples from male cats no growth occurred; 3 samples grew between 10 and 100 cfu/mL. No growth occurred in 11 of 12 samples from female cats in samples collected by catheter; in 1 sample between 100 and 1,000 cfu/mL growth occurred. Quantitative growth (cfu/mL) was much greater in both male and female cats from urine samples collected by voiding. Organisms grew from all 11 urine samples collected by voiding from male cats. Quantitative growth ranged from 100 to > 100,000 cfu/mL in these samples; in 6 of 11 samples, growth exceeded 1,000 cfu/mL (> 10,000 cfu/mL in 2 samples). No growth occurred in 5 of 12 samples collected by voiding from female cats; in 4 of 7 positive cultures, growth was 1,000 to 10,000 cfu/mL and in 1 > 100,000 cfu/mL. In samples with positive growth, more than one organism was frequently isolated. *Escherichia coli, Staphylococcus* spp, *Streptococcus* spp, *Corynebacterium* spp, *Pasteurella* spp, and *Flavobacterium* spp were the organisms isolated in decreasing frequency from the urine of these normal cats.[4]

True bacterial UTI is likely in cats when ≥ 1,000 cfu/ml of organisms are isolated from urine collected by cystocentesis; < 1,000 cfu/ml is more likely to be from contamination during the collection process. Low-level growth from cystocentesis samples is possible in cats with true UTI when antibacterial treatment has been given recently. UTI is likely to exist when ≥ 1,000 cfu/ml are isolated from urine collected by urinary catheterization from either male or female cats; < 1,000 cfu/ml is most likely associated with contamination. Some criteria state that UTI is likely in cats isolating ≥ 10,000 cfu/ml from voided urine[5], but this may not always be true since high level contamination occasionally occurs in both male and female cats using this method of collection.[4] Culture of voided urine is not recommended since high level growth can occur from contamination rather than indicating true UTI, though no growth on voided urine samples does provide meaningful information.

The Uricult® Vet dip paddle system (LifeSign, Skillman, NJ) can be a useful in-house screening tool for identification of bacterial growth.[6] Quantitative results (cfu/mL) determined by comparing growth on the paddles with a standard illustration of organism

density provided by the manufacturer were not always accurate. Inaccuracy in identification of isolated organisms sometimes occurred when paddles were used, particularly when multiple uropathogens were present. This paddle system provides no method for susceptibility testing of isolated organisms, although the bacteria can be categorized into gram-positive or gram-negative status. When growth occurs, paddles or a fresh urine sample should be submitted to a commercial microbiology laboratory for identification and antimicrobial susceptibility testing. Veterinary hospitals should determine whether their referral microbiology laboratory will accept organisms already growing on paddles for definitive identification and minimum inhibitory concentration (MIC) testing. This paddle system for organism isolation appears most clinically useful as an in-house method to identify urine samples that are sterile or samples with low quantitative growth compatible with contamination during the sample collection.[6]

The Accutest Uriscreen® is an in-house color reaction based test designed to rapidly detect catalase from bacteria and from cells in the urine sample from dogs and cats. A negative test supports that UTI does not exist but there are false positives for UTI, so a positive test necessitates a follow-up quantitative urine culture.[7]

Organisms isolated from cats with UTI

Twenty-five percent of urine cultures from cats not biased toward those diagnosed with urinary disease were positive for bacterial growth considered indicative of a UTI in one report from a teaching hospital.[8] The criteria to establish a UTI included any growth in a cystocentesis sample, ≥ 1,000 cfu/ml in catheterized samples, and ≥ 10,000 cfu/ml in voided urine. The number of cats with true UTI is likely overestimated in this study due to the entry criteria. Eighteen bacterial species were isolated in this study. *E. coli* accounted for 47% of the isolates, *Staphylococcus* spp for 18%, and *Streptococcus* spp for 13%. A single bacterial isolate occurred in 85%; > 1 isolate occurred in 15% of the positive cultures. The USG of cats infected with E. coli tended to be < 1.025 whereas those infected with Staph or Strep were usually > 1.025. Older female cats were over represented, as were Siamese cats.[8] *E.coli* and Gram-positive cocci were also the most commonly isolated organisms from Australian cats with UTI in other reports. Older female cats were also more likely to have a positive urine culture as in the previously mentioned study. *E. coli* was isolated in 37% of the positive cultures, *Enterococcus* species in 29%, *Staphylococcus felis* in 20% and *Proteus* species in 5%. *Enterococcus fecalis* accounted for 95% of enterococci spp with the remainder by *enterococcus faecium*.[9,10] *Enterocccus* accounted for 19% of positive urine culture from cats evaluated at the OSU CVM.[11] *Staphylococcus felis* is a coagulase-negative organism that has traditionally been considered a normal commensal organism from healthy cats present on the skin, eyelid margins, conjunctival sac, and in saliva, but appears that this organism can be a uropathogen for the cat.[9]

Occult UTI was documented in 38 of 132 urine specimens (44 isolates) collected by cystocentesis from cats without LUT signs, inappropriate urination, or previous UTI – these samples were submitted as part of other diagnostic workups for a variety of conditions including CKD, hypethyroidism, and diabetes mellitus. Hematuria and pyuria were common in the urinalyses from urine culture-positive cats and culture-positive urine specimens were more likely to come from older female cats. *Enterococcus faecalis* was the most common isolate (19 of 44 total isolates) followed by E. coli (17 of 44 isolates). A few isolates of *Proteus mirabilis*, *Staphylococcus felis*, and *Streptococcus bovis* were also documented in this group of cats. Heavy growth of bacteria at ≥ 100,000 cfu/mL was documented in 39 of 44 isolates and moderate growth at 10,000 to 100,000 cfu/mL was found in 5 of 44 isolates.[12] Occult bacteriuria that is either persistent or transient has been described in apparently healthy dogs or those presented for elective surgical procedures[13,14] but this has not been reported in healthy cats. Urine was collected by cystocentesis from 108 healthy cats (53 males and 55 females) with a median age of 4.0 years without previous or current LUT signs. Both urine and urine sediment underwent quantitative culture resulting in no growth in 107 of 108 samples. In the remaining sample >100,000 cfu/mL of 2 organisms was isolated, likely the result of contamination. [15]

A unique form of relapsing UTI is caused by *Corynebacterium urealyticum*[16,17] or *Corynebacterium jeikeium* [18] in which encrustations of urinary tissue and struvite (so-called “encrusting cystitis”) prevent eradication of the organism with medical treatment alone. These organisms are rarely isolated as a cause for UTI in cats but may be under-diagnosed. These organisms are often reported as “diptheroids” thought to be contaminants that are not further characterized. These organisms are often slow growing and require special media to facilitate their growth and identification. These organisms are highly resistant to commonly prescribed urinary antibacterials and the prognosis for cure is generally poor even with surgery and long-term antibiotics.

Conditions associated with UTI in cats

UTI occurs with increased frequency in special populations of cats that include those with metabolic disease (CKD, hyperthyroidism, diabetes mellitus), prior instrumentation of the urinary tract with urinary catheterization, urinary incontinence, acquired anatomical abnormalities (stones, tumors, perineal urethrostomy), and congenital anomalies. Chronic kidney disease (CKD), hyperthyroidism, and/or diabetes mellitus all increase the risk for cats to acquire a true bacterial UTI, [19] though clinical signs of UTI may not be present (asymptomatic bacteriuria). In one study 10–15% of cats with hyperthyroidism, diabetes mellitus or chronic renal disease had a bacterial UTI,[12] similar to findings of other studies.[19-21]

In a report comparing 155 cats with UTI to 186 cats without UTI, significant risk factors to acquire UTI were identified for cats with urinary incontinence, transurethral procedures, gastrointestinal diseases, decreased body weight, and decreased urine specific gravity. In this study, 35.5% of cats had no clinical signs associated with their UTI (asymptomatic bacteriuria). UTI in this study was defined as any growth from samples collected by cystocentesis and > 10^3 cfu/mL from samples collected by urethral catheterization[22]. Decreased urinary specific gravity was not identified as a risk for UTI in cats of another study.[19]

An early report drew attention to the apparently high rate of UTI in cats with azotemic CKD. Five of 15 CKD cat urine samples without obvious bacteriuria in urinary sediment grew organisms and 12 of 19 CKD cats with bacteriuria grew organisms. Whether or not these CKD cats had LUT signs associated with a positive urine culture was not addressed.[23] The finding of a positive urine culture in cats with CKD could be associated with infection within the kidneys but often this cannot be proven to exist. In a study of 42 female and 44 male cats with CKD undergoing routine urine culture surveillance, positive urine cultures in samples collected by cystocentesis were identified 31 times from 25 cats over a period up to 3 year of their CKD. Eighteen of the 25 cats (72%) were classified as having occult UTI. Eighty-seven percent of cats with positive urine cultures were found to have active urinary sediment. Increasing age was a significant risk factor to acquire occult UTI in female CKD cats. The presence of UTI was not associated with the severity of azotemia or survival in these cats[24].

The frequency of UTI in reports of young cats with non-obstructive LUT signs is quite low (often reported at less than 2%) in most studies in North America, the UK and Europe. [25-31]. Idiopathic/interstitial cystitis accounts for 60 to 70% of diagnoses in cats presenting for some form of urinary urgency. In cats older than 10 years, UTI appeared to be quite common (>50%) in those evaluated for signs of urinary urgency; idiopathic cystitis accounted for only 5% of cases in this group of cats.[32,33]

A study in 2007 of cats from Norway with a variety of obstructive and non-obstructive causes of LUT signs[34] found a surprisingly high number of cats with positive urine culture in large quantitative growth, far more so than in other reports. Findings from this study are difficult to interpret since many of the cultures were from voided midstream (46%) or catheterized urine samples (21%) rather than from the gold standard of cystocentesis (21%); in 10% the method of urine collection was not recorded. 44 of 118 samples cultured on the same day isolated bacteria > 10^3 cfu/ml. In 33 of these 44 samples, growth was > 10^4 cfu/ml and in 20 growth was > 10^5 cfu/ml. Quantitative growth from midstream voided samples from healthy cats is sometimes substantial as was shown in 55% of males and 40% of females that grew > 10^3 cfu/ml in another study [4].

Congenital anomalies of the urinary tract are occasionally the cause of UTI in young cats. Any condition associated with non-urge related incontinence can be expected to be associated with UTI. A common urogenital sinus malformation was found as the underlying cause for UTI and incontinence in 3 young female cats that were evaluated for recurrent lower urinary tract infections and incontinence (Ohio State University CVM 2014 – publication in preparation). Fusion of the vagina to the proximal urethra created a single vaginourethra. No vestibule existed as the vulva and urethra appeared as a continuous structure that allowed easy fecal contamination. Cystoscopy was the diagnostic tool used in these cases to confirm the abnormal anatomical status. Partial invagination of the urinary bladder was diagnosed in one cat with clinical signs of hematuria, stranguria, and inappropriate urination associated with UTI. This diagnosis may be made on the basis of detection of invaginated tissue in the bladder apex during abdominal ultrasonography.[35]

Treatment

Antibacterial susceptibility testing on isolated organisms is recommended to guide the best treatment selection. Results can reveal the presence of resistance organisms that can predict treatment failure and the need for greater surveillance following treatment. A change in urinary antimicrobial may be needed based on the results of susceptibility testing after the initial treatment was started at the time of submission of the culture.

The Working Group of the International Society for Companion Animal Infectious Diseases (ISCAID) recommends treatment with urinary antibacterial drugs that are likely to be effective against more than 90% of the urinary isolates when this information is available. In general, ISCAID recommends initial therapy for uncomplicated UTI with amoxicillin (11–15 mg/kg PO q8h) or trimethoprim–sulfonamide (TMP-sulfa; 15 mg/kg PO q12h); the group does not recommend amoxicillin–clavulanate for initial treatment in these cases because of lack of evidence for the need for clavulanate in addition to amoxicillin.[36] Additional detail and a free PDF download of this work published by Veterinary Medicine International is available at http://www.hindawi.com/journals/vmi/2011/263768/.

Amoxicillin/clavulanic acid was recommended for Gram-negative infections and amoxicillin for Gram-positive infections in one review of cats with UTI. Variation in bacterial prevalence and susceptibility patterns should also be taken into account when prescribing antibacterial treatment[10] Most isolates of *E.coli* in one study showed susceptibility to the 14 antimicrobials tested. *Staphylococcus* felis was susceptible to all antimicrobial agents tested. Enterococcus was universally sensitive to amoxicillin/clavulante and penicillin/amoxicillin in 2 studies of UTI in cats by the same group.[9,12] *Enterococcus faecalis* can vary greatly in its susceptibility pattern to antimicrobial agents and so may require higher dosage, longer duration or a combination of therapeutic agents in some patients with overt LUT signs. A high proportion of *Enterococcus* isolates were resistant to clindamycin

(97.3%) and cephalothin (72.3%). *Enterococcus* had intermediate susceptibility to enrofloxacin, (61.1%) and marbofloxacin (80.5%).[9] All cephalosporins, potentiated sulfas, and aminoglycosides are notoriously ineffective against *Enterococcus* even when the susceptibility test results return as sensitive for those drugs. *Enterococcus* is usually susceptible to imipenem and meropenem BUT use of these drugs should be restricted to those cases that have LUT signs and have failed treatment with amoxicillin or amoxicillin-clavulante. Current recommendations are to NOT treat asymptomatic UTI associated with *enterococcus* since this infection can come and go without treatment. Aggressive treatment for asymptomatic UTI runs the risk that the original *enterococcus* will become more resistant and then become symptomatic when it was not before. There is also the possibility that the *enterococcus* will be eradicated, but UTI with a more virulent and symptomatic organism will take its place.

Resistance patterns were reported for isolates of *E. coli* mostly from urine of dogs (301)and cats (75) in various regions of the United States. Resistance to amoxicillin was 46%, amoxicillin-clavulanate 37%, cefpodoxime 22%, doxycycline 22%, enrofloxacin 21%, trimethoprim-sufla 19%, and gentamicin at 12%. This pattern for E. coli resistance suggests that empirical treatment for UTI may have limited success in this geographic location. Treatment of *E. coli* with amoxicillin or with amoxicillin-clavulanate may be less likely to be effective than commonly believed.[37]

An early report documented the effectiveness of enrofloxacin treatment of UTI in cats. In this study all isolates were considered susceptible to enrofloxacin and post treatment sterility was documented in 21 of 23 cats.[38] As noted above, there are concerns for increasing resistance patterns for *E. coli* in the United States; there are no recent reports of UTI in cats treated with enrofloxacin. The total daily dose of enrofloxacin in cats should be limited to 5 mg/kg either once daily, or divided in order to limit retinal toxicity. Retinal toxicity is a fluroquinolone class risk, especially for those that achieve the highest retinal concentrations and can result in mydriasis and blindness.[39,40] It appears that cats as a species have developed a limited efflux mechanism to remove fluoroquinolones from the retina compared to other species.[41] High-dose short-duration protocols prescribing enrofloxacin to treat UTI have been developed for use in dogs with uncomplicated UTI[42] but these protocols should NEVER be used in cats due to retinotoxicity that predictably develops at high doses. Administration of the 3rd generationi fluroquinolone pradofloxacin at 6 to 10 times the recommended dose was shown to have no retinal toxic effects in cats based on rod and cone function evaluated with ERG. Retinal histopathology was unaltered during high dose pradofloxacin treatment. Cats treated with high doses of enrofloxacin showed diffuse retinal degeneration and poor rod and cone function.[40]

Cefovecin is an extended spectrum semi-synthetic 3rd generation cephalosporin approved in Europe for use in cats with UTI caused by *E. coli*, but not approved for this indication in the United States. As noted in the ISCAID guidelines, routine use of a 3rd generation cephalosporin as a first-choice treatment is controversial. It is designed to have a 14-day dosing interval after a single subcutaneous injection. Post treatment urine cultures revealed sterile urine in 75.9% of all cats treated with a single injection of cefovencin. *Escherichia coli* was eliminated in 76.7 per cent of cefovecin-treated cats compared with 62.5 per cent of cephalexin-treated cats. Cefovecin demonstrated statistical non-inferiority compared with cephalexin for bacterial elimination in this study. [43] Efficacy of cefovecin to sterilize the urine in cats with UTI was less than that reported by the same group in dogs with UTI.[44]

Client-owned cats with bacteriologically confirmed UTI were treated with either pradofloxacin, doxycycline, or amoxicillin-clavulante[45] Urine culture revealed growth following treatment in 0 of 27 cats treated with pradofloxacin, 3 of 23 cats treated with doxycycline, and in 3 of 28 cats treated with amoxicillin-clavulante.[45] Pradofloxacin undergoes more hepatic excretion than does enrofloxacin but still achieves urinary concentrations that can be highly effective in the eradication of uropathogens. Pradofloxacin may be the preferred fluoroquinolone to prescribe for use in cats with UTI and impaired renal function due to the hepatic pathway for its excretion and its retinal safety profile should high concentrations of pradofloxacin accumulate in cats with decreased renal function. Pradofloxacin is FDA approved for soft tissue infections in cats; it can be considered for off-label treatment of UTI in cats.

Study of canine and feline *E.coli* isolates that were considered highly resistant to standard antimicrobial agents showed susceptibility to fosfomycin at concentrations well below the susceptible breakpoint. This finding makes it attractive to consider fosfomycin as a treatment for resistant *E. coli*.[46] Fosfomycin is considered a nephroprotectant in some species but in cats this drug can be highly nephrotoxic. When given to experimental cats for as little as 3 days, severe tubular lesions were evident and renal function declilned as BUN and serum creatinine increased.[47]

The recommendation of 7 to 14 days of an appropriate antimicrobial for treatment of an uncomplicated lower UTI has been based on conventional experience over the years, but surprisingly little data exist to support or refute these protocols. Ultimately, antimicrobials should be given for as long as is necessary to effect a bacteriologically sterile urine during administration of the medication and for a protracted time following discontinuation of treatment.

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Managing Cats with Idiopathic/Interstitial Cystitis (Parts 1 and 2)

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What is Pandora Syndrome ?

Is this terminology more helpful than FUS or FLUTD or IC ?

Results of studies over the past 20 years indicate that idiopathic/interstitial cystitis in cats is the result of complex interactions between the bladder, nervous system, adrenal glands, husbandry practices, and the environment in which the cat lives. A recent review emphasizes that many cats with a diagnosis of FIC have lower urinary tract- predominant clinical signs that are part of a larger systemic disorder referred to as "Pandora Syndrome"[1]. Clinical problems outside the lower urinary tract are common in those with a diagnosis of FIC and include signs related to the GI tract, respiratory system, skin, central nervous system, cardiovascular system and the immune system. It has been traditional to refer to cats that have obvious LUT signs as those having "feline urological syndrome", "feline lower urinary tract disease", or "feline interstitial cystitis" but this method of naming the disease focuses on the organ with the predominant clinical sign rather than a thorough evaluation of the entire cat and all of its organ systems. A diagnosis of Pandora Syndrome would apply to those cats that exhibit clinical signs in other organ systems (in addition to the LUT), waxing and waning of clinical signs associated with stressful events that presumably activate the stress response system, and undergo resolution of severity of clinical signs following effective environmental enrichment. Currently available evidence suggests that many cases of chronic idiopathic LUT signs presently diagnosed as having FIC actually do have a ''Pandora'' syndrome. The syndrome might result from early adverse experiences that sensitize the neuraxis to sensory input, increasing the frequency and duration of activation of the stress response system (SRS) when the individual is housed/living in a provocative environment. The chronic ''wear and tear'' of persistent activation of the SRS can upregulate the inflammatory response in a variety of tissues including the bladder.

Are there different types of presentations for cats with idiopathic/interstitial cystitis ?

There are four possible urinary presentations associated with FIC. An acute seemingly self-limiting episode of FIC is thought to be the most common condition presenting to primary care practitioners with an estimated relative prevalence of 80 to 95%(Lulich ACVIM Forum Proceedings Anaheim 2010) – recurrence is likely if stressful situations become severe enough in the future. Frequently recurrent episodes of clinical signs related to FIC is next in occurrence (2 to 15%), followed by persistent forms of FIC (2 to 15%) in which the clinical signs never abate. The fourth possibility is for urethral obstruction to develop in male cats suffering from FIC (15 to 25%). These 4 types of presentations may represent a spectrum of signs from the same disease process, but this hypothesis has not been tested. Most publications reflect data from cats with frequent recurrences or persistent clinical signs that are presented to university referral practices. Based on our data, a potential fifth category could be healthy cats, especially males, that develop LUT signs when when exposed to sufficient stressors[2].

What are the differential diagnoses for cats with LUT signs?

Though FIC is the most common diagnosis associated with LUTS in young cats, it is important to exclude the diagnosis of bacterial UTI and urolithiasis in a population of cats with risk factors. Collection of a detailed history that includes queries regarding environmental issues and husbandry practices is an essential first step in deciding if the LUTS are related to irritative voidings or not, and how likely stress may be playing a role. In order to determine if Pandora Syndrome is part of the LUTS, the history and physical examination must be extended beyond that immediately related to the urinary tract. Quantitative urine culture and survey radiography are recommended in the evaluation of all cats with recurrent LUTS to exclude UTI and radiopaque calculi. Advanced imaging that includes contrast radiography, ultrasonography, and urethra-cystoscopy are useful for the exclusion of anatomical defects, radiolucent calculi, and proliferative lesions in some cats.

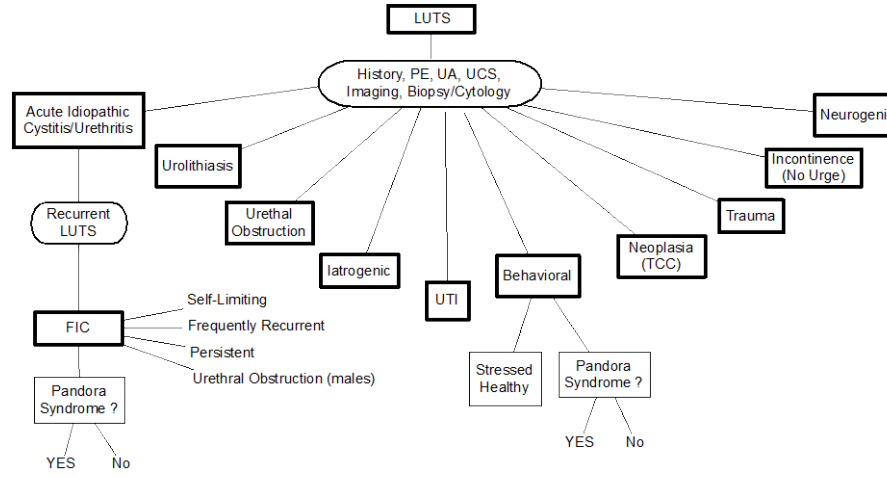


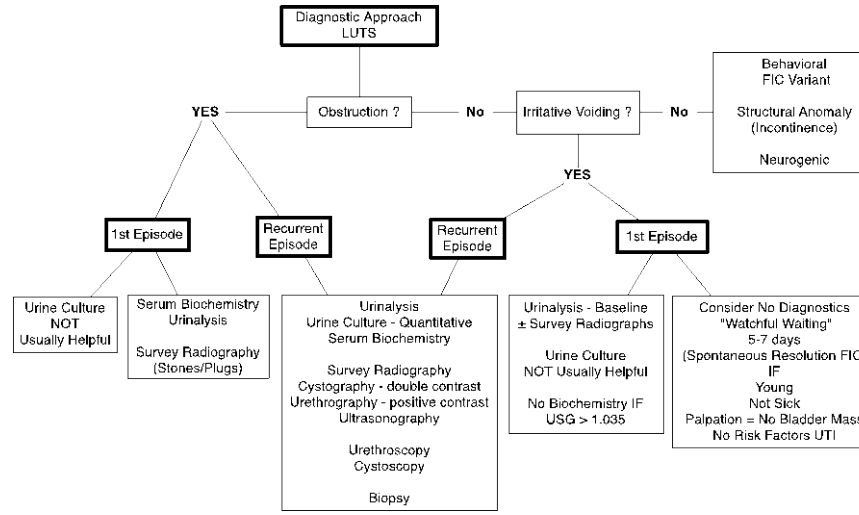
Figure 1

Some possible causes of LUTS in cats after appropriate diagnostic evaluation. PE – physical examination; UCS- quantitative urine culture (cfu/ml); Imaging – some combination of radiography, contrast urography, ultrasonography, and/or uroendoscopy. Not all tests are appropriate for every cat, so diagnostic evaluations tailored to each individual cat are most likely to arrive at the correct diagnosis.

What diagnostic workup is needed f or cats with LUTS signs?

Figure 2

A diagnostic approach for cats with LUTS, emphasizing the distinction between those cats that are obstructed or not, and cats that do or do not have irritative voiding.

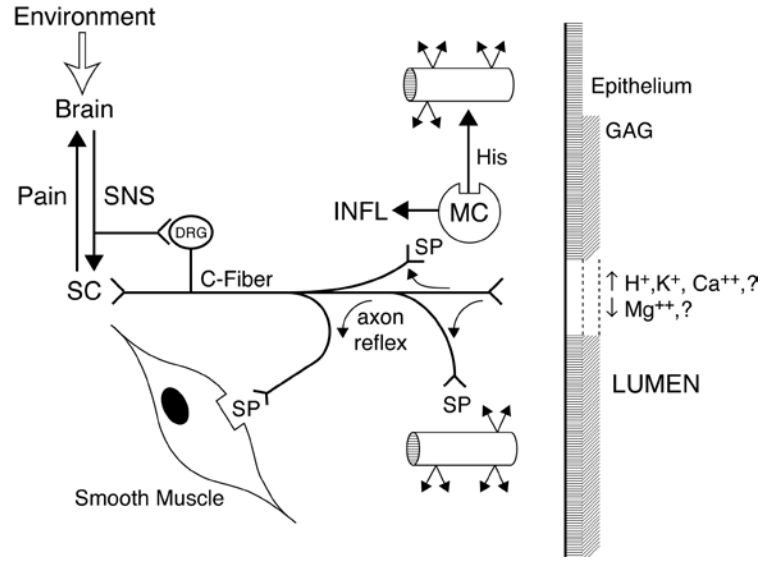


Can you summarize where we are in our understanding of the pathophysiology of FIC ?

Though all the pieces are not completely understood, the basic centerpiece is one of neurogenic inflammation – this type of inflammation is quite different from the standard kind of inflammation classically involving infiltration of neutrophils. Increased bladder permeability is an important part of this process, as this allows constituents of urine to gain access to the bladder wall- these compounds stimulate sensory nerve endings to carry excessive pain signals to the brain. The increase in bladder permeability likely involves changes in the GAG layer and the integrity of the structure and function of the urothelium. The stress response system (SRS) becomes activated but is not adequately terminated by release of cortisol as it is in normal cats. Unrestrained outflow of sympathetic nervous system activity characterizes this disease. Excess effects of norepinephrine are known to upregulate a variety of inflammatory processes including that in the bladder. Infiltration with mast cells is important in some cats with FIC – degranulation of mast cells then contributes to the inflammatory process (vasodilation, edema, diapedesis of RBC, recruitment of sensory nerves with NGF). Local axon reflexes within the bladder wall can result in vasodilation directly, degranulation of mast cells, and detrusor muscle contractions. Certain constituents of urine that gain access to the bladder wall are more potent stimulators of pain than others; absence of some substances in urine can magnify the pain response. The "bottom up" theory emphasizes defects in the bladder wall (GAG and or urothelium that increase permeability) and then over-activation of the noradrenergic nervous system. The "top-down" theory emphasizes that stressors from the environment can be potent enough to directly activate the SRS and turn on neurogenic inflammation[3]. Another piece of the pathophysiology is that cats with FIC appear to have mild adrenal insufficiency based on a blunted increase in cortisol concentration following ACTH stimulation compared to normal cats. The adrenal glands of cats are also smaller than those of normal cats and do not contain histopathologic lesions [4]. One explanation proposes that these small hypofunctioning adrenal glands are the result of a maternal perception of threat from the environment that is transmitted to the fetus from hormones that cross the placenta to effect the development of the fetal adrenal gland at a critical time for its development. [5]. It should be emphasized that only adrenocortical steroid measured was that of cortisol, and that many other adrenocorticosteroids have the potential to also be deficient[6], but this has not yet been studied in cats. Cats with idiopathic cystitis do not appear to experience long-term benefit from current glucocorticoid therapy regimens. The same in utero developmental story just described could also account for a fetal stress response that has been programmed toward enhanced vigilance that would then be manifested after birth by an intense SRS output when the cat faces provocateurs. FIC cats in colony housing have higher levels of circulating catecholamines and their metabolites compared to normal cats, especially when exposed to a stressful environment. A return to lower levels of circulating catecholamines occurred in stressed FIC cats following environmental modification, but this response was less complete and took longer than that which occurred in healthy cats [7]. FIC cats were recently reported to have a heightened response to sensory stimuli when measured by the acoustic startle reflex (ASR) compared to healthy cats [8]. The ASR is a defensive brainstem mediated response to sudden intense stimuli. Environmental enrichment led to a significant decrease in ASR in cats with IC compared to healthy cats. Habituation to new housing prior to environmental enrichment decreased ASR in female but not male cats with FIC[8]. Results of this study add to the concept that management of FIC benefits the cat when the patient's perception of unpredictability in the environment is reduced. Urodynamic evaluation of female cats with FIC revealed no finding of spontaneous detrusor muscle contraction that can occur in overactive bladder (OAB) further separating FIC from OAB [9]. Consequently, drugs that target detrusor muscle contraction do not appear warranted in cats with FIC. High maximal urethral closure pressure (MUCP) was documented in female cats with FIC of the same study, suggesting that alpha-1 –adrenoceptor antagonists, alpha-2 agonists, or skeletal muscle relaxants could potentially be useful treatment [9] but this has yet to be studied.

Figure 3. Neurogenic inflammation as it affects the urinary bladder in interstitial cystitis.

Sensory neurons (C-Fiber) seem to play a central role in transmission of action potentials via the dorsal root ganglia (DRG) to the spinal cord (SC) and brain. These signals may be perceived as painful by the brain. Sensory fibers also can propagate a local axon reflex without transmission of an axon potential. The axon reflex results in release of peptide neurotransmitters such as substance P (SP) by the nerve endings. Interaction of SP with receptors on vessel walls results in vascular leakage, which can be augmented by SP-induced release of histamine by mast cells. These actions may give rise to the submucosal petechial hemorrhages (glomerulations) observed at cystoscopy. Receptors for SP also occur on smooth muscle, which when activated stimulate muscle contraction. Also shown are the urothelium (epithelium) and the overlying glycosaminoglycan (GAG) layer adjacent to the bladder lumen. Damage or malfunction of either or both of these layers may permit constituents of the urine, such as protons, potassium ions, or hyperosmolar (>2,000 mOsm/L) fluid to activate the sensory fibers. The effects of stress on sensory fibers may be related to descending efferent sympathetic (SNS) signals stimulating the DRG and inducing peripheral release of neuropeptides. Local release of neurotransmitters by bladder sympathetic fibers also could stimulate sensory fibers. Another factor probably involved in chronic, neurogenic inflammation of the bladder, but not shown, is local and systemic release of nerve growth factors, which may promote sensory fiber terminal sprouting to increase the size of sensory fiber receptive fields.



Since GAG excretion is decreased in active and quiescent phases of FIC, is glycosaminoglycan (GAG) treatment helpful in the treatment of FIC ?

Three studies have employed glycosaminoglycan (GAG) as treatment for FIC, none of which were able to show a benefit over control. In the first study, 40 cats with recurrent idiopathic cystitis were treated with either 125 mg N-acetyl glucosamine or a placebo by mouth daily for six months. No significant differences were observed using the owner assessment of the mean health score, the average monthly clinical score, or the average number of days with clinical signs. Both groups improved over the course of the study, possibly due to salutary effects from dietary change initiated at the start of the study[10]. In a second study of 18 cats, injectable pentosan polysulphate (PPS) was compared to control injections in cats with non-obstructive idiopathic cystitis. Subcutaneous injections of PPS were given at 3mg/kg on days 1,2,5, and 10. Clinical signs were not different between treatment groups when evaluated on day 5, 10, 14, and then 2, 6, and 12 months[11]. A multicenter study involved 4 universities comparing BID oral PPS to placebo as treatment in 107 cats with interstitial cystitis. Enrolled cats had at least two episodes of LUTS within the past six months, cystoscopic findings of glomerulations, and absence of an alternative diagnosis. Cats were randomly assigned to 0.0 (vehicle placebo), 2.0, 8.0 or 16.0 mg/kg PPS orally twice daily for 26 weeks. No statistically significant differences were observed between any of the groups based on the owner's evaluation of clinical signs or overall improvement in cystoscopic score. A statistically significant decrease in friability score on cystoscopy was observed at the 16.0 mg/kg dose. Clinical improvement occurred in most cats (owner reported scores decreased by 75% in all groups), regardless of the dose of PPS administration or changes in cystoscopic appearance of the bladder. It is likely that accidental environmental enrichment occurred during this study which could account for the improvement scores in all cats overall [12,13]. In a 4th study, N-acetyl-d-glucosamine (NAG) at 250 mg PO once daily significantly increased plasma GAG concentrations in cats with IC after 21 days of treatment. Subjective improvements in LUT signs were suggested to occur in those treated with NAG but not those treated with placebo [14].

Is there a role for pheromontherapy in treatment of FIC ?

Feline facial pheromones (FFP) are commercially available (Feliway®) with the listed indication to decrease urinary spraying and marking. Activation of the sympathetic nervous system is part of the vigilance system that results in urinary spraying and marking and it is thought that these products lower the intensity of sympathetic nervous system output. Since unrestrained output of sympathetic nervous system activity is a central component in neurogenic inflammation that occurs in FIC, it seems reasonable that use of FFP could also be useful for treatment of FIC. In one study of hospitalized healthy and sick cats videography was used to score behavior and food intake of cats in which the cage was pre-treated with vehicle placebo or feline facial pheromones[15]. Increased grooming, facial rubbing, interest in food, and walking were found in cats exposed to FFP compared to vehicle. Results of this study suggested

that hospitalized cats exposed to FFP were calmer and more comfortable in their cages than cats exposed to vehicle. It has been our observation that some cats are very affected by FFP while in others the effect is minimal to nil. A randomized, double-blinded, placebo-controlled, crossover study was performed in 12 cats (9 of 12 completed the full study) with recurrent FIC, comparing once daily environmental treatment with FFP (Feliway®) or placebo; treatment was for 2 months and then switched to the other treatment for the next 2 months [16]. This small number of cats exposed to FFP had fewer mean days displaying signs of cystitis, a reduced number of episodes of cystitis, and fewer negative behavioral traits, but this data did not achieve statistical significance for a difference over placebo treatment of the environment.

Is there a role for amitriptyline or other tricyclic anti-depressant (or analgesic) TCA for the treatment of FIC ?

In some cases YES. The need for this kind of therapy has dramatically lessened since we as a profession have become much more successful at implementing environmental modification, which usually works well without need for chronic drug therapy. We do prescribe amitriptyline for its beneficial effects for cats with FIC that have frequent recurrences or persistent LUT signs AFTER the client's best efforts to implement environmental enrichment have failed to improve the cat's clinical signs. This type of therapy should NOT be undertaken for an initial episode of FIC or a "flare" of signs that occur infrequently. We sometimes prescribe amitriptyline for cats owned by clients that are considering euthanasia for their cat with FIC – this can sometimes allow the client to see early benefits while implementing environmental enrichment. Maximal beneficial effects of TCA, if any, often require weeks to months to be observed and in general should not be abruptly discontinued (so called "abrupt withdrawal syndrome"). Treatment series of FIC with amitriptyline has been reported 3 times, 1 study of chronic FIC (frequently recurrent or persistent signs) and 2 of acute bouts of FIC. In the chronic study, 15 cats were enrolled with FIC that failed to respond to other treatments; no placebo group was treated. Amitriptyline treatment (10 mg PO every 24 hours in the evening) successfully decreased clinical signs of severe recurrent FIC in 9 of 15 cats treated for 12 months (11 of 15 cats for the first 6 months). Somnolence, weight gain, decreased grooming, and transient cystic calculi were observed during treatment in some cats. Despite clinical improvement, cystoscopic abnormalities persisted in all cats at the 6- and 12-month evaluations [17]. In one short term study, 31 untreated male and female cats with acute (<14 days signs), nonobstructive, idiopathic lower urinary tract disease were enrolled in a placebo controlled study. Cats were hospitalized and treated with 5mg amitriptyline or a placebo daily for 7 days and then treatment discontinued. Clinical signs and hematuria resolved similarly in both groups of treated cats by day 8. Cats were evaluated in the clinic 1 month later and by questions over the telephone 6, 12, and 24 months after treatment. Clinical signs recurred faster and more frequently (10.5 vs. 2.4 events/1,000 days) in the amitriptyline treated cats, a finding likely attributable to the abrupt withdrawal of amitriptyline treatments after 7 days- there was no difference in recurrence when the first 21 days were excluded from the analysis [18]. In another short-term study of FIC, amitriptyline at 10 mg once daily per os (11) or placebo (13) was given for 7 days by owners at home. All cats were also treated with amoxicillin BID for 7 days. The severity of clinical signs was assessed at days 0, 7, and 14 – no significant difference was found between amitriptyline and placebo treated cats of this study[19].

How do we treat an acute episode of LUT signs for either its first time, or an infrequently recurrent event ?

We treat nearly all FIC cats of this type with a combination of buprenorphine and acepromazine PO for 5 to 7 days. The combination of an analgesic and a tranquilizer with properties that also decrease urethral tone seem like a compassionate and appropriate choice of treatment. It is likely that the tranquilizer reduces the activity of the autonomic nervous system which is useful in the initial treatment of FIC. We believe that this helps to acutely decrease clinical signs in cats with acute episodes of FIC or flares of chronic FIC, though this has not been specifically studied. Whether this regimen reduces future episodes of FIC has also not been tested. We take the opportunity at the first visit to discuss with the owners that even a first event of FIC may be associated with recurrence and that there may be steps that can be taken to reduce this likelihood (not yet studied in a prospective way) when environmental enrichment and modification are successfully implemented.

What analgesic treatments should I consider?

The best approach to analgesia for bladder pain (visceral) has yet to be determined. Butorphanol has been used, but its effects are less long-lived or potent than those of buprenorphine [20,21] Sustained release formulations of buprenorphine have recently become available that can provide up to 72 hours of therapeutic drug levels for pain relief following a single injection. Fentanyl patches have been used in rare cases in which bladder pain was assessed as severe.

Should I consider NSAID treatment to provide anti-inflammatory and analgesic effects?

Anecdotal reports of the usefulness of non-steroidal anti-inflammatory drugs (NSAID)s, especially meloxicam and ketoprofen, abound, but no studies of safety or effectiveness are available for review. Some specialists have prescribed piroxicam for use on alternate days, but there are no controlled clinical trials of its effectiveness or safety. NSAIDs are not commonly used for treatment of interstitial cystitis in humans. NSAIDs that are licensed for use in cats list indications for pre-emptive pain management, usually as a single treatment before anesthesia and surgery. Chronic use of NSAIDs in cats can be dangerous due to the possibility for

development of acute intrinsic renal failure; especially should the cat become dehydrated for any reason at the time of NSAID administration. The FDA recently required the following statement to be added to the label for meloxicam use in cats, "Repeated use of meloxicam in cats has been associated with acute renal failure and death. Do not administer additional injectable or oral meloxicam to cats. See Contraindications, Warnings, and Precautions for detailed information." Robenacoxib, a long acting NSAID recently has become available for use in cats; its effectiveness and safety for use in cats with FIC has yet to be reported to our knowledge.

What is the most-important therapy to recommend to owners of cats with frequently recurrent or persistent signs of FIC?
There is no simple answer to this question but a key component to a successful outcome is empowering the owner with skills that allow the cat's husbandry to be improved and the environment enriched to a point that decreases the cat's stress response system. We refer you to the Indoor Cat Initiative site that is maintained by Dr. Buffington- this site provides a great number of details and resources that can be considered to implement that will reduce the cat's perception of stress and improve its general sense of well being while living largely in confined spaces with people (and often with dogs too). Environmental enrichment involves effective resource management, including; litter box (es) (type, location, number, substrate,cleaning regimen,), food and water (type, location, number), resting areas, opportunities to climb and scratch, interactions with people that are positive, and methods to reduce conflict in the living space with other cats, dogs, and humans [22-24]. Outcome of environmental enrichment and modification was proven beneficial to most FIC cats of a study in which they had failed multiple other treatments [25]. In addition to a dramatic increase in the use of the litterbox, there were benefits in behavior and some gastrointestinal signs.

Is there anything new regarding dietary treatment of FIC ?
A non-blinded and non-randomized study of feeding canned vs. dry diets of similar formulation (Waltham pH Control®) in the treatment of 54 FIC showed a beneficial effect of the canned over the dry product [26]. 52 of 54 cats exhibited more than one episode of LUT signs in the prior 12 months. The study lasted for 12 months, or until signs of recurrence occurred. Signs of LUTD did not recur in 16 of 18 cats fed the canned diet, and 17 of 28 cats fed the dry diet ($P < 0.05$). The recurrence rate in cats being fed the dry food was also reduced compared to the rate encountered in the previous year, but not to the degree of benefit observed in cats consuming the wet formulation. The mean urinary specific gravity was lower in urine from cats fed the canned formulation but the basis for the salutary effect of this particular canned product over the dry formulation was not determined [26]. Other factors that could have influenced results of this study include hedonics (the mouth feel of the food) or the ritual associated with the feeding of canned foods and this effect on cat behaviors. The consumption of dry foods is known as a risk factor for the development of LUT disease in cats on a dose-related basis [27]. The results of a test food vs control food as treatment of FIC was recently reported as an abstract in 31 cats over 12 months. The test food contained more anti-oxidants and omega-3 dietary oil than the control food as the main difference. The feeding of the wet or dry formulation was determined by owner preference. The number of episodes for LUT signs and days exhibiting LUT signs (1.3 vs. 10.3 events/1000 days) were fewer in cats fed the test food of this study. Outcome was the same during the feeding of either the wet or dry formulations of the test food[28]. The event rate for the test diet was not significantly different from the same author's previously reported event rate in untreated cats [18]; the basis for the effect of the control or test formulations in this study was not determined. The test diet is not available commercially, as the original diet was altered to include stress-reducing compounds for the commercial diet that was launched but this specific formulation was not studied.

How important are non-specific therapeutic responses in treatment of FIC?
Nonspecific therapeutic responses might occur during treatment of cats with FIC, possibly by altering their perception of their surroundings as part of a placebo-response. The effectiveness of environmental enrichment suggests that pharmacological or other therapeutic interventions face an important barrier to demonstrate efficacy in the presence of the large therapeutic response to this approach in cats with the syndrome.

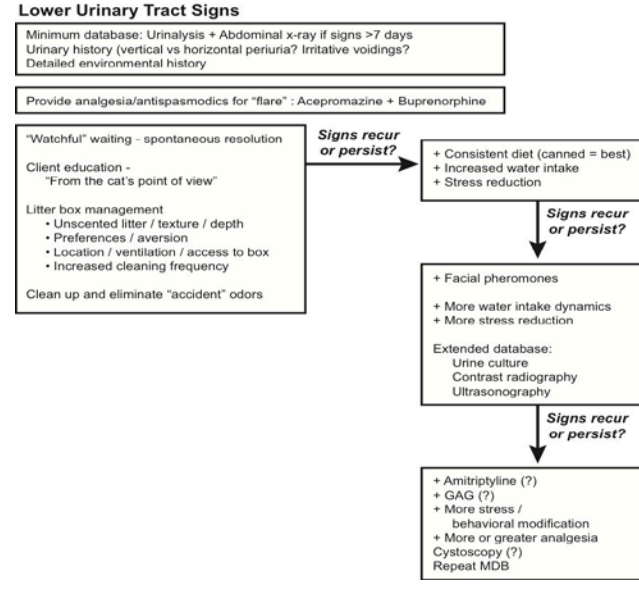


Figure 5. What do WE do ?
Step-wise approach to treatment of cats with idiopathic lower urinary tract signs. More diagnostics should be performed when cats fail to spontaneously clear of their initial lower urinary tract signs and when signs recur to ensure that the diagnosis is really idiopathic lower urinary tract disease.

Properly controlled clinical trials may provide better approaches to treatment in the future, but this is what we do in the interim.

"Pearls" Pandora Syndrome – aka feline interstitial/idiopathic cystitis (FIC)

1. Signs of urinary urgency during FIC may be expressions of a systemic disease created by a highly active outflow (unrestrained) from the sympathetic nervous system in response to stressors (provocateurs) .
2. When multi-modal environmental modification (including environmental enrichment) is effectively implemented, treatment with drugs is RARELY NEEDED.
3. Stress up-regulates the inflammatory potential of several organs, including the bladder.
4. Bacterial urinary infections (UTI) are rarely identified in cats with signs of lower urinary tract disease, unless they have specific risk factors (U-cath within last 6 months, perineal urethrostomy, dilute urine – CKD, diabetes mellitus, hyperthyroidism)
5. The term "Pandora Syndrome" should help to remind the clinician that LUT signs may be part of a bigger picture that involves other organ systems.
6. We advocate the use of analgesia (buprenorphine) during acute episodes of FIC.
7. We use tranquilization with acepromazine in combination with buprenorphine in most of our cases of non-obstructive episodes.
8. On occasion, the use of amitriptyline can be useful in the treatment of FIC.
9. The use of GAG (glycosaminoglycan) supplementation has failed to show an effect superior to placebo in several studies of FIC treatment.
10. The use of feline facial phaeromones has not been shown to be superior to placebo in the treatment of FIC.
11. The feeding of as much wet food as possible in the diet is advocated by some for its protective effect on the recurrence of the signs of FIC, and may be helpful as long as it does not result in additional threat to the cat.
12. There is no indication for surgery in non-obstructive FIC.
13. When surgery is performed in patients with FIC, obtain a full thickness bladder biopsy to allow evaluation of mast cells with special stains (toluidine blue).
14. Sometimes a so-called "placebo" treatment actually can have a positive effect between the cat, the owner, and the environment such that a positive outcome is achieved.
15. In most cases, antibiotic treatment does not have a role in the treatment of FIC.
16. Treatment of FIC with glucocorticosteroids has not shown an effect greater than that of placebo in limited study.
17. Chronic treatment of FIC with NSAIDs is NOT ADVOCATED due to the high sensitivity of the cat to sustain renal injury with this class of drugs, especially if there is any tendency toward dehydration.

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Updates on Managing Male Cats with Urethral Obstruction

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Pathophysiology of urethral obstruction (UO)

Thrity-nine % to 67% of male cats evaluated with lower urinary tract signs have been reported to have urethral obstruction.[1-4] Male cats with urethral obstruction (UO) were described to have urethral plugs as the most common cause in early reports,[3] but recent reports emphasize idiopathic causes.[1,2,5] In one study the cause of obstruction was considered to be idiopathic in all 82 cats studied,[6] but other studies report plugs, uroltihiasis and UTI in decreasing order behind idiopathic causes for UO.[1,2,5] When plugs do form, it is likely that they are extensions of the process leading to feline idiopathic/intersititial cystitis (FIC). This is consistent with findings from an unpublished study at The Ohio State University using urethroscopy at the time of initial evaluation in which plugs were rarely identified. Urethral plugs have minimal intrinsic cohesive structure but often are cylinder-shaped after extrusion from the urethra. Urethral plugs are fundamentally different from calculi that lodge within the urethra (i.e., urethroliths). Uroliths have an organized internal structure with much less matrix, and are not easily compressed or distorted. Urethral plugs consist largely of matrix mucoprotein with embedded minerals. The predominant mineral composition in most plugs is magnesium ammonium phosphate hexahydrate (i.e., struvite). This is true despite the fact that cats form calcium oxalate and struvite uroliths with nearly equal frequency. Most plugs are assumed to lodge within the penile urethra, but obstructions also can occur at more proximal sites. Definitive diagnosis of a urethral plug requires retrieval of the plug. Supportive evidence for the presence of a urethral plug can be seen on radiographs in some cats with UO. Previously, the crystalline-matrix hypothesis proposed that plugs formed secondary to precipitation of struvite crystals in the urine that then became embedded in a matrix. According to this hypothesis, plugs created UO and urethritis. It is now hypothesized that plugs form as a consequence of underlying idiopathic urethritis and cystitis (i.e., inflammation occurs first, followed by plug formation).

Some cats have signs of non-obstructive idiopathic/interstitial cystitis before UO, while many cats have lower urinary tract signs after relief of UO. Obstruction can be secondary to functional urethral spasm in addition to swelling of the urethra due to edema and hemorrhage. Pathologic or neurogenic processes cause contraction of the circular smooth or skeletal muscle of the urethra or both. Stimulation of adrenoreceptors (particularly α-1) within the urethra increases urethral tone in normal cats. Pain and stress after UO increase sympathetic outflow from the central nervous system which can lead to additional urethral spasm.

Bacterial urinary tract infection (UTI) is very uncommon before urethral catheterization.[3,7] UTI deserves more consideration in cats with recurrent UO that have undergone urinary instrumentation. Urethral stricture may occur, especially in cats that have had previous indwelling urinary catheters and for those with severe recurrent episodes of non-obstructive idiopathic/interstitial cystitis. Neoplasia of the urethra or bladder neck is rare. Urinary catheter fragment foreign body in urethra or bladder is rare, as is phimosis as a cause for UO.

Signalment, history, physical examination

Approximately 75% of cats presented with UO are experiencing their first episode.[6,8] Median duration of clinical signs before initial presentation was 3 days in a study of 223 cats. Signs include those of cystitis and partial obstruction before development of complete obstruction. The majority of cats with UO are relatively stable however, approximately 10% are critically ill.

Severe bradycardia (< 100 bpm) from the effects of hyperkalemia has been reported in 5% of cases, moderate bradycardia (100-140 bpm) in 6% of cases and mild bradycardia (140-160 bpm) in 12% of cases; arrhythmias were detected in 11% of cases. Fifty % of cats can be expected to have normal body temperature, hypothermia in about 40% and hyperthermia in 10%. Rectal temperature < 95-96.6°F or heart rate < 120 bpm was the most the accurate predictor of severe hyperkalemia. A combination of hypothermia and bradycardia was 98 to 100% predictive for severe hyperkalemia (> 8.0 mEq/L).[9] Twitching or seizures is very uncommon (0.5%) and related to ionized hypocalcemia. Systemic blood pressure most often is normal.[10] Mean arterial pressure correlated inversely with serum potassium and directly with total serum calcium concentrations. Major abnormalities on physical examination and serum biochemistry were encountered despite normal blood pressure in this study.

Diagnostics

A recent report noted that darker red urine observed at the time of urinary catheter placement was associated with azotemia, hyperkalemia, and lower USG. Color of the urine was not associated with the presence or absence of urinary stones.[11]

Hyperkalemia does not occur in isolation and often is accompanied by acidosis and low serum ionized calcium concentration. Serum potassium concentrations ranged from 3.4 to 10.5 mEq/L in 199 cats. Six % were below the reference range; 41% were above the reference range, and 53% in the reference range. Serum potassium concentration was < 6.0 mEq/L in 66% of cases, > 6.0 but < 8.0 mEq/L in 12% of cases, > 8.0 but < 10.0 mEq/L in 12% of cases, and > 10.0 mEq/L in < 1% of cases. Hyperkalemia most often was encountered with acidosis (pH < 7.2 in 74% of cases) and low serum ionized calcium concentration (< 1.0 mmol/L in 75% of cases).

Approximately 33% of cats with UO are expected to have clinically relevant hypocalcemia based on serum ionized calcium concentration. Serum ionized calcium concentration was below the reference range in 34%, above the reference range in 19%, and in

the reference range in 47%. Serum ionized calcium concentration was > 1.2 mmol/L (> 4.8 mg/dL) in 23%, > 1.0 but < 1.2 mmol/L (> 4.0 but < 4.7 mg/dL) in 57%, > 0.8 but < 1.0 mmol/L (> 3.2 but < 4.0 mg/dL) in 14%, ≤ 0.8 mmol/L (≤ 3.2 mg/dL) in 6%. Serum total calcium concentration in 51 cats was below the reference range in 39%, above the reference range in 0%, and within the reference range in 61%. Cats with low serum total calcium concentrations had moderate to severely decreased serum ionized calcium concentrations.[8,12] In one study, more cats were found to have hypocalcemia when defined by measurement of serum ionized calcium concentration (75%) than when defined by serum total calcium concentration (27%).[12] Survival of cats with UO was influenced by ionized calcium status in another study. The median concentration of ionized calcium in survivors was 1.08 mmol/l (range 0.65 to 1.28 mmol/L) and in non-survivors was 0.88 mmol/l (0.66 to 1.11 mmol/L); P = 0.037). Hypocalcemia was detected in 51% of survivors vs 100% of non-survivors; P = 0.024.[6]

Struvite crystals may be observed at the time of obstruction, especially if urine pH is alkaline. The presence and amount of struvite crystalluria preceding UO has not been reported. Struvite crystalluria can be expected from any condition associated with urinary pH increased above 6.7. Crystals are more likely to be secondary to urine stasis or alkaline urine pH (secondary to sterile inflammation with extravasation of plasma proteins into urine) than a primary cause of obstruction. Struvite crystalluria was greater in male cats with obstruction than in male cats without obstruction (P 0.051), though cause or effect of the crystalluria was not established in one study. Struvite crystalluria was not associated with hematuria, proteinuria, or pyuria but was associated with urinary pH in this same study.[5]

Nearly all cats with UO have sterile urine on original presentation for obstruction. Zero of 18 cats with UO in one study[7] and in 0/36 cats in another study soon to be published out of The Ohio State University (Dr. Ed Cooper OSU - personal communication 2014) had bacterial growth. Bacteria were isolated from urine collected through the urinary catheter at initial presentation in 14% of cats (14/192) in one study, but quantitative methods as to cfu/mL were not used. Many of these cats were referred with an indwelling urinary catheter already in place.[13] Only 1 of 32 cats in another study had a positive urine culture from a cystocentesis sample at the time of UO relief.[14] Bacterial culture at the time of urinary catheter removal is more likely to identify pathogenic bacteria. Isolation of bacteria from cats with a previous history of UO is more likely than isolation from cats suffering an initial episode.

Imaging of cats during/after UO

All cats with UO should have radiography to determine if urolithiasis is contributing to obstruction. Attention is usually centered to determine the presence of urinary stones in the bladder and/or urethra. It is very important to include the perineal region in the radiographs to identify urethral calculi. Evaluation of the kidneys and ureters is important to be sure nephroliths or ureteroliths are not part of the overall process, because upper urinary tract involvement can markedly affect the overall prognosis. Free fluid resulting in a loss of abdominal detail can be seen in some cats with severely distended and highly permeable ("leaky") urinary bladders. A small amount of free abdominal fluid may be identified at initial presentation that is more easily detected on ultrasonography. In cats with recurrent UO, contrast radiography and ultrasonography may be informative as to the underlying diagnosis. Positive contrast urethrography is especially useful to disclose urethral trauma, urethral perforation, or urethral stricture, especially after recent instrumentation of the urethra. Radiography is the gold standard imaging method for the detection of urethral stones as ultrasonography only examines the most proximal portion of the urethra. If only ultrasonograpy is available to image the urinary tract (limitations of equipment, personnel, or cost), then it is advisable to perform the sonogram before AND after reverse flushing of the urethra in order to detect the presence of small stones that may now appear in the bladder after hydropulsion that were not initially visible. This however does not exclude the presence of stones still within the urethra.

Caudal abdominal effusion was detected in 10 of 34 cats on radiographs after placement of a urethral catheter without associated cystocentsis.[15] Nineteen of 34 cats with UO that underwent abdominal radiography had signs of abdominal effusion before or after cystocentesis and passage of a urinary catheter. Prior to cystocentesis, 11 of 20 cats had abdominal effusion in the same study.[14]In another study in which therapeutic cystocentesis was used as the sole treatment to relieve bladder pressure, 8 of 15 had evidence for abdominal effusion after bladder pressure was first relieved.[16] In yet another study, 87 cats underwent abdominal ultrasonography within 24 hours of the relief of UO by passage of a urethral catheter and no use of cystocentesis.[17] Hyperechogenic pericystic fat and pericystic effusion were each observed in 60% of these cats. Ninety % of evaluated cats had bladder thickening, 20% had suspended linear strands, and over 50% of cats had either moderate or severe increases in urinary sediment or hyperechogenicity. Cystolithiasis was documented in 47% of these cats. This frequency is much higher than that in another report in which only 2 of 35 cats were found to have stones (radiography in 34 cats and ultrasonography in 3 cats).[14] The reason for this disparity between ULS and radiography in detection in cystolithiasis is not obvious. ULS could be more sensitive in the detection of uroliths, but ultrasonography and radiography has not been compared in the same cats with UO at the same time of their clinical presentation, before or after instrumentation. It is also possible that more stones were detected in the study using ultrasonography since these images were acquired after urethral flushing which could have retropulsed urethral stones into the bladder. Eight cats with pseudomembranous cystitis associated with UO have been described in two reports.[17,18]Thick echogenic septa were described traversing the bladder lumen. These

bands could represent sloughing of necrotic areas of the bladder into the lumen and they were associated with fibrinous exudate, blood clots, and necrotic debris.

It has long been taught that acute UO in male cats adversely affects renal function but does not create structural changes in the kidneys. It has been known for decades that palpably enlarged kidneys are detected during physical examination in some cats before relief of UO. In cats with UO undergoing ultrasonography, either unilateral or bilateral renomegaly was detected in 42 %, pyelectasia in 60 % (10% > 3.4 mm), and perirenal effusion (retroperitoneal) in 35% of the cases. Ureteral dilatation was detected in 24%. How rapidly these changes resolve has not yet been reported.[17]

Relief of obstruction due to plugs or idiopathic causes

Decompressive (therapeutic) cystocentesis is the next step recommended to perform after sedation and IV catheter placement. The benefits of decompressive cystocentesis outweigh potential adverse effects. Decompressive cystocentesis has been considered controversial by some clinicians who fear that bladder rupture will occur or that urine will continue to leak from the bladder. No adverse effects were observed in a recent report of 47 UO male cats that underwent decompressive cystocentsis.[14] Cystocentesis to empty the bladder should be performed as soon as possible in cats with very large bladders to prevent rupture of the bladder and to allow renal excretory function to resume. Cystocentesis allows for rapid reduction of urinary tract pressure and resumption of GFR compared to catheterization, which can take considerable time. Decompressive cystocentesis may stabilize the cat before anesthesia for urinary catheter placement. Relief of bladder pressure before urethral catheterization also may facilitate efforts to dislodge urethral plugs, and allows collection of a superior urine sample for analysis before manipulation of the urinary tract and contamination by irrigation solutions.

Some leakage of urine immediately after decompressive cystocentesis may occur, especially if the bladder is not adequately emptied. The use of a 22-gauge needle on an extension set or use of a butterfly needle can minimize trauma and urine leakage during the procedure. In one study, the median volume of urine removed by urinary catheter at the time initial obstruction was relieved in 28 cats was 85 mL (range, 35 to 280 mL).[10] Plain abdominal radiographs (including the perineal region) should be obtained after decompressive cystocentesis to identify mineralized plugs, urethral calculi, or cystic calculi. Some clinicians obtain radiographs after catheter passage, but the presence of an indwelling urinary catheter can obscure the presence of urethral calculi.

Standard epidural techniques require special expertise and training but a new simplified method using sacro-coccygeal placement of local anesthetic to allow urethral catheterization and pain management appears promising.[19] This technique produces anesthesia to the perineum, penis, urethra, colon, and anus within 5 minutes of preservative-free lidocaine injection and lasts up to 60 minutes. The authors of this study concluded that relief of urethral obstruction was easier and quicker during placement of the urethral catheter, presumably associated with urethral relaxation. Cats of this study received pre-medication protocols but not full anesthesia. Cats did not appear to struggle during catheterization, flushing, or suturing after the lidocaine infusion and appeared to be less painful after catheter placement.

Studies in cats have shown that indwelling polyvinyl catheters create less urethral trauma and inflammation than do indwelling polypropylene catheters. Silicone urinary catheters have not been specifically studied in cats. Do not administer glucocorticoids to a cat while an indwelling urinary catheter is in place. The risk for bacterial pyelonephritis is great in this setting and glucocorticoids are unlikely to control urethritis in this setting (i.e. continuous trauma from an indwelling catheter).[20] The use of antibiotics does not prevent the development of UTI in patients with indwelling urinary catheters. Do not prescribe antibiotics while a urinary catheter is in place (unless you have documented by bacterial culture that a UTI already is present). Antibiotic use may promote development of resistant isolates when UTI does develop. Consider culturing the urine when the urinary catheter is removed. This recommendation is supported by the finding that 6 of 18 cats developed significant bacteriuria (3/6 at 24 hours and another 3/6 at 48 hours) within 48 hours while the indwelling urinary catheter was in place.[7] Recurrent UO at day 30 was significantly less common when the indwelling urinary catheter was left in place for more hours, though the median times were similar between those with recurrence and those that did not recur.[15]

The chronic prognosis for recurrence of LUTD signs following relief of UO is guarded. Eight of 22 (36%) cats with idiopathic UO re-obstructed after a median of 17 days in one study whereas 3 of 7 (43%) cats with UO associated with urethral plugs re-obstructed within 7 months. Recurrent obstruction was the cause for euthanasia in 21% of cats in this study.[2] The recurrence rate was 22% at 6 months and 24% at 2 years.[6] Ten of 68 cats were reported to developed recurrent UO within 30 days of release from the hospital in another study.[15] In an older study, the recurrence rate was 35% within 6 months.[21] No studies on recurrence rates for UO have been reported prospectively after implementation of aggressive environmental modification. Recurrence rates may be lower in cats for which environmental modification can be adequately implemented. A small number of cats develop urethral strictures. This is a complication that occurred in 11% of affected cats in one study.[22] Some cats develop bacterial UTI after instrumentation of their urinary tract (i.e. catheterization) and we have observed positive urine culture in some cats as late as 6 months after relief of UO. Signs of ongoing idiopathic cystitis are expected in 30-50% of cats that have had an episode of UO. In one study, 50% of cats with idiopathic UO developed lower urinary tract signs after relief of obstruction.[2] In a study of 68 cats treated for UO, 50 cats had lower

urinary tract signs following release from the hospital. Pollakiuria (50%), stranguria (46%) and periuria (40%) were the most common clinical signs. Clinical signs lasted ≥ 7 days in 29 of 68 cats.[15]

Non-conventional treatment for urethral obstruction in male cats

Non-invasive non-instrumentation treatment protocol

A report describing a method for relief of urethral obstruction in male cats without the use of urethral catheterization was recently described.[16] The reported treatment protocol was proposed for use only as an alternative to euthanasia due to financial constraints of owners unable to afford conventional treatment costs. Conventional treatment with passage of a urinary catheter and IV fluid infusion in the hospital was offered as the first choice. This non-invasive approach is not meant for cats with urethral calculi or those with severe metabolic derangements. The severity of azotemia does not determine use of this protocol. A plain lateral abdominal radiograph is taken to exclude calculi. Decompressive cystocentesis is performed initially and then as needed up to every 8 hours. The urethra is not irrigated or catheterized, though the distal penis is gently massaged. No IV catheter is placed and IV fluids are not administered. Drug treatments include: acepromazine (0.25 mg IM or 2.5 mg PO q8h), buprenorphine (0.075 mg PO q8h), medetomidine (0.1mg IM q24h if no urinations are noted in the first 24 hours). The cat is placed in a quiet, low stress environment. Some fluids may be given subcutaneously as needed, but the goal is to avoid excessive urine production from full hydration. Treatment success was defined as spontaneous urination within 72 hours and subsequent discharge from the hospital. Successful discharge from the hospital occurred in 11/15 cats (73%). Treatment failure occurred in 4/15 (27%) cats due to uroabdomen (3) or hemoabdomen (1). Cats that experienced treatment failure had significantly higher serum creatinine concentrations. At necropsy, severe bladder inflammation was found, but there was no evidence of bladder rupture.

Atracurium

The intraurethral installation of atracurium besylate was compared to that of physiological saline prior to retrograde flushing of the urethra. Atracurium besylate is a curare derivative that provides neuromuscular blockade of striated muscles by antagonizing acetylcholine at the nicotinic receptor in the neuromuscular junction. Atracurium besylate is rapidly inactivated by plasma esterases or by spontaneous degradation and does not depend on the liver or kidneys for excretion. Atracuium was first diluted from 10 mg/dl to 0.5 mg/dl and then injected under steady gentle pressure for 5 minutes while the external urethral orifice was occluded. Sixty-four percent of cats treated with atracurium were unobstructed during the first hydropulsion attempt compared to 15% of cats receiving the saline installation prior to flushing. The mean time to relieve obstruction was 21 seconds in those receiving atracuriurm compared to 235 seconds for those receiving the saline control.[23]

Lidocaine

The recurrence rate and clinical signs for UO in 26 cats were determined at 2 weeks, 1 month, and 2 months following intravesical installation of lidocaine vs placebo once daily for 3 days through the indwelling urinary catheter. The recurrence rate for obstruction (58% [7/12] in the lidocaine group and 57% [8/14]) in the control group and magnitude of clinical signs were not different between treatment groups.[24]

Prazosin vs phenoxybenzamine

In a recent report of UO cats, overall recurrent obstruction at 24 hours occurred in 21/192 cats(10.9%) and at 30 days in 37/157 (23.6%)cats.[13] The recurrence rate in cats treated with prazosin was 10/140 (7.1%) and 20/110 (18.8%) at 24 hours and 30 days following urinary catheter removal compared to 10/46 (21.74%) at 24 hours and 16/41 (39.02%) at 30 days in cats treated with phenoxybenzamine, which was different statistically. Recurrent urethral obstruction is most likely to occur within the first 7 days following urinary catheter removal in most studies. Recurrent urethral obstruction occurred within the first 4 days of urinary catheter removal in 32 of 37 (86.49%) male cats in this study. The use of a 3.5 Fr indwelling urethral catheter was associated with less recurrent obstruction at 24 hours following removal of the urethral catheter compared to the use of a 5.0 Fr indwelling urinary catheter.[13] The logic for the use of prazosin in the treatment of male cats with UO was challenged by one group on the basis that this drug blocks alpha receptors of urethral smooth muscle and that the obstruction usually involves the penile urethra which is surrounded by striated muscle.[25] We seemingly have also had success using drugs that are designed to block peripheral alpha adrenoceptors – there could be central nervous system effects that have yet to be studied in cats. It is also possible that there is “cross-talk” between the autonomic nerves and those controlling somatic tone to the urethra. Another possibility for a salutary effect could be some “down-stream” effect on the striated muscle after tone in the smooth muscle is reduced.

Intravesical GAG treatment

A proprietary GAG formulation designed for intravesical administration has recently been manufactured by Arthrodynamics and marketed as A-CYST® from Dechra Veterinary Products. This formulation consists of 5 mg/mL of hyaluronic acid and 100 mg/mL of chondroitin sulfates (C4 and C6) in a 10 % solution of n-acetyl-d-glucosamine [NAG].[26] The commercial preparation designed for intravesical installation was studied for its safety when administered IM (0.1 mL/lb) to 8 healthy cats every 4 days for a total of 5 treatments. No systemic toxicity was observed and decreased oxidative stress was suggested based on one measured marker.[26] Sixteen male cats with acute urethral obstruction were enrolled in a randomized placebo controlled study comparing this GAG treatment to that of placebo installations.[27] After relief of urethral obstruction, the bladder was flushed to remove debris. After residual urine was

removed, either the GAG preparation or saline placebo was instilled (2.5 mL) through the indwelling urethral catheter at times 0, 12, and 24 hours after placement of the indwelling urethral catheter. Saline or GAG solution was kept in contact with the bladder for 30 minutes prior to allowing urine to flow through the collection system again. All cats were followed for 7 days following removal of the urethral catheter the time of which varied to the individual cat's needs. Acute repeat obstruction occurred in 0/9 cats treated with the GAG preparation and in 3/7 cats treated with the saline placebo (P= 0.06). Two of the 3 cats that failed placebo treatment were crossed-over to enter the GAG treatment group to contribute to the final 9 cats in this group that did not reobstruct. No adverse effects were identified following intravesical infusion of either the GAG or saline solutions.[27] Though the GAG treatment group did not achieve statistical significance, zero cats treated with the GAG solution had recurrence of UO during the 7 days of this study. Further study is warranted to see how the data emerges in a larger series of cats with UO that are treated with this treatment protocol.

Amitriptyline

A report from Brazil suggests that oral amitriptyline may be useful in relief of UO in male cats caused by urethral plugs.[28] Obstructed cats had serum creatinine concentrations of > 4.0 mg/dL and BUN concentrations of >120 mg/dL before treatment. Treatment details were not provided in this publication but were obtained by me from the author with the help of a Portuguese-speaking translator (2009). Some cats had decompressive cystocentesis performed and all were given IV 0.9% NaCl. No cats had urethral flushing or placement of an indwelling urinary catheter. No other drugs or anesthetic agents were administered besides ampicillin for prevention of UTI. This protocol has been used in Dr. Achar's practice as the standard of care for many years. Amitriptyline (1 mg/kg) was given orally for 30 days. This time period was arbitrarily chosen to decrease the likelihood of recurrence of UO. Amitriptyline should never be abruptly discontinued because of possible development of "abrupt withdrawal syndrome." Urethral plugs were spontaneously eliminated and urinary flow was restored in all cats within 72 hours. Urethral plugs were analyzed and found to contain varying proportions of struvite, calcium oxalate, and ammonium urates. Transient somnolence was attributed to the use of amitriptyline, an effect that lessened as azotemia resolved. This effect has been described when amitriptyline is used in cats without azotemia. All cats had normal BUN and serum creatinine concentrations when measured 30 days later. No cats experienced recurrent UO during the 30 days of treatment. The beneficial effects of amitriptyline in cats with UO appear to be mediated by relaxation of urinary tract smooth muscle through mechanisms that involve voltage-dependent potassium channels.

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Acute Kidney Disease in Cats: Diagnosis, Management, and Prevention

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Acute kidney injury (AKI) is the term used to describe a spectrum of acute alterations in kidney function and structure that range from mild (clinically inapparent) to overt acute renal failure (varying degrees of azotemia). Portions of the nephron may be temporarily injured or they may sustain lethal injury resulting in permanent loss of nephron mass depending on the severity of the insult. Recovery of full renal function and histopathological structure is possible in some cases. Partial recovery with substantial nephron loss will result in recovery as a CKD patient in some. In other patients, severe injury results in substantial loss of nephron mass and renal function that will not allow a reasonable quality of life without dialysis. Severely azotemic AKI patients often require dialysis to be managed adequately.

The details of a new grading system for categorization of acute kidney injury (AKI) developed by IRIS (International Renal Interest Society) are available for further review at http://www.iris-kidney.com/guidelines/grading.shtml. Much like the IRIS staging system for CKD, this grading system is designed to detect AKI at early stages when it is more likely that therapeutic interventions can avert further injury and allow recovery of renal function and tissue repair. The clinical prognosis is likely to align with the AKI grade that develops. Historically, attention was mostly directed to patients with serum creatinine that exceeded the reference range. In the IRIS AKI scheme, even a small increase in serum creatinine within the reference range is considered an important marker for potential acute renal injury. The IRIS AKI grading system involves evaluation of fasting serum creatinine concentration as the first step and then the staging is refined based on urine output if it is known (see Table 1). The same cutoffs for creatinine and urine output have been chosen for use in the dog and the cat. Oliguria, normal urine production, or polyuria can all occur depending on the specific cause and severity of renal injury sustained during AKI. History and physical examination parameters also enter into assignment of the grade. AKI typically focuses on those with acute injury to kidneys that were intrinsically normal prior to the acute injury. Pre-renal and post-renal disorders can occur in the absence of primary renal injury but they can also occur on top of a primary renal injury. Patients with CKD often have an "acute-on-chronic" presentation with changes in level of azotemia that falls into the AKI grading scheme. An inability to regulate solute and water balance is often present and renal synthetic and degratory functions are impaired to varying degrees during AKI. It should be noted that this AKI staging scheme is dynamic in that the grade may increase or decrease in severity over time and treatment. Extensive diagnostic evaluation may be needed to determine the specific cause(s)/diagnosis underlying the AKI; specific diagnosis is not specified by the AKI grading status.

Differential diagnosis and frequency of AKI – See Table 2. Causes of AKI in cats

The frequency of underlying conditions associated with AKI varies with the nature of the veterinary practice. Nephrotoxicity is the leading cause for AKI at The Ohio State University Veterinary Hospital, followed by ischemia. The aggressive use of potentially nephrotoxic antibiotics, particularly the aminoglycosides, can contribute to nephrotoxic AKI. The exposure to cholecalciferol rodenticides, use of non-steroidal anti-inflammatory drugs (NSAID), and exposure of veterinary patients to extensive surgical procedures and aggressive post-traumatic resuscitative maneuvers as emergency patients can result in AKI. Ischemic and nephrotoxic AKI occur more readily in patients that have underlying chronic renal disease or renal failure.

Diagnosis of AKI

Rapid increases of BUN, serum creatinine, and serum phosphorus may be observed during severe AKI. This is particularly helpful to document AKI in the absence of recent serum biochemistry values for comparison. For example, a patient's serum creatinine of 4.3 mg/dl, 6.0 mg/dl, and 7.5 mg/dl sequentially over three consecutive days supports a diagnosis of azotemic AKI. Serum creatinine and BUN do not increase over this short a time period in hydrated patients with CKD. Hyperphosphatemia may be out of proportion to the degree of increase in BUN or serum creatinine in those with AKI compared to CKD. The magnitude of elevation in BUN or serum creatinine concentrations is not helpful in the diagnosis of azotemic AKI vs CKD or in the differentiation of pre-renal, intrinsic renal, or post-renal azotemia. See Table 1 AKI grading for how to detect AKI at earlier levels of increasing serum creatinine. Urinalysis reveals a low specific gravity (USG) during the maintenance phase of azotemic AKI (SG less than 1.030, but most-often in the 1.007 to 1.015 range). Decreased maximal USG may be detected before an increase in serum creatinine is detected. Dipstrips may show proteinuria, hematuria or glucosuria on occasion. UPC can be increased due to increase in protein excretion normally handled by renal tubules. Urinary sediment is typically "active" at early stages of the maintenance phase of severe AKI exhibiting increased numbers of casts (particularly cellular casts) and small epithelial cells compatible with renal tubular epithelium. Animals with AKI as the sole problem should have smooth kidneys with normal or increased kidney size whereas those with chronic renal failure may show small and or irregular kidneys both on palpation and abdominal radiographs. Renal ultrasonography can provide additional anatomic

information to confirm intrarenal lesions, but cannot be relied on to distinguish acute from chronic renal failure or to suggest a specific microscopic lesion. Failure to document ultrasonographic renal changes does not exclude a diagnosis of AKI. Kidneys may enlarge during AKI but this may not be detected if they are still within the normal range for kidney size; kidneys tend to become "plump" before they measure elongated. Peri-renal effusion was described in 6 cats with azotemic AKI.[1] Renal biopsy may be helpful to determine that an azotemia is due to primary renal lesions and to characterize the changes as acute or chronic. A positive urine culture in the face of AKI is of concern for upper urinary tract infection, but this finding alone is not definitive to establish a diagnosis of pyelonepohritis.

It is imperative to exclude acute post-renal azotemia due to ureteral stones or stricture in cats presenting with azotemia that appears to have developed suddenly. In some cats ureteral stones cause complete obstruction of one or both ureters resulting in varying degree of oliguria or anuria and rapidly escalating magnitude of azotemia. Due to the frequency of this syndrome associated with calcium oxalate urolithiasis, survey radiographs need to be evaluated in all cats suspected to have AKI. If renal or ureteral stones are noted, ultrasonography to determine the degree of any hydronephrosis and or hydroureter is the next step. Many of these cats have pre-existing chronic kidney disease that makes it relatively easy for azotemia to develop even when only one ureter is obstructed. In many instances, there is the presence of "big-kidney little-kidney" syndrome likely reflecting previous chronic kidney injury reducing the size of one kidney and hydronephrosis increasing the size of the second kidney.[2] Though the azotemia can be quite striking and rapid in development, these cases represent acute post-renal azotemia on top of chronic primary kidney disease. Medical therapy is not often successful in management of these cats and relief of the ureteral obstruction by minimally invasive stenting or traditional surgery will be needed in order to sustain life without dialysis. The prognosis following relief of the obstruction is often guarded due to the underlying chronic kidney disease.

Prognosis of AKI

The attending veterinarian and client often have greater expectations for immediate improvement following treatment than is realistic, remembering that the maintenance phase of azotemic AKI can last weeks in some cases before adequate renal repair and function can occur. The most likely causes for death during the initial management of the azotemic AKI patient in the maintenance phase are from the effects of hyperkalemia, metabolic acidosis, and severe azotemia. Overhydration and resulting pulmonary edema are the next major causes of death during vigorous fluid therapy.

There is no magnitude of increased serum creatinine concentration measured at one time point that determines prognosis. Serial serum creatinine measurements over time are much more informative. Acute changes in the concentration of serum creatinine were associated with prognosis in one study of 209 cats with an initial serum creatinine of < 1.6 mg/dl and at least 2 serum creatinine measurements within 7 days. A poorer prognosis was found in cats that increased their highest serum creatinine to > 1.6 mg/dl with at least an increase of 0.3 mg/dl. If this increase in serum creatinine were achieved within 3 or 7 days, cats were about 3 times more likely to die at 30 days and 4 times more likely to die within 7 days. When this increase in serum creatinine occurred within 2 or 3 days, death within 90 days was 3 times more likely.[3] Azotemic AKI was diagnosed in 32 cats of an earlier study (serum creatinine >2.5 mg/dl); 18 cats were oliguric at the time of diagnosis. About half of these AKI cats survived (53%) with complete resolution of azotemia in 25% and persistent azotemia (CKD recovery) in 28%. The initial BUN or serum creatinine concentration did not predict survival nor did oliguria. Serum potassium increases seemed to be the most important predictor of survival; a 57% decreased chance in survival occurred for each mEq/L increase over the initial serum potassium concentration. Low initial serum albumin and bicarbonate were also associated with less survival.[4]

A grave prognosis is warranted for cats that develop anuric AKI after IV fluid treatment, a situation most-likely to develop in ethylene glycol intoxication but may also be encountered in cats following ingestion of Easter or day lilies. It should be noted that dogs and cats with severe oliguric AKI have recently been shown to survive with return of renal function and urine production following several months of hemodialysis. The presence of non-oliguria does not guarantee survival either. Due to the poor to grave prognosis for many cases with severely azotemic AKI, prevention is far preferred to treatment.

General goals for treatment of azotemic AKI during the maintenance phase

Placement of an indwelling intravenous catheter is necessary to adequately administer fluids and drugs in the management of azotemic AKI. Rapid correction of dehydration is indicated and can be individually calculated (estimated % dehydration x body weight in kg = Liters of dehydration) or given as 2 to 3 times maintenance fluid needs (60 to 90 ml / pound per day). Further fluids are given to match sensible (urinary volume), insensible (respiratory losses at about 10 ml/lb/day),and contemporary (an estimated volume from vomiting and diarrhea) fluid losses. Since urine output is widely variable in AKI, it is advisable to place an indwelling urinary catheter to monitor urine output to facilitate fluid therapy decisions for the initial 24 to 48 hours. The recognition of oliguria is important initially as it dictates the volume of IV fluid therapy that can be safely given. Urine production less than 1.0 ml/kg/hour (24 ml/kg/day) qualifies for oliguria in our hospital prior to rehydration and volume expansion. Relative oliguria exists if urine production is form 1.0 to 2.0 ml/kg/hour while on IV fluids. Urine output should be from 2.0 to 5.0 ml/kg/hour during vigorous administration of

IV fluids if the kidneys are healthy. It is essential to curtail the fluid prescription for volume to be further infused once hydration has been established especially when urine output does not increase. It is the author's impression that it is easier for cats with AKI to develop overhydration compared to dogs with AKI even with careful monitoring.

Newer thinking about the dangers of IV fluid therapy in the critically ill

If insufficient fluids are given to the AKI patient, the kidneys are not optimally perfused and sustain further ischemic injury. If too much fluid is given, then overt overhydration with pulmonary edema, congestive heart failure, and death follow. A new paradigm suggests that too many fluids and subclinical development of overhydration also result in further renal injury from visceral overhydration and reductions in renal blood flow and GFR as renal interstitial edema develops.[5-9] Renal edema can be an early development following some forms of renal injury. It appears that renal edema can also develop as a consequence of too aggressive fluid therapy. Conventional wisdom has been that it is better to have a little over-hydration than to have the damaged kidneys endure any chance for underperfusion and ischemic injury. It now appears that contrary to popular opinion, it is better to be a little on the "dry" side following rehydration and moderate resuscitation rather than to risk the development of over-hydration. It is possible that declining renal functions in the face of aggressive fluid therapy (reflected by rising BUN, creatinine, and phosphorus) may actually be caused by this treatment and resulting renal edema. Interstitial edema decreases renal blood flow by compression of renal vessels, and opposes GFR by compression of Bowman's capsule and compression of renal tubules. This concept needs to be further evaluated in both human and veterinary medicine. For now, caution is advised so that minimal fluids following correction of hypotension and rehydration are administered. The concept that "less is more" has been advocated in a veterinary review of AKI in cats.[10]

Conversion from oliguria to non-oliguria

Mannitol, furosemide, dopamine, or combinations of these are the diuretics most often employed in attempts to convert oliguria to non-oliguria or to increase renal function (RBF, GFR) Rehydration prior to use of diuretics should occur first to allow greater delivery of the diuretic to its site of action. There are no reports that detail the response of cats or dogs with clinical AKI to these treatments. The so-called "renal-dose" of dopamine (below the vasopressor dose, often from 2 to 5 micrograms/kg/minute) has surprisingly little clinical documentation to support its use in either human or veterinary medicine.[11,12] A combined infusion of dopamine and furosemide to awake normal cats increased urine output but did not increase GFR.[13] Fenoldopam as a selective DA-1 receptor agonist has the potential to cause renal vasodilatation with increased RBF, GFR, and natriuresis without activation of alpha and beta adrenergic receptor effects that occur with dopamine at higher doses.[14]

Ethylene glycol nephrotoxicity

The gold standard to prove the presence of ethylene glycol or its toxic metabolites following bioconversion remains testing with HPLC on serum or plasma samples. This type of testing is not commonly available, though it can be performed at local human hospital laboratories. The EG Test Kit (Allelic Biosystems, Kearnesville WV) is supposed to be able to detect 50 mg/dl of ethylene glycol in a serum/plasma sample but this has not been studied in cats. Test strips designed to detect ethylene glycol (Kacey ethylene glycol test, Kacey Inc, Asheville, NC.) were found to have too many false positives and false negatives to be useful for clinical work in cats.[15] The Catachem test kit (Catachem Inc., Oxford, Connecticut) detected the presence of EG when added to serum or plasma of dogs and cats but did have a positive bias in slightly overestimating actual EG concentrations.[16] This company provides both a quantitative and qualitative test to detect EG. The utility of the osmole gap has been ignored by many in the critical care community. A large osmole gap is proportional to the amount of unmetabolized ethylene glycol in many cases. A large osmole gap is most commonly created by ethylene glycol ingestion in small animals, but a large osmole gap could also result in animals that have consumed propylene glycol as an alternate and less toxic formulation of antifreeze. The presence of calcium oxalate crystalluria is supportive for the diagnosis of ethylene glycol intoxication in the appropriate setting – cat that is sick, possible history or observation of ingestion, and sub-maximally concentrated urine. Calcium oxalate crystalluria is observed in fewer cats than in dogs with ethylene glycol intoxication.[17,18] Calcium oxalate monohydrate crystalluria is more commonly detected than calcium oxalate dihydrate crystal following EG ingestion. Calcium oxalate monohydrate has several different morphologic appearances that can be difficult to identify whereas calcium oxalate dehydrate is more easily recognized.[19] An extremely hyperechogenic renal cortex and medulla may be observed soon after ingestion of lethal quantities of EG in the cat as in the dog.[20,21]

Fomepizole at high doses is the antidote of choice to treat cats following EG ingestion. Fomepizole is administered in higher doses than needed in dogs in order to effectively inhibit alcohol dehydrogenase[22], which otherwise is the first step in the bioactivation of EG to its toxic intermediary metabolites. Fomepizole is given to cats with an initial dose of 125 mg/kg IV followed by 31.25 mg/kg at 12, 24, and 36 hours. Use of this treatment protocol was effective in prevention of azotemic AKI in experimental cats treated within 3 hours of exposure to an otherwise lethal dose of EG. Fomepizole was a more effective treatment than ethyl alcohol and provided less CNS depression (some sedation was observed).[23] This fomepizole protocol was successfully used to treat 3 cats with naturally occurring EG poisoning that were not azotemic at presentation.[24] If fomepazole is not available and it is within 3 hours of EG ingestion, 20% ethanol at 5mL/kg IV initially, followed by the same dose every 6 hours for 5 treatments and then every 8 hours for 4

treatments could be a life-saving alternative antidote. Ethyl alcohol should ALWAYS BE DILUTED prior to administration, otherwise IV administration can cause cardiac arrest.

Lily nephrotoxicty [25-32]

The cat is exquisitely and perhaps uniquely sensitive to the nephrotoxic effects following lily ingestion. The specific toxic principle is unknown but all parts of the lily are toxic to cats. Nephrotoxicity has been observed in cats that have chewed only a small portion of a single lily leaf. The Lilium genus contains nearly 100 species and hundreds of hybrids that are thought to be toxic too. Aqueous extracts of the flower and leaf from the Easter lily contain the toxic principle, with the flower being more potent. Calla lily and peace lily are not real lilies and are not associated with AKI in cats. Lily of the valley does not contain a nephrotoxin, but does contain a digitalis-like toxin. Pancreatic histopathology is observed in some cats.

A history that the cat was observed chewing on lily plants or the finding of fragments of the plant observed in the cat's vomitus provides pivotal clues to the diagnosis. Hypersalivation and vomiting may occur soon after ingestion of lilies due to local irritant effects on the GI tract. Vomiting and lethargy are commonly described 1 to 5 days after plant ingestion in those suffering AKI. Renomegaly and abdominal pain may be detected on physical examination. Varying degrees of azotemia may be documented in cats presenting days after lily ingestion. On urinalysis, isosthenuria, proteinuria, glucosuria, cylindruria, and occasionally ketonuria are present in those with severe AKI but crystalluria is notably absent. Oliguria or anuria may persist despite intravenous fluid therapy in those with severe AKI.

Decontamination combined with fluid diuresis for 48 hours prevents development of azotemic AKI for up to 6 hours after ingestion of lilies. Decontamination 18 hours or more after lily ingestion does not prevent development of azotemic AKI. Induction of vomiting followed by administration of activated charcoal and a cathartic is recommended by the Animal Poison Control Center. Vomiting should not be induced in cats that already are vomiting as a consequence of lily ingestion. No antidote is available to counteract effects of the absorbed nephrotoxin. Nearly all cats presented early with GI signs alone survive after decontamination and induction of diuresis.

As many as 33% to 50% of cats that ingest lilies will develop azotemic AKI if not treated within a few hours following lily ingestion. Anuric AKI can occur 18 to 24 hours after ingestion. Prognosis for recovery is poor after lily-induced development of severely azotemic AKI. The magnitude of azotemia that develops during AKI does not predict survival, but urine output does. Cats with aoztemic AKI that are polyuric are more likely to survive. Cats with azotemic AKI and persistent oliguria or anuria are unlikely to survive. Cats that survive severe azotemic AKI after lily ingestion tend to have substantial permanent loss of renal mass and go on to develop various stages of CKD.

In a recent abstract, 30 cats were treated for lily ingestion associated AKI and 22 cats survived. Eighteen of the 30 cats were managed with aggressive medical treatment in which 89% survived. Twelve of the 30 cats were treated with intermittent hemodialysis with a 50% survival rate. Urine output and hydration status at time of diagnosis were not related to survival. Cats with a serum creatinine > 2.0 mg/dl at the time of diagnosis were more likely to die.[33]

NSAID AKI

NSAIDs are not directly nephrotoxic, but rather work as nephrotoxicants that cause their damaging effect through intense vasoconstriction that develops under special circumstances. NSAID cause AKI only if systemic vasoconstrictor signals have been activated following hemodynamic insult (sodium depletion, volume contraction, hypotension, shock, anesthesia). Normal renal vascular resistance and renal blood flow are relatively well maintained during times of vasoconstriction if synthesis of renal vasodilator substances is normal. Renal vasoconstriction however proceeds unopposed if the synthesis of renal vasodilatory prostaglandins has been blocked by NSAID administration. In these instances, progression to acute azotemic AKI and papillary necrosis may occur. An increased frequency of azotemic AKI was reported in 16 young cats given NSAID at the time of routine desexing without IV fluid administration. Four of these cats were euthanized due to failure of severe azotemia to resolve, 4 cats survived with azotemic CKD, and 8 cats recovered with complete resolution of azotemia[34] In 21 cats with NSAID AKI of another study, the mortality rate was 25% mostly in cats associated with papillary necrosis. Supportive therapy for up to 4 weeks was required for some survivors.[35] The FDA recently required the following statement to be added to the label for meloxicam use in cats, "Repeated use of meloxicam in cats has been associated with acute renal failure and death. Do not administer additional injectable or oral meloxicam to cats…" Robenacoxib, a long acting NSAID, recently has become available for use in cats in North America. Whether the incidence of NSAID-associated AKI is less during treatment with newer generation NSAIDs touted to have less GI side effects remains to be determined.

Table 1. IRIS AKI grading criteria – 2013 guidelines

Each grade is sub-graded as non-oliguric (NO) or oligoanuric(O) and if needing renal replacement therapy (RRT)

AKI Grade	Serum Creatinine	Clinical Description
Grade 1	< 1.6 mg/dL < 140 μmol/L	Non Azotemic AKI: a. Documented AKI: Historical, clinical, laboratory, or imaging evidence of acute kidney injury, clinical oliguria/anuria, volume responsiveness**, and/or b. Progressive non azotemic increase in blood creatinine; ≥ 0.3 mg/dl (≥ 26.4 μmol/L) within 48 hours c. Measured oliguria (< 1 ml/kg/hr) or anuria over 6 hours
Grade 2	1.7 – 2.5 mg/dl 141 – 220 μmol/L	Mild AKI: a. Documented AKI and static or progressive azotemia b. Progressive azotemic increase in blood creatinine; ≥ 0.3 mg/dl (≥ 26.4 μmol/L) within 48 hours, or volume responsiveness** c. Measured oliguria (< 1 ml/kg/hr) or anuria over 6 hours
Grade 3	2.6 – 5.0 mg/dl 221 – 439 μmol/L	Moderate to Severe AKI: a. Documented AKI and increasing severities of azotemia and functional renal failure
Grade 4	5.1 – 10.0 mg/dl 440-880 μmol/L	
Grade 5	> 10.0 mg/dl > 880 μmol/L	

** Volume responsive is an increase in urine production to > 1 ml/kg/hr over 6 hours; and/or decrease in serum creatinine to baseline over 48 hours

Table 2. Causes for AKI in cats

Renal ischemia (hypoperfusion)

Dehydration	Shock
Trauma	Hemorrhage
Anesthesia	Surgery
Sepsis	Burns
Hyperthermia	Hypothermia
Hemolysis	Myoglobinuria
ACE Inhibitors	Non-Steroidal Anti-Inflammatory Drugs (NSAID)

**Note that renal ischemia can occur in the absence of systemic arterial hypotension.

Nephrotoxins

More common

- Glycols (Ethylene Glycol)
- Antimicrobials
  - Aminoglycosides
  - Amphotericin-B
  - Sulfonamides - dehydration
  - Tetracyclines – IV
  - Fosfomycin – not dogs[36]
- Easter Lilly – Cats

Less common

- Hypercalcemia
  - Cholecalciferol Rodenticide
  - Cholecalciferol – Diet
  - Calcipotriene – antipsoriasis cream
- Cancer Chemotherapeutics
  - Platinum compounds alone and more so when combined with piroxicam
  - Radiocontrast Agents - IV

- Heavy Metals

Miscellaneous causes of AKI

- Renal thromboembolism – renal infarction
- Acute-on-chronic renal failure
- Renal amyloidosis with acute papillary necrosis

Acute hyperphosphatemia

- Tumor lysis syndrome
  - Phosphate enema
  - Phosphate acidifier
  - Massive soft tissue trauma
- Pancreatitis
- Food-associated renal failure – FARF
- (melamine with cyanuric acid tainting)

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Special Aspects of Diagnosing and Managing Chronic Kidney Disease

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The incidence of the diagnosis of CKD in cats is made 2 to 3 times as frequently compared to dogs and is especially common in geriatric cats.[1] CKD is clinically characterized by the development of variably progressive irreversible intrarenal lesions and loss of renal functions. Compensatory increases (so called adaptations) in glomerular hemodynamics and glomerular volume may actually be maladaptive in the long term as they cause increased protein trafficking across the glomerulus.

The initial diagnosis of CKD is made on some combination of findings from clinical signs, physical examination (especially large or small kidneys, irregular kidneys), renal imaging, urinalysis, and serum biochemistry. A surprising number of cats with CKD have upper urinary tract uroliths at the time of initial diagnosis.[2-4] Abdominal radiographs should be routinely obtained to determine the presence or absence of radiopaque stones. Renal and ureteral ultrasonography should be performed in all cats in which renal or ureteral stones were found on radiography in order to tell whether or not there is an obstructive component to the CKD. T4 should be measured in all cats with suspected CKD since hyperthyroidism can mask the detection of azotemia by its effects that increase GFR and RBF; hyperthyroidism may also contribute to progression of CKD through a variety of mechanisms including intraglomerular and systemic hypertension. [5] Conventional wisdom and experience suggests that client owned cats with healthy kidneys elaborate urine with a specific gravity of >1.035. This concept was recently validated in a study of cats evaluated at first opinion clinics.[6] Cats with USG < 1.035 should undergo further diagnostic investigation to determine if they have an endocrine or renal disorder with or without associated clinical signs. A surprising number of experimental [7] and clinical cats with CKD continue to be able to elaborate urine with a USG > 1.035, so the presence of "concentrated" urine and mild to moderate azotemia does NOT exclude the presence of primary kidney disease in cats as it often does in dogs. Cats that have thin body condition, prior periodontal disease or cystitis, anesthesia or documented dehydration in the preceding year, or being a neutered male (vs spayed female) were reported to be at increased risk for the diagnosis of CKD.[8]

A staging system initially based on the level of serum creatinine concentration has been developed by IRIS (International Renal Interest Society) for use in cats that are hydrated and stable. Serum creatinine is measured again on at least 2 occasions 2 weeks apart by the same lab. Sub-staging is then based on the degree of proteinuria as measured by UPC and also the magnitude of blood pressure. Staging using this system is designed to detect CKD much earlier than with traditional methods and also to potentially match treatments by stage. Normal and stage 1 CKD cats have serum creatinine concentrations < 1.6 mg/dl (< 140 μmol/L). Normal cats usually have a UPC < 0.2, with 0.2-0.4 considered borderline increased, and > 0.4 overtly proteinuric. Details of this staging system can be found online at http://www.iris-kidney.com. This staging system does not indicate the underlying cause for the CKD which requires other diagnostic workup to determine. It is important to remember that nearly all studies on the effect of diet or drugs have studied overtly azotemic cats (serum creatinine > 2.0 mg/dl). It has not been determined whether or not the salutary effects of treatment in azotemic cats confer the same benefits to CKD cats at earlier stages.

Tubulo-interstitial nephritis of unknown origin is the most common cause of azotemic CKD in the cat, as in the dog. However, cats have several renal diseases that deserve additional consideration as compared to dogs including breed related predilection for renal amyloidosis (Abyssinian, Oriental Short Hair) and polycystic kidney disease (Persian, Himalayan). Cats have greater frequency of CKD associated with renal LSA than dogs. Peri-nephric pseudocyst can be associated with CKD in cats and should be considered as a differential diagnosis for apparent renal enlargement in addition to renal LSA and hydronephrosis.

A variety of interventions (diet and drugs) can slow the progression of the renal disease, improve the quality of life for the patient, and/or extend the quantity of life. Dennis-I just moved this here as it opens your discussion re treatment.

Dietary interventions for CKD

Dietary therapy remains the cornerstone of management of CKD. Diet modifications include phosphorus restriction (most important), providing reduced quantity but high quality protein, adequate non protein calories from fat and CHOs, modifying sodium content (not the degree of restriction once recommended by some), supplementing potassium, B vitamins, alkali as needed and providing omega three fatty acids. In one 2-year study, cats with a serum creatinine > 2 mg/dl fed a renal diet had a median survival time that was 2.4 times longer than cats fed a maintenance diet (633 days vs 264 days). [9] In another study, IRIS stage 2 & 3 cats were followed for 24 months. Cats fed the maintenance diet had more uremic episodes and more renal-related deaths compared with cats fed the renal diet. [3] In a study of 175 CKD cats fed 1 of 7 different renal diets, the median survival time was 16 months (12 to 23 months) compared to a median survival time of 7 months for cats eating their maintenance diet. Interestingly, the longest survival period was found in cats eating a renal diet with the highest eicosapentaenoic acid (diet not available in North America), otherwise the renal diets were similar in composition. [10] Patients are more likely to accept a new renal diet if offered before uremia develops and a gradual transition may be needed.

The number one reason to restrict dietary protein is to provide an adequate degree of restricted intake of phosphorus, especially those associated with animal tissues in the diet. Decreased production of nitrogenous wastes can occur in those with large increases in BUN, and consequently improve the clinical well-being of the pet even though renal function remains unchanged. If proteinuria is present, dietary protein restriction may lower the magnitude of proteinuria through obscure mechanisms. Reduced dietary protein intake may also lessen inflammatory, fibrogenic and oxidative stress pathway.[11] The amount to restrict dietary protein is not known, so it is currently recommended to provide at least maintenance levels. For cats with CKD, the minimum dietary protein requirement suggested is 20% of calories, which equates to 24% protein on a dry-matter basis.[11-14]Others suggest 28–35% (DMB).[15]It is emphasized that less total dietary protein can be fed if high biologic value proteins, such as egg, are fed.[13] Lowering animal-derived protein (source of phosphates) in the diet may be essential to lower dietary phosphorus intake needed to achieve target levels of serum phosphorus.[16] Too much dietary protein restriction can and often does result in protein: calorie malnutrition. Protein malnutrition from any cause is strongly correlated with morbidity and mortality. If protein malnutrition becomes evident in a patient (hypoalbuminemia, anemia, weight loss or loss of lean muscle mass), then the amount of protein should be increased until signs are no longer evident. Cats with sarcopenia, regardless of the stage of renal disease, may require more protein than a renal diet can provide-careful monitoring and adjustment will be needed in these cats.

Pets with CKD often suffer from poor appetite that can contribute to poor body condition. This is often associated with decreased prognosis as the owner's often euthanize when quality of life is perceived as unacceptable. *Mirtazapine (Remeron)* helps not only with appetite but with uremic-associated nausea. Recent work in cats indicates mirtazapine can be administered at a low dose (1.88 mg) every 48 hours to cats with CKD, but was only studied for its effects for 3 weeks.[17,18] Remember that mirtazapine and cyproheptadine cannot not be administered concurrently. Cyproheptadine is in fact used as an antidote for serotonin effects of mirtazapine overdose. *Maropitant (Cerenia*): NK-1 receptors are in the chemoreceptor trigger zone, in the emetic center itself, as well as peripherally. Consequently, Cerenia is a great choice to treat vomiting/nausea in renal cats. Despite the label recommendation, many specialists are recommending Cerenia for longer than 5 days (personal communication with specialists and with Zoeitis scientists). Dose: 1 mg/kg PO once daily. Refrigerate to help alleviate the sting associated with injectable cerenia.[19] *Omeprazole* (*Losec*): Studies in cats have also shown Omeprazole to be more effective than H2 blockers such as famotidine and ranitidine in decreasing gastric acidity.[20] Dosage: 0.5-1 mg/kg once a day. If H2 blockers are used, dosages recommended are *Famotidine* (Pepcid®) 0.5 mg/kg IM, SQ, PO q 12 hours or *Ranitidine* (Zantac®) 1-2 mg/kg q 12 hours (cat). Studies have shown most cats with uremia do have elevated gastrin levels (and likely corresponding hyperacidity) but no GI ulcers. [20,21] Consequently, *sucralfate* is not usually indicated. The GI bleed with uremia could be from dysregulation of the vasculature and platelet dysfunction associated with uremia.[20,21] If used, a dose of 0.25 -0.5 g/cat q 12 hours is recommended. In some countries *sucralfate* is used as an intestinal phosphate binder due to its aluminum content. *Ondansetron* at the time of this writing is not highly recommended. The bioavailability is not high (maybe 30% at best in cats) and the half-life is very short (it would be best to give this drug 4 times/day).[22]

Phosphorus

Higher concentrations of serum phosphorus predicted an increase in serum creatinine > 25% above baseline over 12 months in 47% of CKD cats. [23] Serum phosphorus was the only clinicopathologic variable predictive of survival in one study of CKD cats. There was an increase in risk of death of nearly 12% for each mg/dl increase in phosphorus in the same study.[24] Higher phosphorus concentration was associated with a higher risk of death within1 month in another study.[25] Even when serum phosphorus was within the reference range, cats with CKD of one study that had phosphorus concentration > 4.7 to ≤ 6.8 mg/dl serum phosphorus had a higher risk of death compared to CKD cats in which circulating phosphorus concentration was ≤ 4.7 mg/dl. [26]

Dietary phosphorus restriction is critical at least from Stage 2 onwards; there is no data to evaluate any potential benefit of Pi restriction in Stage 1. Compared to the average grocery or pet store foods, the renal friendly veterinary diets are restricted in phosphorus by 70 to 80%. Serum phosphorus concentration may increase in CKD pets that increase their food intake following other supportive CKD treatments. Renal diets may provide sufficient dietary phosphate restriction during early stages of CKD but often the addition of dietary phosphate binders will be needed to reach targeted control of serum phosphorus. Early phosphorus restriction in CRF has been shown in dogs and cats to blunt or reverse renal secondary hyperparathyroidism.[27]

Intestinal phosphate binders

Aluminum salts are the most widely used phosphate binders in cats. Aluminum based phosphate binding agents (aluminum hydroxide, aluminum carbonate) are highly effective in lowering serum phosphate levels, forming insoluble and nonabsorbable aluminum phosphate precipitates in the intestinal lumen. THERE IS NO KNOWN SAFE DOSE OF ALUMINUM SALTS FOR HUMANS WITH CKD. Detrimental effects of aluminum based phosphate binders as described in humans seen in humans have not been systematically evaluated in small animal patients and are rarely clinically appreciated. As cats with CKD can live for years on treatment, concerns for aluminum accumulation deserve more study as to long-term safety. Calcium-based binders are not as effective as aluminum salts, having a lower affinity for phosphorous, thus effective binding of dietary phosphorous requires large doses of calcium, often enough to induce hypercalcemia in humans. The most commonly used calcium based phosphate binders are calcium carbonate and calcium acetate. Animals should be monitored for development of hypercalcemia whenever calcium-containing

phosphorus binders are used. Sevelamer hydrochloride (Renagel®, Genzyme Corporation) and the more recently FDA approved Sevelamer carbonate (Renvela®, Genzyme Corporation) are organic polymers that do not contain aluminum or calcium and are not absorbed from the gastrointestinal tract (excreted entirely in feces). Their effects on dogs and cats with clinical CRF have not been reported. Epakitin® (Vetoquinol Inc.) is marketed as a complementary feed on the veterinary market. It contains the adsorbent chitosan (8% crab and shrimp shell extract), 10% calcium carbonate, and 82% lactose and is designed to reduce GI phosphorus absorption and to lower urea nitrogen due to effects of reduced protein digestibility. The results of two studies [28,29] suggest that this supplement could be an alternative to prescription of renal veterinary diets thereby allowing some cats to continue on their regular diets while still reducing the risks for progression of CKD associated with total body phosphorus burden. We have, however, observed the development of hypercalcemia in a few CKD cats with the use of this product probably as a consequence of the calcium carbonate. Lanthanum carbonate (Fosrenol®, Shire Pharmaceuticals) is a non-aluminum and non-calcium containing intestinal phosphate binder and is indicated for use in human patients with end-stage renal failure to reduce serum phosphorous. Very little lanthanum is absorbed across GI tract and lanthanum accumulates to a far less degree following absorption compared to aluminum since lanthanum undergoes extensive hepatic excretion whereas aluminum is excreted mostly by the kidneys. Lanthanum appears to have minimal toxicity in humans. A recent abstract in a small number of CKD cats administered lanthanum carbonate in food at 95 mg/kg/day to achieve very modest serum phosphate control.[30] Several reports of the efficacy and safety of lanthanum carbonate treatment in cats have been published. [31] Lanthanum carbonate octahydrate (Lantharenol® Bayer HealthCare AG) is marketed as a feed additive for adult cats in order to decrease intestinal phosphate absorption. Renalzin® (Bayer HealthCare AG) is the proprietary name for the delivery system of Lantharenol® and comes as a pump system that delivers lanthanum carbonate along with kaolin and vitamin E at appropriate doses to food for cats. This system is widely available in the UK and Europe, but not in the USA or Canada. The proprietary formulation of human lanthanum carbonate is soon to become available as a generic product.

Pronefra® recently has been launched (Virbac, France) as a dietary supplement for cats with CKD. This product provides a combination of calcium and magnesium carbonate as the intestinal phosphate binders, chitosan for “uremic toxin” binding, vasoactive peptides (designed to maintain normal blood pressure) and an extract of Astragalus membranaceus (Chinese herb for anti-inflammatory and anti-fibrotic effects). Safety of this product was reported in 10 normal cats in which Pronefra was added to the food once daily for 12 weeks[32,33] No changes in circulating calcium or magnesium were noted at during this study. Presently there are no reported studies of safety or efficacy in clinical cats with CKD treated with this supplement.

Novartis has developed a new oral phosphate binder for cats called Lenziaren ® (SBR759). Iron oxide with starch and sucrose exist in this preparation as an insoluble complex. A dose of 0.5 to 1.0 Gm/cat/day is recommended when added to standard diets.[34] A dose of 0.25 Gm/cat/day to 1.0 Gm/cat/day is recommended when adding this phosphate binder to a renal diet. [35] Safety and efficacy of Lenziaren® in cats with CKD are not yet reported. Lenziaren is touted by the authors as a phosphate binder that does not contain aluminum, calcium, or lanthanum that could be problematic in cats with CKD. That is true for the aluminum and calcium as a factor in favor of its use, but there is no known toxicity of lanthanum yet reported.

Control of proteinuria

Cats with azotemic CKD increased their risk for death or euthanasia when the UPC was 0.2 to 0.4 compared to <0.2 and was further increased in cats with UPC of >0.4.[36] The prognosis for survival is influenced by the UPC despite what has traditionally been thought to be low-level proteinuria. The effect of treatments that lower proteinuria on survival have not been specifically studied. Since even low-level proteinuria is a risk factor for cats to not survive, it is prudent to consider treatments that lower the amount of proteinuria in those with CKD. See discussions about the potential benefits of dietary protein restriction (above) and RAAS inactivation (below) to reduce the magnitude of proteinuria.

RAAS inactivation

RAAS inactivation results in decreased generation of angiotensin-2 and aldosterone that can exert benefits to reduce progression of CKD. These beneficial effects can occur through variable combinations of reduction in systolic blood pressure, decreased intra-glomerular hypertension, decreased glomerular proteinuria, and less generation of pro-inflammatory and pro-fibrotic cytokines in patients with CKD.

Benazepril is labeled for treatment of azotemic CKD in cats in the UK, Europe, and Canada (Fortekor®), but not in the USA. The ACE-inhibitor benazepril consistently reduces proteinuria in various stages of CKD in cats even when the base line level of proteinuria is seemingly trivial. Benazepril has been shown in two clinical studies to reduce the UPC in cats with azotemic CKD.[37,38] Despite reduction in proteinuria in CKD cats with initial UPC > 1.0 that were treated with benazepril in one study, increased survival time was not found over placebo.[37] The average survival time of all benazepril treated cats in this study was 501 days vs. 391 days for placebo treated cats but this effect did achieve statistical significance. [37] In another study of 61 cats with CKD, benazepril treatment for 189 days appeared to stabilize those in IRIS stage 2 or 3 with less transition to stage 4 compared to treatment with placebo, though this effect did not achieve statistical significance (low number of cats and short duration of study.[38]

The angiotensin receptor blocker (ARB) telmisartin (Semintra® Boehringer Ingelheim) was approved by the European Commission in 2013 for use in the European Union as a drug for use in cats with CKD and is available for use in Canada but not yet

in the USA. Semintra was found to be at least as effective as benazepril in reducing proteinuria in cats with CKD and was well tolerated.[39,40] A US Patent application was filed in July 2013 by Boehringer Ingelheim. It is not clear when or if an ARB should be chosen to reduce RAAS activity instead of an ACE-Inhibitor for treatment of CKD in veterinary patients to reduce proteinuria, systemic blood pressure, or intra-renal inflammation. A veterinary review of the RAAS system, ACE-Inhibitors and ARB's provides more detail for the interested reader.[41]

Activated vitamin-D metabolites: calcitriol

Calcitriol treatments help to decrease PTH or prevent its increase in those with renal secondary hyperparathyroidism. This occurs largely through genomic effects to block PTH synthesis in addition to a mild calcemic effect, and anti-proliferative effect that prevents parathyroid gland hyperplasia. It has become increasingly apparent that calcitriol has major beneficial anti-inflammatory and anti-fibrotic intrarenal effects that are independent of effects on PTH.[27]During treatment of CRF patients with calcitriol, simultaneous monitoring of serum ionized calcium, serum phosphorus and PTH concentrations is the ideal way to document successful and safe control of renal secondary hyperparathyroidism. Calcitriol should not be administered until hyperphosphatemia has been controlled. If the Ca X P solubility product exceeds 60-70, calcitriol should be avoided because of the risk of soft-tissue mineralization.

In a recent study of dogs with azotemic CKD that were treated with calcitriol a median of 365 days survival was observed compared to 250 days in dogs treated with placebo (renal diet in both groups).[42] Similar studies were performed in cats by the same investigators who concluded that there is no advantage to calcitriol treatments in cats with CRF but the study followed cats for just one year. In order to show a difference in treatment effect, if one exists, studies in cats with CKD must be conducted for at least 2 and possibly 3 years due to the inherently slow nature of the progression of chronic renal disease in this species. The authors believe that beneficial effects of calcitriol treatment are likely to occur in cats with CKD.

A compounding pharmacy will be needed to reformulate calcitriol from the human parent drug to a concentration suitable for the dosing of cats. We recommend intermittent rather than daily dosing treatment protocols as the standard of care since less hypercalcemia occurs using this protocol. The equivalent dose given at 2.5 ng/kg daily is given instead every 3.5 days. This works out to a dose of 9 ng/kg (8.75 ng/kg rounded to 9 ng/kg). It is important to give the dose every 3.5 days, rather than on day 1 & 4. For example if a dose is given Tuesday PM the next dose should be given Saturday AM. This is the longest time in between dosing that will still suppress the parathyroid gland. This method of dosing is especially attractive for cat owners since medication will only be given twice weekly.

Systemic hypertension

Systemic hypertension is common in cats with CKD with 13-28% of cats presenting with hypertension when CKD is first diagnosed and up to 65% of cats developing hypertension at some point during the progression of their renal disease.[43-51] Cats that have systemic hypertension from a variety of causes have been shown to survive longest when their blood pressure is well controlled.

Enalapril or benazepril as monotherapy has not been very effective for treatment of hypertensive cats or dogs. The calcium channel blocker, amlodipine has been used successfully in cats at a dosage 0.625 to 1.25 mg per cat given orally once per day. Follow-up evaluations should be scheduled for one week after beginning treatment with amlodipine. Adverse effects (including hypotension) are very uncommon with the use of amlodipine in cats.[43,46,47]

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Treatment of Idiopathic Hypercalcemia in Cats: Case Studies- Diets or Drugs?

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How common is hypercalcemia in cats?

The frequency of the detection of hypercalcemia in cats has dramatically increased in many regions of the world over the past 20 years mostly due to the diagnosis of idiopathic hypercalcemia (IHC).[1-7] Hypercalcemia is most often initially defined in primary care practice by the finding of increased serum total calcium on routine serum biochemistry. Mild hypercalcemia based on serum total calcium is often overlooked during analysis of serum biochemical profiles, so the frequency of hypercalcemia is likely to be more common than generally recognized. Mild serum total hypercalcemia is frequently attributed to hemoconcentration from dehydration.

Total serum calcium cannot be reliably used to predict the metabolically active ionized calcium fraction in cats.[8] There was an overall diagnostic discordance of 40% during evaluation of 434 feline serum samples using total calcium to predict ionized calcium in cats of one study. Ionized hypercalcemia and normocalcemia were underestimated and ionized hypocalcemia was overestimated.

Characterization of hypercalcemia

Once ionized hypercalcemia has been identified, the next step is to determine if the process is PTH-dependent (high PTH from failure to suppress abnormal parathyroid glands) or PTH-independent (PTH is appropriately suppressed as the response of normal parathyroid glands). In a study of 322 cats, ionized hypercalcemia was parathyroid independent in 82%, equivocal in 10%, and parathyroid-dependent in 8% of these cats.[9] In cats with parathyroid-independent hypercalcemia, malignancy-associated hypercalcemia (MAH) needs to be excluded. MAH most often results from humoral mechanisms as the tumor secretes calcemic substances such as PTHrP into the circulation; local osteolytic hypercalcemia is far less common. When PTHrP is reported to be high, the presence of malignancy is likely. A low or undetectable PTHrP does not exclude malignancy as the cause for hypercalcemia since other cytokines that cause calcemia can be elaborated by the tumor instead of PTHrP on occasion.

If the diagnostic evaluation does not reveal malignancy as the cause for parathyroid-independent hypercalcemia (PTHrP and body cavity imaging), evaluation of circulating vitamin D metabolites may be useful in determining the underlying cause or mechanism for the hypercalcemia. Hypervitaminosis D is classically characterized by increased concentrations of circulating 25(OH)-vitamin D (calcidiol) following excess ergo/cholecalfierol exposure from food[10,11] or from cholecalciferol-containing rat-bait.[12,13] Increased circulating calcitriol has been reported in cats with granulomatous disease and hypercalcemia, likely the result of unregulated conversion of calcidiol to calcitriol by activated macrophages.[14-16]

What are the causes of hypercalcemia in cats?

The frequency for the occurrence of total serum hypercalcemia from biochemical panels from sick or well cats is not known. The only large survey of the causes of hypercalcemia in cats was reported from a veterinary teaching hospital based on the measurement of serum total calcium in 2000.[17] Ionized hypercalcemia concentration has been sporadically reported in cats with specific diseases, but not in a series of cats with varying causes of hypercalcemia. Idiopathic hypercalcemia, CKD, and neoplasia are the most common and important differential diagnoses to exclude as the cause for parathyroid independent hypercalcemia. Overt hypervitaminosis D, granulomatous disease, and hypoadrenocorticism are other far less common causes of hypercalcemia in cats. Calcium oxalate urolithiasis was reported to be associated with hypercalcemia in cats; however, it is likely that hypercalcemia preceded the formation of stones rather than the urolithiasis acting as a stimulus for the formation of hypercalcemia.[17,18] IHC was not considered as a diagnostic category in one large study of cats with hypercalcemia,[17] but in another study the occurrence of IHC in 20 cats was published that same year.[18] Primary hyperparathyroidism was infrequently diagnosed as the cause of the hypercalcemia at a teaching hospital (4 of 71 cats),[17] but this diagnosis is far more frequently made by veterinary endocrine referral laboratories.[1,9] Based on the number of consultations by veterinary internists and endocrinologists, as well as sample submissions to endocrine laboratories, idiopathic hypercalcemia (IHC) is currently the most-common cause of hypercalcemia in cats in North America and likely so in other parts of the world.[1,2,5-7]

While MAH is the number one cause of pathological hypercalcemia in the dog,[19] it occurs far less frequently in the cat. Based on serum total calcium and how the data is parsed, MAH is 3rd in frequency behind IHC and CKD in cats with hypercalcemia.[17] In dogs, the overwhelming cause of MAH is lymphoma with occasional carcinoma as the diagnosis,[19] whereas in cats lymphoma and carcinomas each account for about 1/3 of the cases.[17] Patients with MAH are usually “sick” as it takes a reasonably large tumor burden to synthesize the messengers that result in hypercalcemia.

Signalment and clinical signs of IHC cats

In a report from 427 cats with IHC evaluated at an endocrinology laboratory, the age at diagnosis ranged from 0.5 to 20 years (mean 9.8 ± 4.6 yr). Males and females were equally represented in this study. Long-haired cats were noted to be overrepresented at 27% of

the cases in this report,[20] but not in a recent case-control epidemiological study (data analyzed post Todd Green Master's Ohio State University 2008).

No clinical signs were noted in 46% of IHC cats. Other clinical signs were largely related to gastrointestinal signs, including mild weight loss (18%), chronic constipation (5%), vomiting and decreased appetite. IBD was diagnosed in 6% of the IHC cats of this study. Lower urinary tract signs may be observed, especially if urolithiasis is present. Uroliths or renoliths were observed in 15%, and calcium oxalate stones were specifically noted in 10% of cases. Polyuria/polydipsia has not been frequently reported in cats with IHC.[20]

In many instances, hypercalcemia based on measurement of total serum calcium is fortuitously discovered following submission of serum samples from wellness examinations, pre-anestheic evaluation of seemingly healthy individuals, those with routine medical conditions, and those from cats forming calcium-oxalate stones. Hypercalcemia is also sometimes discovered following submission of samples from cats with seemingly trivial clinical complaints like intermittent vomiting of hairballs. Though many cats with IHC do not have obvious clinical signs at first look, a more careful review of the history and physical examination often discloses some abnormality that could be explained by persistence of chronic ionized hypercalcemia. This includes low-grade weight loss, loss of muscle mass, and lethargy. Intermittent vomiting and constipation are also possibly due to adverse effects of ionized hypercalcemia on gut motility. Chronic ionized hypercalcemia is a risk factor for the genesis of calcium oxalate urolithiasis and for the development of chronic renal injury resulting in CKD that may take months to years to develop.

How is the diagnosis of IHC established ?

The diagnosis of IHC is one of exclusion after initially confirming that the ionized calcium is increased. All the known causes of hypercalcemia should ideally be eliminated – this kind of workup can be exhaustive and expensive. The increase in circulating ionized calcium in IHC can be mild, moderate, or severe, as it can also be with other causes of hypercalcemia. Often mild increases in total or ionized calcium that are discovered fortuitously tend to increase over time, but to a varying magnitude. We have observed the ionized calcium concentration to fluctuate into and above the reference range, especially when the hypercalcemia is marginal in magnitude. We have observed large fluctuations in total and ionized calcium concentrations on occasion in some cats with IHC and those with primary hyperparathyroidism.

In order to exclude other causes of hypercalcemia, a minimum database including a CBC, biochemistry profile and urinalysis, should be performed. Additionally, analysis of PTH and 25-hydroxyvitamin D are necessary to rule out hyperparathyroidism and hypervitaminosis D as the cause of the hypercalcemia. The typical pattern for calcium regulatory hormones in IHC would be for the PTH concentration to be within the reference range (often lower end), the PTHrP concentration to be undetectable, and to have a normal serum ionized magnesium concentration.[20] Most 25-hydroxyvitamin D and calcitriol concentrations are usually within the reference range, but a few cats with IHC have been noted to have values increased above the reference range.[18,20]

Chest radiographs are useful to rule out metastatic pulmonary nodules and mediastinal lymphoma that may be associated with hypercalcemia. Unlike in dogs, mediastinal lymphoma is not common in cats. A combination of abdominal radiographs and ultrasonography can be useful to determine the presence of urolithasis (kidney, ureter, bladder, urethra), obstructive nephropathy from the stones, or the presence of inflammatory/infiltratitve masses that could be associated with the genesis of the hypercalcemia. Treatment recommendations and prognosis may change with the presence of stones and their location.

Should all cats with IHC receive treatment?

Cats with minimal increases in circulating calcium concentrations are often ignored in clinical practice since many of these cats have mild or no apparent clinical signs. Even though obvious clinical signs are often not apparent, subtle clinical signs often exist. Excess calcium can be toxic to cells, exerting either physiological or structural effects particularly in the central nervous system, gastrointestinal tract, heart, and kidneys. Mineralization of soft tissues is an important potential complication related to the presence of ionized hypercalcemia that is in part determined by the concomitant concentration of serum phosphorus, but this does not develop in all IHC cats. The clinical outcome for cats with IHC that have not been treated has not been established following the initial diagnosis. An argument can be made to withhold treatment when an IHC cat has no recognizable signs, no identified risk factors for urolithiasis or CKD, and the increase in ionized calcium is minimal. A stronger argument can be made to treat IHC cats in which the ionized calcium concentration continues to escalate. The strongest argument to start treatment exists for cats that have ongoing weight loss, depression, vomiting, constipation, urinary stones, emergence of CKD and or development of sub-maximally concentrated urine.

Treatment of IHC – diet

Management of IHC usually begins with a dietary recommendation to attempt to restore normocalcemia. Reports of treatment outcome following dietary change are quite limited, so diet recommendations are largely based on expert opinion and uncontrolled case studies in small numbers of cats. We have observed decreased circulating ionized calcium in some cats following dietary change, but the magnitude and duration of this decrement can be quite variable. Future studies comparing test and control diets are needed to

determine the effects, if any, of altering intake of nutrient(s) on concentrations of the calcium regulatory hormones PTH, calcidiol, calcitriol, and 24,25(OH)2-vitamin D in addition to that for ionized calcium.

Is there one specific dietary nutrient on which we should focus that will consistently decrease circulating ionized calcium?

Regulation of the circulating calcium concentration is dynamic and complex. It has not been determined how much of the hypercalcemia in IHC cats results from too much dietary calcium intestinal absorption, increased bone resorption, reduced renal excretion of calcium, or combinations of these processes. Many of the nutrients in the diet interact with each in ways that affect dietary calcium absorption and not all calcium in the diet is biologically available for absorption.[21] Vitamin D is one obvious dietary nutrient that can affect intestinal absorption of calcium and it also has effects on osteoclastic bone resorption that can contribute to the degree of calcemia.[22] Vitamin A has effects on the osteoclast that can work in concert with vitamin D to increase bone resorption.[23]

What do we know about dietary calcium content in the management of IHC?

Some veterinary nutritionists recommend diets to treat IHC based on a decreased calcium content on a g calcium/1000 kcal (Mcal) energy basis.[24] Minimal and maximal nutrient recommendations for cat food are provided by the Association of American Feed Control Officials (AAFCO) and the National Research Council (NRC). Most diets sold over-the-counter should meet AAFCO requirements; however, veterinary therapeutic diets may be specifically modified in order to provide certain nutrients at concentrations less than AAFCO minimums. The average calcium content of grocery store foods in the USA is approximately 2.0 to 3.0 g calcium per Mcal (200-300 mg/100 kcal), though some contain up to 6.0 g calcium per Mcal (600 mg per 100 kcal).[25] Some of the highest calcium diets are “high-fiber” diets; thus one must carefully weigh the pros and cons of recommending a high-fiber diet for dietary management of IHC when there is some evidence that reducing dietary calcium may be effective in restoring normocalcemia. Nutrient concentrations of diets can be found either in product guides or by contacting the diet manufacturer, but this information is not readily available from the routine diet label. Nutrient profiles are constantly evolving and this information may change up to every 6-12 months. For feline adult maintenance, the NRC recommended allowance (RA) is 0.72 g calcium per Mcal [26] and the AAFCO minimum is 1.5 g calcium per Mcal.[27]

Feeding of a high protein and low carbohydrate food similar to what cats would eat in the wild (i.e., 40-60% of calories from protein; 30-50% of calories from fat, and <15% of calories from carbohydrates) has been recommended to effectively lower serum calcium concentration in some cats with IHC, especially those with low magnitude hypercalcemia.[4,28] This nutrient profile is what would be expected from veterinary therapeutic diets designed for cats with diabetes mellitus and also many over-the-counter canned feline diets. In reviewing these types of diets however, it should be noted that calcium content varies from about 1.5 to 5.5 g per Mcal.

What do we know about dietary vitamin D content in the management of IHC?

IHC is not the result of obvious excess dietary vitamin D intake since serum concentrations of 25(OH)-vitamin D have been within the reference range in most cats with IHC. However, the minimal requirement for vitamin D in cats is debatable since reference ranges have been established in cats fed vitamin D–supplemented diets. Normal concentrations of 25(OH)-vitamin D could still potentially be associated with IHC in cats if there are up-regulating mutations in the VDR (vitamin D receptor). These possibilities have not yet been investigated.

For adult cats, the NRC-RA for dietary vitamin D3 (cholecalciferol) is 70 IU per Mcal. The safe upper limit (SUL) is listed as 7,520 IU per Mcal.[26] AAFCO minimum and maximum recommendations for feline adult maintenance are 125 and 2,500 IU per Mcal, respectively.[27] Clearly, there is a wide range of acceptable dietary vitamin D in commercial cat foods. Feeding a diet formulated to be low in vitamin D content at < 200 IU per Mcal has been recommended in dietary treatment of cats with IHC.[4,28]

How helpful are high fiber diets in restoration of normocalcemia in cats with IHC?

Higher fiber diets were associated with the restoration of normocalcemia in 5 of 5 cats with calcium oxalate stones and a likely diagnosis of IHC (high ionized calcium concentration) in one report.[29] The effects of fiber on intestinal absorption of calcium are complex and depend on the type and amount of fiber in the diet and the interactions with other nutrients in the diet. It has been theorized that supplemental fiber may lead to increased binding of intestinal calcium, preventing its absorption, and also to decreased intestinal transit time through the small intestine, reducing calcium absorption.[29,30] The salutary effect of a higher fiber diet, if any, is not simply due to the binding of calcium to fiber. It appears to be common practice for most manufacturers to increase the concentration of calcium in high-fiber diets to offset the potential for decreased absorption.

How helpful are higher salt diets in management of IHC?

Treatment with higher salt content diets has not been studied in IHC cats, with or without calcium oxalate stones. Higher salt intake potentially could promote increased water intake, volume expansion, and a dilution effect that would decrease circulating ionized calcium to some degree. Increased water turnover would then create more dilute urine that should help prevent calcium oxalate stone growth by reducing RSS. Increasing salt intake up to 3.7 g per Mcal has been reported to be safe without detection of deleterious effects on renal function, cardiovascular function, and systemic blood pressure when studied in normal cats, geriatric cats, and cats with surgically reduced renal mass.[31-35] Future studies of higher dietary salt intake for treatment of cats with IHC are warranted.

Treatment of IHC- glucocorticosteroids and oral alendronate

We do not recommend starting drug therapy immediately after the diagnosis of IHC since dietary treatment is effective in restoration of normocalcemia in some cats. Treatment with glucocorticoids restores normocalcemia or dramatically reduces the ionized calcium concentration in most cats with IHC, at least initially. A maximal decline in calcium to within the reference range often requires dose escalation and the beneficial effect may be transient. Approximately 80% of cats with IHC become normocalcemic with 1.5 to 2.0 mg/kg/day prednisone per day, but some may require increasing doses to remain normocalcemic over time.[36] It is important to not prescribe glucocorticosteriods before the diagnosis of the hypercalcemia has been established with some certainty, otherwise cytolytic effects in LSA and myeloproliferative disorders will make definitive diagnosis difficult or impossible. A mild calcium-lowering effect can be exerted by use of glucocortocosteroids in other forms of malignancy-associated hypercalcemia and in those with primary hyperparathyroidism. It is also preferred to have biopsy-proven IBD before the start of glucocorticosteroids. Oral prednisolone achieves greater maximal concentration in the circulation than does oral prednisone in the cat, possibly due to greater GI absorption of prednisolone or less hepatic conversion of prednisone to prednisolone.[37] Prednisolone is given orally at 5 – 10 mg/cat/day for 1 month before reevaluation. Though prednisolone can be effective in restoration of normocalcemia in IHC cats, we now usually consider prednisolone as treatment after oral bisphosphonate treatment has failed to restore normocalcemia. In these instances, prednisolone is prescribed in addition to the oral bisphosphonate, but much lower doses of prednisolone may now be effective during combination drug therapy. Long-term treatment with prednisolone contributes to muscle wasting[4-6] and possible induction of diabetes mellitus in some cats.

Bisphosphonate treatment for IHC cats

Historically, oral bisphosphonates have been recommended to treat IHC cats when dietary modification and prednisolone treatment have been unsuccessful in restoration of normocalcemia. Oral alendronate has become our preferred option to treat IHC cats after dietary modification has failed to restore normocalcemia.[28] Even though not extensively reported, we now consider bisphosphonate therapy a safer alternative to glucocorticosteroid use in cats that failed dietary intervention. Treatment with bisphosphonates may be useful to decrease the magnitude of hypercalcemia in cats with IHC by altering osteoclastic bone resorption. IV treatment with bisphosphonates is almost never needed in IHC since the hypercalcemia is chronic and the cats are usually not in an acute crisis.

The long-term safety and efficacy of oral alendronate therapy has not been reported in cats. The safety and efficacy of oral alendronate treatment given once weekly for 6 months was reported in 12 cats with IHC.38 Two of the 12 cats developed mild ionized hypocalcemia at 6 months of treatment. We have followed some IHC cats undergoing alendronate treatment for over 2 years without reported clinical side effects.36 The safety of oral alendronate treatment for cats with IHC and CKD has not been specifically studied, but we have not observed any documented decreases in renal function that we could attribute directly to the alendronate. Drug-induced esophageal damage (erosive esophagitis and esophageal stricture) and gastritis are of concern in humans taking oral bisphosphonates.39-42 We have not observed the development of these lesions, nor have they been reported by others, following oral alendronate treatment in IHC cats.

An increased risk for bone fracture has been reported in humans on long-term bisphosphonate treatment presumably because of the increased brittleness of bone due to bisphosphonate therapy.43 Bisphosphonate treatment in humans generally does not exceed 3 years due to concerns that acquired bone pathology outweighs previous benefits.44 We have become aware of two cats that developed pathologic fractures following 9 and 5 years of treatment with weekly oral alendronate.

Any food in the stomach can drastically reduce the absorption of alendronate to near zero – bisphosphonates are poorly absorbed at best under optimal conditions. To maximize intestinal absorption of alendronate, we recommend fasting cats overnight for 12 hours prior to the administration of medication, giving the pills in nothing other than tap water, and then feeding the cat two hours later. Though not specifically studied, an 18-hour fast prior and 4-hour fast post-pill might be a better protocol to achieve the highest possible intestinal absorption.45 We do not recommend the administration of alendronate in pill pockets due to concern about decreased intestinal absorption that could occur. For the same reason, we do not recommend alendronate that has been formulated by compounding pharmacies in flavored solution or suspension.

Given the risk of esophagitis and stricture associated with oral bisphosphonate treatment in humans, we advise extra caution to prevent esophageal tissue damage following oral alendronate administration in cats. The starting dose is usually 10 mg/cat (NOT per kg) per week initially. We recommend administration of whole tablets only, as cut tablets may increase exposure of the esophagus and stomach to adverse effects. We recommend “buttering” the cat’s lips/nose as this has been shown to increase salivation and swallowing which contributes to decreased transit time and less time for mucosal contact from the pill.46 The effect of butter on intestinal absorption of alendronate has not been specifically studied, but use of butter as part of our treatment protocol has effectively restored normocalcemia in many cats. Five to 6 ml of tap water is administered via syringe to provide an additional measure to prevent the pills from getting caught in the esophagus.47 Using these preventative measures, we have not yet observed any signs of esophagitis in cats treated with alendronate.

Some cats return to normocalcemia on 10 mg oral alendronate per week, whereas other cats require dose escalation to do so. If the ionized calcium remains above the reference range at the 4 to 6 week visit, increase the dose to 20 mg once each week, or alternate

giving 10 mg one week followed by 20 mg the next week to provide an average of 15 mg per week. Once the ionized calcium enters the reference range, we recommend reevaluation in 1, 3, and 4 to 6 months if the ionized calcium remains stable within the reference range. Many IHC cats return to normocalcemia following a 10 mg once weekly dose of oral alendronate, whereas some IHC cats will require 20 mg weekly to achieve normocalcemia. Rarely, 30 or 40 mg/cat/week oral alendronate will be needed to restore normocalcemia. Alendronate dose reduction should be prescribed for cats that achieve very low reference range ionized calcium in order to prevent the development of overt hypocalcemia. For cats that develop overt hypocalcemia, alendronate treatment should be discontinued, at least temporarily.

When should bisphosphonate treatment be stopped for IHC cats?

Alendronate treatment should be stopped in IHC cats that fail to regain normocalcemia despite 30 to 40 mg weekly doses after ascertaining strict adherence to the pre-pill fasting protocol. Alternatively, prednisolone can be added on top of alendronate to see if a beneficial effect can be gained to lower circulating calcium during combination therapy.

It is not known how long oral alendronate treatment should be continued in those IHC cats that have regained normocalcemia for long periods of time. It is possible that the salutary effects to keep circulating calcium concentrations within the reference range may last long after alendronate is discontinued due to its long half-life in bone, but this has not been specifically studied.

Though bisphosphonate treatment is very often effective in restoration of normocalcemia in IHC cats, it would be far preferable to find the underlying cause(s) of IHC so that drug therapy would no longer be needed. Guidelines as to how long bisphosphonate treatment can safely be given to cats with any disease have yet to be established. We are concerned that some cats are now receiving bisphosphonate therapy for years that may be detrimental to the cat's long-term bone health (based on emerging reports of pathological fractures in some cats). It may not be enough to just monitor calcium and renal function status in IHC cats during treatment interventions. The measurement of calcium regulatory hormones (PTH, calcitonin, calcidiol, calcitriol, 24,25$(OH)_2$-vitamin D, FGF-23, Klotho) before and after treatment interventions will likely reveal important components for the pathophysiology of IHC in cats and may provide targets to be altered during therapy, and also information to ensure long-term safety. Our new recommendation is to include baseline long bone radiographs for all IHC cats being treated with oral bisphosphonates for more than one year, and then yearly thereafter to more readily detect early bone injury that may be developing. Long-term safety studies in cats treated with oral alendronate are needed.

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Feline Pain Management: Recognizing, Preventing, and Treating

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Pain recognition and treatment in cats has lagged behind that of dogs because of the challenge to recognize sings of pain and the concern for adverse effects of drugs. However, pain management is essential to patient welfare, successful case outcomes, and client satisfaction.[1] Fortunately, pain can be recognized by identifying changes in an individual cat's behavior, making owner history a critical factor in the recognition of non-surgical pain. Multi-modal pain management with multiple drugs often used at lower doses can relieve feline pain without the negative effects of medication. Advances in feline pain recognition

Recognizing pain through behavior

Clients recognize pain more accurately in their cat

Changes in an individual cat's behavior are the best method to identify pain in the cat,[1]Because the cat owner knows their cat and its normal behaviors better than anyone, it is important to include them as an integral part of the healthcare team when it comes to recognizing pain.[2] Changes can be either changes in normal behavior(s) or a start of a new, but abnormal behavior for an individual cat.[2,3,4,5,6]

Studies indicate that clients can often identify pain in their own pets more accurately than veterinarians can.[3,4,5] Unfortunately, they often consider the changes to be associated with "old age" rather than pain or illness.

Veterinary teams and pain recognition and assessment

A comprehensive approach to identifying pain includes every member of the healthcare team, in addition to the client. All team members should be educated to recognize pain, and client education for early pain recognition is critical as well. Changes in behavior and behavior problems are the most important signs (See Tables 1 and 2); although the signs may also be associated with other conditions, pain must be assessed when they are noted.

Body posture

Other signs include changes in body or facial posturing. The body may be hunched in pain. A common facial posturing in acute pain is squinted eyes.[8]

Mobility

Changes in movement may be the easiest signs to notice. However, most cat owners consider these to be normal aging changes instead of signs of degenerative joint disease. These include stiffness upon wakening, legs that tremble or shake, being "down" in hocks or carpi, or a decrease in overall mobility. A common sign seen is the cat who wants to jump but hesitates, standing in position as if it is readying itself to jump but is thinking about whether it is worth the discomfort or effort.

Pain scoring should occur in all patients.

There is now a validated acute pain scale for cats, and pictures and videos are available to go with that scale.[7,8] A score that is more readily usable is also available,[9] and Dr. Lascalles is developing a feline chronic pain scale.

Preventing pain

Handling feline patients to prevent pain

Because it is difficult to recognize pain, even before it is diagnosed it is important to handle each and every cat regardless of age as potentially having pain. Since anxiety can exacerbate pain, allow the cat to hide in the bottom half of the carrier or a cat bed brought from home. Use gentle and respectful handling techniques. Non-skid surfaces prevent slipping. Allow the cat to be where it wants to be, and as comfortable as possible throughout the examination.

Start the examination from a distance to assess body posture, stance, and gait. If possible, entice the cat to walk but do not force it to do so. Usually the best way to assess gait is at the end of the appointment by placing the cat at the opposite end of the room from the carrier and watching the cat go to its carrier.

Examination should start with the least painful parts of the examination, and obtaining heart and respiratory rates as well as blood pressure prior to joint palpation improves accuracy of these results. If pain is noted at any time before or during the physical examination, stop and give analgesia, and examine the non-painful areas and collect lab samples prior to further assessing the painful areas. Transmucosal or intramuscular buprenorphine is an excellent analgesic in this situation.

Weight optimization and prevention of dental disease

Preventive veterinary care can help prevent pain in the majority of our feline patients. Preventing dental disease, the most common condition seen in cats, prevents oral pain. Client education for home care and medical treatment to prevent dental disease is an excellent and cost-effective plan.

Obesity, the second most common condition in owned cats, exacerbate discomfort to joints. We know that weight optimization alone helps reduce pain in people and dogs with DJD,[9] and it is likely that this is true in cats as well.

Peri-operative and "peri-procedure" analgesia

Systemic and local analgesics, including opioids, local and topical analgesics are part of analgesic protocols in feline surgical and dental patients. There are also many procedures that deserve analgesia prior procedure, which include anal gland expression, manual extraction of stool, ear cleaning, and radiographs. A complete list can be found in the 2007 AAHA-AAFP Pain Management Guidelines.

Home environment

Many cats have degenerative joint disease, and other cats may have difficulty getting to favored locations because of other medical problems. Providing ramps or steps to get to favored places, placing food, water, and litter in easily accessible places will allow cats to continue to perform their normal behaviors.

Treating pain

Favorite feline drugs

Opioids are commonly used for prevention and management of acute pain, as well for flare-ups of chronic pain, and palliative care. They are often used pre-operatively in conjunction with other medications. Buprenorphine is commonly used in cats, and should be given either transmucosally, intramuscularly, or intravenously.[10]

Non-steroidal anti-inflammatory drugs (NSAIDs) are the mainstay for management of chronic pain. Many studies have indicated its chronic use in cats despite NSAIDs not being approved for long-term use in cats in the United States.

Local anesthetics should be used with surgical and dental procedures as one of the modalities to prevent pain.

Gabapentin is routinely used in people with neuropathic or maladaptive pain. The author routinely uses gabapentin in cats with diabetic neuropathy and amputations, and frequently for degenerative joint disease. Studies indicate that used with caution – examination, diagnostics, instructions to stop the medication if anorexia or vomiting, and regular follow-up – increased the comfort and activity of the feline patients. Its use in lower doses in cats with chronic kidney disease did not reduce lifespan.[11]

Degenerative joint disease

Degenerative joint disease (DJD) is a very common condition in cats that impacts quality of life and the relationship owners have with their cats. However, it is frequently unrecognized and under-diagnosed. In one random study of cats in different age groups, 91% of 100 cats had radiographic evidence of arthritis, occurring as early as 6 months of age, and with equal frequency in all age groups.[12] Signs appear to worsen with age.[13]

Patient history and owner awareness are critical steps to recognize DJD and to help assess response to treatment. Since changes in behavior are the most common sign, and owners know their cats better than anyone, owner input is integral to recognizing whether their cat is jumping as high, climbing steps as previously, or hesitates to jump. Since most cat owners think their cat is just "getting old", our task therefore is to educate owners that behavior changes, even subtle, can indicate pain or illness.

The signs of DJD pain in cats are subtle because of the cats' tendency to hide pain as a protective mechanism. Additionally, as opposed to the dog, most cats with DJD don't limp because the disease is bilaterally impacting the same joints.[13] Concurrent conditions occur frequently, and were found in 44% of cats affected with DJD in one study.[14] Cat owners think their cats are "just getting old", and the common signs that dogs have don't occur in cats.

Behavioral signs of pain are either loss of normal behaviors, development of new or different behaviors for that individual cat, or abnormal behaviors.[13] Decrease or loss of normal behaviors are the most concerning for owners, and include decreased mobility and a decline in grooming due to stiffness and pain. Toileting outside the litter box can occur because of the challenges to get to the box that is often in the basement, or hidden or raised so that a dog won't dine on its "tasty treats". Changes in behavior or abnormal behavior can occur with many other conditions, making it difficult to identify the underlying cause.

DJD includes joint degeneration of either synovial (appendicular) or cartilaginous (intervertebral disc) joints.[15] Feline DJ occurs in both the spine and the appendages. Spinal or axial DJD is more frequently found between thoracic vertebrae T7-T10, but the lumbar vertebrate are affected more severely. Axial DJD increases with age.[12] The more commonly affected appendicular joints are the hips, elbows, knees, and hocks. As opposed to axial JD, appendicular occurs equally through the ages.[12]

Although many cats have radiographic evidence on DJD, changes on radiographs do not equate with pain. Additionally, cats that have early DJD without obvious radiographic changes consistent with DJD can also be painful. This makes owner input even more important.

Changes in jumping, going up and down stairs, and hesitation to jump or climb are signs that owners should watch for in addition to all other behavior changes noted in Table 1. Letting owners know that purring is often used to comfort self, and can occur in painful cats.

The mainstay of DJD treatment in cats is NSAID's. Other medications are also used in cats. Environmental management is an important supportive measure, providing easy access to litter boxes, resting areas, and other favored spots.

Table 1. Changes in normal behaviors associated with pain

- Appetite
  - Decrease or increase
- Eliminations
  - Increase or decrease in volume
  - Changes in ability to get in and out of the box
- Grooming
  - Overgrooming in one or more areas
  - Not grooming +/- matting
- Sleep
  - Sleeping more
  - Sleeping less because cannot get comfortable (restless)
- Activity
  - Decrease or increase
- Vocalizing
  - Yowling during the night or at any time
  - Not meowing for treats or food as usual
  - Increase or decrease in purring -
  - Purring can occur in cats trying to comfort themselves \
- Play
  - Decreased
- Interactions with people or other pets
  - Intercat aggression
  - Human directed
  - Withdrawn or hiding
  - "Clingy"
  - More "cranky"

Table 2. Abnormal behaviors associated with pain

- House soiling
  - Urine and/or feces outside the litter box
  - May be over the litter box edge or in an area away from the box
- Irritable or cranky
- Aggression
  - Human directed
  - Directed toward another pet or pets

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Multi-Cat Household: Introducing a New Cat and Intercat Aggression

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Many cat owners think that the more cats, the merrier. Although many cats may be content together, cats routinely don't accept a newly adopted cat into the household, which results in many of the recently adopted cats being returned to shelters. Intercat aggression in cats that live in the same home is often subtle, but it commonly occurs leading to feline stress and behavior problems. The behavior problems often lead to surrender or euthanasia of a once beloved pet. Even if the cat remains in the home, a decline in the cat's physical and emotional welfare is likely.

Is ownership of multiple cats or introducing a new cat to the home a veterinary responsibility? We joined this profession to help animals, but we have been educated primarily to in the treatment of medical and surgical issues and behavioral concerns are a prominent issue to owners. Fortunately, animal welfare has recently been incorporated into our oaths, and all major veterinary organizations have developed welfare statements to help understand the needs of a species different from our own. Animal welfare means how an animal is coping with the conditions in which it lives. Welfare includes health, comfort, safety, and prevention from unpleasant states such as pain, fear, and distress. It also includes the ability for a species to express innate behaviors. Protecting an animal's welfare means providing for its physical, social, and emotional needs.

We must understand that species to be able to provide for its' welfare. Understanding the cat is essential to help clients make educated decisions about adoption and introduction of a new cat to a household, and as well as the essential needs of each cat in a multi-cat household to prevent stress and resolve many negative welfare issues.

Understanding the cat

Cats as solitary hunters

As solitary hunters of multiple small prey each day, cats have protective mechanisms to maintain their physical health and avoid danger. Cats do so by maintaining their familiar territory in which they have a sense control over their physical and social environment.[1] Having a sense of control - even if it is not exerted – reduces stress and increases a sense of safety.[2] It is only if there are sufficient resources that cats may choose to either be with other cats or not.

A change in the household such as the addition of a new cat or an existing cat becoming socially mature can lead to a lack of sense of control and increased fear. Some cats are so frightened that they refuse to pass or come near a "bully" cat, and may avoid litter boxes, eat rapidly, and do other abnormal behaviors because they don't have easy access to the resources they need. This often results in sickness or behavior problems. By understanding the cat's needs and educating clients about them, we can reduce feline stress.

To protect selves, cats possess heightened fear responses in response to fear.[3] If a suspected threat enters their territory (e.g., a new cat), they respond to the confrontation primarily by avoiding or hiding, with fighting occurring only as a last resort.[4] Fear responses are normal feline protective behaviors.

Cats as communicators

The primary goal of cat communication is to prevent altercations and active fighting with other cats over food and territory.[5] This is done primarily through scent marking of territory and posturing. Fighting only occurs when other means of communication have failed.

Olfactory communication

Olfactory communication plays an important role in social behavior. It enables hunting cats to communicate remotely by marking a territory as their own with a long-lasting signal.[3] The sebaceous glands located around the lips and chin deposit the cat's scent on objects, other cats, and/or people. The interdigital sebaceous glands leave olfactory signals through scratching, and the perianal area most commonly leaves the scent through spraying, but can also occur with urination and middening (fecal marking). Spraying is usually a normal olfactory communication among cats, although inter-cat conflict in the household can induce spraying.

Unfamiliar scents can frighten and arouse cats. Providing familiar scents such as that of a favorite person can help a cat adapt to new situations. The synthetic feline facial pheromone analog, Feliway®, mimics the natural pheromone that is deposited when a cat rubs its face on objects, and has been shown to provide a calming effect in unfamiliar or stressful environments or situations.[6,7,8] The new product, Feliway Multicat, is now available in the US only, and is supposed to be helpful for introducing a new cat and reducing intercat conflict in multicat households.

Vocal communication

Feline vocalizations are a medium-range communication, and can also protect cats without physical conflict. Most vocalizations bring cats together; the trill and meow are friendly greeting calls. Cats hiss, growl, or shriek as a threat to others to protect themselves and their territory when olfactory communication has not worked to keep cats at a long-range distance from others.

Visual communication

Cats communicate with a range of subtle body postures, facial expressions, and tail positions to diffuse tension and avoid physical contact with unfamiliar cats. Body postures help us identify a fearful cat from a short-range distance. Facial signals change more quickly than body postures, and provide more immediate indications of a cat's fear and aggression level.[5]

Tactile communication

Affiliate cats engage in tactile communication (see The Social Cat).

The social cat

Cats are social animals, but their social structure differs significantly from that of people and dogs. The feline social system is flexible, meaning that cats can live alone or in groups called colonies if there are sufficient resources.[9,10] Females, usually related, live in colonies and collaboratively rear and nurse kittens. Males often have a larger home range or territory and hunt solitarily.

Within the colony, cats will choose preferred associates or affiliates. These cats demonstrate affection towards each other by allorubbing (rubbing against each other) and allogrooming (grooming each other) to maintain the colony odor.[5] Allogrooming occurs preferably on the head and neck. Affiliates also engage in other behaviors that help us recognize that they like each other; these include nose-touching, and sleeping together or partially on top of another. Cats are more likely to allogroom a related cat rather than one that is not related.[9,11] Adopting an already socially bonded pair, such as siblings, is preferable to adopting cats from different social groupings. If it is not possible to adopt related cats, adult cats are more likely to accept kittens than mature cats.[11]

The sensitive period for socialization to humans and other animals is the time during which particular events will most likely have long-term effects on development[12]; for kittens, this is between 2 and 7 weeks of age (much earlier than it is for puppies, which is between 7-14 weeks of age). If kittens have positive experiences with other kittens and cats during this period, they are more likely to accept other cats later in life.

Colony members do not welcome unfamiliar cats into their colony, and usually show aggression toward these strangers. If these unfamiliar cats continue to come around the colony and become familiar, they may gradually be integrated into the colony. This gradual process of increasing familiarity should occur when we introduce a new kitten or cat into a household with already existing cat(s). Educate clients about cats needing to feel safe and with a sense of control in the environment, and that the cats may never become affiliates.

The territorial cat and needed resources

In the wild, cats reduce potential fights by dispersing or avoiding each other.[1] This is often not possible in the multi-cat household. Inter-cat conflict and behavior problems often occur because household cats don't have multiple resources in multiple places, and therefore cannot avoid the other cat(s).

Hiding is a coping behavior that cats may display in response to stimuli or changes in their environment. It is commonly seen in stressful situations and when cats want to avoid interactions with other cats or people.[13] In a study of 60 pairs of neutered, indoor-only cats, cats spent approximately 48-50% of their time out of each other's sight.[1]

Just because cats come together for feeding or to sleep on the same bed, it doesn't mean that they like each other or that stress isn't occurring in the feline household; in many households, cats come together because the primary resources are placed in one location. Cats are more likely to rest or sleep alone [5]; multiple comfortable resting areas should be provided.

Multiple resources with easy access, and out of view of other resources must occur. This includes hiding places and use of vertical space to allow cats to be apart if they so choose. Vertical space increases overall space and provides for the cat to oversee the environment. Litter boxes, food, and water stations that are placed in different locations so that individual cats don't need to see each other reduces competition for resources, bullying, and stress.[12] Serious consideration should be taken before adopting a new cat if cats already exist in the home. Clients should be educated to let cats choose their own affiliates, and be made aware that the greater number of cats in a household, the greater the chance of behavior problems.

Introducing a new cat

Most owners introduce cats by putting them together right away. Although some cats adapt quite readily, the majority have a more difficult time. How cats are introduced can make a tremendous difference in the stress of all the household cats, and making the new cat feel comfortable.

There are several different suggested methods for how to introduce a cat, but the most important principles are the following:

- The owner(s) must have patience and make introductions very gradually
- Increase familiarity
- Provide a sense of control
- Multiple resources, and each resource in multiple places
- Reward the positive
- If a problem occurs at any time, start over

The speaker's preferred method: Prior to bringing home the new cat, set up a separate room so that the new cat can have its own safe space with all resources. Add synthetic feline pheromone analog to all cat areas, including both the new cat's space and that of the other cats. Ensure that the rest of the home has all the resources needed and that each of these resources is found in multiple places.

Confine the new cat into the separate room so that the other cats can first become familiar with its scents and sounds. Spend quality time with the newcomer, but also with all the other cats. Provide safe hiding places for the new cat in its space so that it can hide if desired; this is an important coping strategy for a cat.

Once cats are comfortable with the scents and sounds – usually days to weeks – start to play and feed the most enticing food on each side of the door. Calm and curious behavior should be rewarded with special treats. Encourage them to paw at toys under the door.

Bedding or a towel with the scent can be swapped to see how the cats react. If things are going well, open the door a crack so that cats can see each other. This can easily be done with rubber door wedges on each side of the door or a hook and eye. It is important to remind clients that patience and time are our friends with introductions. Weeks to months can make a lifetime of difference.

Multi-cat households

There may be many social groupings in a multi-cat household; in fact, each cat may be its own social group. Many cats do not get along well in multiple cat households, but people often don't recognize the problem because the cats don't fight. The more obvious behavior problems or signs of stress-associated sickness are also often misinterpreted.

People also often misinterpret cats liking each other when they come together to eat or sleep; the behavior may also occur when the primary resources are all in one location. Many cats in multiple cat households learn to avoid, and even "time share", using same resting and other areas, but at different times. By understanding the cat's communications and body postures, we can recognize the subtle signs of the aggression. Providing multiple resources with easy access, and in multiple locations that are out of view of other resources, gives the cat choice and a sense of control. Resources include food, water, toileting, resting, and elevated areas. Vertical space increases overall space and allows the cat to monitor its environment. Litter boxes, food, and water stations that are placed in different locations so that individual cats don't need to see each other reduces competition for resources, bullying, and stress.[12]

Conclusion

Veterinary professionals who educate cat owners about the social nature of the cat and its need for sufficient resources and space reduce potential behavior problems and feline stress. Cats are fascinating and allowing them to be cats greatly enhances their quality of life and welfare.

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Understanding the Cat and Owner: Getting them Back into Your Practice

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Cats are the most popular pet in the United States and several other countries. However, many owners don't understand their healthcare needs, and veterinary practices often don't cater to what both owners and cats need. You can change that in your practice with steps that will demonstrate your knowledge of and compassion for cats and their people, and help your practice grow in one of the largest niches.

Understanding cat owners

Cat owners love their cats but they often don't understand them, their healthcare needs, or how to recognize when they are sick. The good news is that they want to do the best for their cats. As veterinary professions, we need to not only understand what is best for the cat, but also for cat owners, because it is both the behavior of the cat and the fallacies people have about them that lead to the lack of veterinary care. We must also understand the stress associated with the veterinary visit – for both them and the cat.

If we listen to clients, we can develop opportunities to resolve their concerns and transform them into aware clients who recognize the value of veterinary care. Bayer Veterinary Care Usage Studies have identified the following based on interviews of thousands of cat owners.

Here is what they say:

- My cat *hates* going to the vet: 58.2%
- Just thinking of taking my cat to the vet is stressful: 37.6%
- I don't take my cat to the vet except for shots: 40.9%
- I would take my cat to the vet if I knew I could *prevent problems and expensive treatment later:* 66%
- I would take my cat to the vet if I was convinced it would help my cat liver longer: 53%

This information provides us with opportunities to increase veterinary visits through client education and awareness. Carrier training and making the veterinary practice and patient handling less stressful will reduce that barrier to care. Educating cat owners about the value of preventive care and early detection are critical to increase their awareness and to make educated decisions about their pet's veterinary care.

Understanding the cat

We must understand the cat to understand respectful and successful handling techniques that prevent injury and stress for all involved.

Feline protective mechanisms

Cats are solitary hunters, who have retained many of the behaviors of their wild ancestors, Felis sylvestris lybica.[1,2] They must maintain their physical health and avoid danger, so that they are strong enough to hunt each and every day. They do so by maintaining their familiar territory in which they have a sense control over their environment.[3] Having a sense of control, even if it is not exerted, makes the cat more comfortable and reduces stress.[4]

Fear is a normal protective response in unfamiliar situations. As solitary hunters, cats must protect themselves to survive, and therefore possess a heightened fear response.[5] If a suspected threat enters their territory (e.g., a new cat), they respond to the confrontation by avoiding or hiding, with fighting occurring only as a last resort.[6]

Feline communication acts to prevent altercations and to avoid the risks of active fighting.[11] Fighting only occurs when other means of communication have failed. Cats use olfactory, visual, auditory, and tactile communication. Olfactory communication plays an important role in social behavior and marking of territory as their own with a long-lasting signal.[3] The sebaceous glands located around the lips and chin deposit the cat's scent by rubbing or marking on others or objects.

Cats communicate with a range of subtle body postures, facial expressions, and tail positions to diffuse tension and avoid physical contact with unfamiliar cats. Body postures help us identify a fearful cat from a medium-ranged distance. Facial signals, especially changes in pupils and ear position, change more rapidly than body postures and provide more immediate indications of a cat's fear and aggression level.[3,11]

The cat perceives staring (especially by an unfamiliar person) as a threat. As visual people, we may stand in front of and look directly at a cat and induce fear. Standing to the side and not directly looking at a cat that considers us unfamiliar or threatening will reduce fear. Additionally, blinking signals that the cat is seeking reassurance in a tense environment; we can help comfort the cat if we blink slowly or make "winky-eyes" in the direction of the cat. Cats are often calmer if they can hide, eliminating the visual cues

Tactile communication is common in affiliate cats (cats that like each other). Affiliative behavior includes allorubbing (rubbing against another); they will do this with people too to mark us with their scent in the veterinary practice. Massaging or petting on the head and neck from the side or behind is comparable to affiliative behavior. It is safer than scruffing in addition to reducing fear.

Using this information to make veterinary visits less stressful

We can alleviate many of the stressors of feline veterinary visits if we incorporate the information about who the cat is with what we need to do. This starts with making the carrier and other aspects of the veterinary visit familiar. Recognizing that scent is tremendously important in the cat's world, and using synthetic feline pheromones and eliminating strong scents that are offensive to the cat. Recognizing fear and handling cats to prevent fear and aggression is critical and will be covered in the next lecture.

Handling principles based on understanding the cat

1. Give the cat a sense of control
2. The fewer the handlers, the better.
3. Stay calm and speak in a soft voice.
4. Move slowly to obtain quicker results.
5. Do not stare at the cat, but rather look from the side or "wink".
6. Cats like the familiar – have owner bring what's familiar.
7. Cats prefer to be massaged or petted around the face – under the chin, in the cheek area, and between the ears – always try to do this instead of scruffing or "clipping", which don't allow the cat a sense of control.
8. Cats want places to hide (boxes, towels or blankets, tall-sided cat beds)
9. When cats feel more secure, they also like places to perch to oversee their environment (kitty condominiums, the top of a box, shelf, etc.
10. Punishment usually backfires – cats learn from rewarding desired behavior
11. Stand to the side instead of looming over the cat – we are big and scary! – when getting out of a carrier or cage.

Handling through an appointment

History

If the cat is not highly aroused when placed in the exam room, allow the cat a sense of control by obtaining the history with the carrier on the floor, and with the door open so that the cat can come out and inspect the environment on its own. It the cat is highly aroused, cover the carrier with a large towel – either one from home or one sprayed with feline pheromone analog spray – over the carrier to block the cat's vision of us.

If the owner indicates that they think the cat is painful or if you notice the cat acting painfully while collecting the history, a cursory exam can be done and then buprenorphine given to prevent pain during the rest of examination and sample collection.

Examination

Examine the cat where it chooses to be – on a lap, on the floor, a bench or in the bottom half of the carrier.

Many cats prefer to remain in the bottom half of the carrier for as much of the examination as possible. Some cats do well also on our lap or the lap of the client's as long as the cat is calm in their lap. When we sit on a stool near the client with the cat in our lap, we are now on the same physical level as the client (as most clients tend to sit on the chairs/benches in the exam rooms), which creates the sense of being an equal partner with the client in the care of their cat. This increases value and respect by the client for what we do and how we do it. When we are standing and the client is sitting, the height difference is huge, conveying different levels which can create a barrier to engaging the client. Also, without a physical barrier, such as an exam table between us, the communication is more open.

To prevent both fear and pain, it is best to take the cat out of the carrier only once; for example, the exam can be done in the bottom half of the carrier, ending with the weight. After weighing, collect lab samples if indicated. It is much less stressful for the feline patient if lab samples are collected in the examination room instead of the treatment area. Once a cat has acclimated to one room, the stress of moving to another alerts the cat once again to potential danger, increasing blood pressure and other parameters.

If the client brings in more than one cat for an examination, and the cats are not getting along well in the unfamiliar environment, or if one cat is very stressed, separate the cats into different examination rooms, and work with each individually. Discuss the potential problems and how to deal with them if the cats still don't get along well when they return home.

Lab sample collection

Collect samples with the least amount of people and minimal handling. Usually only one holder is needed. Speak softly or distract with food, treats, or toys. Allow the cat to remain in a natural position, and without stretching or holding legs tightly; this prevents both pain and fear. Have a blanket or something soft for them to lie on, preferably one that smells like home. Older, arthritic, and underweight cats are especially uncomfortable on cold and hard surfaces, and need thick padding or fleece underneath them. Gently wrapping the cat in a towel can increase security.

Senior cats and cats of any age with chronic kidney disease or hyperthyroidism should have blood pressures measurements taken. Blood pressure should be measured before other diagnostic tests, while keeping the patient as relaxed and calm as possible to avoid white coat hypertension. The environment should be quiet, away from other animals and generally have the owner present.[1] Measuring blood pressure is usually best conducted in the exam room, rather than in the treatment area, because it takes 5-10 minutes

for the cat to acclimate to a new room; obtaining the history and performing the examination prior to blood pressure measurement will take approximately that time, allowing the cat to adapt to the exam room.[1,2]

It is best to collect all lab samples in the examination room to prevent additional fear for the cat. Many clients prefer to watch blood pressure evaluation, venipuncture, and cystocentesis instead of worrying about what's happening to their cat "in the back". It is great client education and increases perception of value. If the client prefers not to watch, they can wait in the reception area while samples are collected in the exam room. When all procedures are completed, allow the cat to return to the carrier if it wishes to while the client is educated about necessary treatments and next veterinary visits.

The above applies as well if fine needle aspirates or samples for a dermatologic workup are taken. Pain relief should be given if these conditions are painful.

Analgesia and chemical restraint

Pain relief should be given to cats with painful conditions, regardless of whether that is what the cat presents for.

Chemical restraint may increase safety and reduce stress for the cat, client and veterinary team. It is always better to use restraint pre-emptively because, once the cat is agitated, chemical restraint is less effective or reliable.[6] Low-dose dexmedetomidine (which is reversible), combined with an opioid is an excellent option for sedation; if more sedation is needed, ketamine can be added.

Preventing anxiety at future visits

Alprazolam and gabapentin are both medications that are helpful to prevent anxiety at future veterinary visits. Gabapentin at 100mg per cat given 90 minutes prior to the veterinary visit is helpful in many cases where cats were still anxious or fear-aggressive with alprazolam.

Helpful resources

AAFP Cat Friendly Practice

AAFP and ISFM Feline-Friendly Handling Guidelines

CATalyst Council Handling Videos

The Best Place to Examine a Cat: http://www.youtube.com/watch?v=izUsUH5SRUM&feature=relmfu

Massage to calm an anxious cat: http://www.youtube.com/watch?v=6-IPmWTa_0o&feature=relmfu

Tips for handling a fearful cat: http://www.youtube.com/watch?v=dZDSoYyMs9Y&feature=channel&list=UL

Handling a Cat for Lab Sample Collection: http://www.youtube.com/watch?v=C8iAexzg710&feature=relmfu

Getting a cat out of a cage: http://www.youtube.com/watch?v=Xr5W91nFK4M&feature=relmfu

Cats and Carriers: Friends not Foes:http://www.youtube.com/watch?v=9RGY5oSKVfo&feature=channel&list=UL

Cat Clicker Training into Carrier with Dr. Jacqui Neilson and Bug:
http://www.youtube.com/watch?v=JRGKJ8FCH94&feature=channel&list=UL and
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Recognizing and Treating Feline Arthritis

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Arthritis, or more appropriately termed, degenerative joint disease (DJD) is a common cause of chronic feline pain. Although DJD has been recognized to occur commonly since the early 2000's, numerous journal articles have been written since then to help us recognize the signs of DJD pain and to assess treatment options.

The challenge to diagnose is that cat owners think their cat is just slowing down due to aging. Feline DJD is also difficult to diagnose in the veterinary practice because cats don't demonstrate the more obvious signs seen in dogs and gait assessment is usually challenging. Feline DJD is also untreated or inadequately treated in cats concern for adverse events from drugs and owner difficulty to administer medication. Feline DJD impacts the cat's quality of life and the relationship that owners have with their cats.

Is it arthritis or DJD?

Arthritis is inflammation of the joint and DJD consists of both inflammatory and non-inflammatory disease processes that lead to the degeneration or destruction of synovial (appendicular) or cartilaginous (intervertebral disc) joints.[1] It is osteo-productive leading to the development of osteophytes.

Incidence of DJD

Degenerative joint disease is a common cause of chronic pain in cats.[1,2,3,4] In one random study of cats in different age groups, 91% of 100 cats had radiographic evidence of DJD, occurring as early as 6 months of age, and with equal frequency in all age groups.[5] Signs appear to worsen with age.[4]

Concurrent conditions occur frequently, and were found in 44% of cats affected with DJD in one study.[6] Although concurrent disease is common in older cats, chronic kidney disease and DJD occur concurrently in all age groups.[6]

Where does DJD occur?

Feline DJ occurs in both the spine and the appendages. Spinal or axial DJD is more frequently found between thoracic vertebrae T7-T10, but the lumbar vertebrate are affected more severely. Axial DJD increases with age.[7]

The more commonly affected appendicular joints are the hips, elbows, knees, and hocks. As opposed to axial DJD, appendicular occurs equally through the ages.[7]

The challenge to diagnose

Feline DJD is difficult to detect because of the cat's tendency to hide pain as a protective mechanism. Cat owners think their cats are slowing down or "just getting old". Additionally, as opposed to the dog, most cats with DJD don't limp because the disease is bilaterally impacting the same joints.[8]

Although many cats have radiographic evidence on DJD, radiographic signs do not equate with pain. Additionally, cats that have early DJD without obvious radiographic changes consistent with DJD can be painful. This makes owner input even more important.

Changes in behavior are the most common signs of DJD, but they also occur with other physical pain, either acute or chronic, non-painful illness, as well as with emotional pain, such as stress.

Recognizing pain through behavior changes

The signs of DJD are often subtle changes in behavior. These signs are so subtle that they frequently are unrecognized both by owners and veterinary professionals. The signs can be either changes in normal behavior(s) or the start of a new, but abnormal behavior for an individual cat, which can include behavior problems such as house soiling or aggression (see Table 1).[1,2,3,5,9,11] A cat may present with one or multiple changes in behaviors.

Since changes in behavior are the most common signs of pain, the client is an important member of their cat's health care team because of their familiarity with their cat's behaviors and the ability to detect the earliest changes to those behaviors. Owner education is critical for them to recognize that even subtle changes are significant and to contact the veterinary practice if they notice deviations from their cat's normal behavior(s). However, signs of DJD are frequently only appreciated during the veterinary visit.

The team approach to diagnosing DJD

The history: Owner input is critical

Studies indicate that clients often recognize the pain of DJD in their own pets more accurately than veterinarians because they know their cat's normal behaviors and often recognize changes to the behaviors more readily.[1,2,5,9,10] Unfortunately, clients frequently think the changes are associated with "old age" rather than pain. Owner involvement is also important to recognize response to treatment of pain.[3,8] Interestingly, a study demonstrated that cat owners placed more importance on non-physical outcomes (60%) such as

grooming and comfort during resting, in contrast to the hypothesis that physical activity (mobility) would be more significant to owners.[5]

Changes in jumping, going up and down stairs, and hesitation to jump or climb are signs that owners should watch for in addition to all other behavior changes noted in Table 1. Letting owners know that purring is often used to comfort self, and can occur in painful cats.

History should include open-ended questions about changes in behavior.[12] For example: "What changes have you noted in Fluffy's behavior since the last visit?" A good second question is: "What else?" If the owner has not mentioned the cat's jumping and step climbing ability, these are good questions to follow with. Sometimes, the signs of DJD are so subtle that they may appear as a hesitation to jump up to or down from a favorite spot, or moving more slowly going up and down steps. House soiling can also be seen with DJD, either because the cat cannot jump over the high sides of the box or because they cannot climb the steps to the basement, the preferred litter box location for many owners.

Examination from a distance

While observing the cat prior to handling it, assess for stiffness and muscle atrophy over back and limbs. If the cat chooses to stay in the carrier, it is best to assess the gait at the end of the appointment, often following both examination and diagnostic testing. The easiest method is to place the cat on the floor on the opposite end of the room from the carrier because most cats will immediately head towards the carrier, providing the veterinarian the opportunity to assess the gait. If there is not enough space in the exam room or if the cat slinks while walking at the hospital, home videos are recommended, which are now readily obtained with use of smart phones or other equipment. Cats should not be walked in a hallway as one would a dog due to fear, probable freezing or fleeing, and possible fear-associated aggression if the fleeing cat is chased.

Comparison with previous examinations can be very helpful. In addition to medical records, many hospitals have the capability to add patient pictures to the veterinary software. Use of this technology provides the opportunity to monitor changes such as the previously well-fleshed cat that has become muscle wasted either due to lack of usage with DJD or another underlying problem.

Hands-on examination

A painful cat may be tense and resist examination in an attempt to protect self. Some cats that become aggressive with handling are painful cats. Gentle handling and providing analgesia will facilitate the exam and keep the patient as comfortable as possible.

Letting the cat remain in its preferred location and position, and tailor the order of examination, postponing the potentially painful areas until the end. Palpation of back and limbs should be performed to identify painful axial and appendicular DJD respectively. Spinal pain is most commonly located over the lumbar and lumbosacral regions. Palpation of thickening of the elbow or knee joints is not uncommon with DJD of these joints. Other signs are crepitus, effusion within the joint capsule, and decreased range of motion.

Handling DJD patients to prevent pain

Because it is difficult to recognize pain, even before it is diagnosed it is important to handle each and every cat regardless of age as potentially having arthritis. Additionally, soft bedding should be provided because hard surfaces can increase the pain of an arthritic cat. Non-skid surfaces prevent slipping. Allow the cat to be where it wants to be, and as comfortable as possible throughout the examination.

Start the examination from a distance as we do to identify respiratory distress. Most cats will not limp, but often one will see stiffness, a subtle change in their gait, and/or hesitancy with jumping. If possible, entice the cat to walk, jump, or at least stand or sit. If you suspect potential pain, a trial dose of buprenorphine is helpful to differentiate between pain and fear.

Examination should start with the least painful parts of the examination, and obtaining heart and respiratory rates as well as blood pressure prior to joint palpation improves accuracy of these results. Palpation and manipulation of joints can be performed gently to assess muscle condition, range of motion, +/- joint discomfort. Analgesia may be needed prior to assessment. Often joints will be thickened or have reduced range of motion. The patient often will tense of palpation of painful joints, but fearful patients are often tense throughout the examination.

There is potential for exacerbation of pain or further injury if cats with spinal pain, regardless of etiology, are held or picked up by the scruff, or other painful manipulations occur.

Many cats are uncomfortable due to DJD when legs are handled during examination or diagnostic testing. It is important that the cat be allowed to remain in positions it prefers, which are often more comfortable to them. Legs should not be stretched out tightly, but instead held in a comfortable position. Analgesia or anesthesia may be required prior to evaluation.

Treatment of feline DJD

DJD treatment includes the need for both medical and environmental modifications to allow the cat to perform its normal behaviors and maintain comfort.

Non-pharmacological treatment

The most important non-pharmacologic approach to treatment of feline DJD is modification of the home environment to allow easy access to favored places. Pet steps or ramps can provide easy access to preferred resting area for cats with DJD. Providing food, water, and litter in easily accessible areas where there is no competition for these resources improves feline welfare.

Pharmacologic treatment

NSAIDs are the mainstay of pharmacologic treatment for DJD in cats as well as other species.[3,13,,14] Meloxicam is the only NSAID approved for long-term use at this time. In Canada, Europe, and many other countries, meloxicam is approved for long-term use in cats at a dose of 0.05 mg/kg *q* 24 hr. It is not approved for long-term use in the United States US), and it is recommended that owners sign a waiver when prescribed for long-term in the US. Dosing should be by lean body weight. Owners should be warned to stop medication and call the veterinary practice if the cat is not eating, is vomiting, or any other changes. The patient should be reassessed for comfort as well as for diagnostic monitoring. The author does taper meloxicam to every other or every third day when possible.

Although veterinarians are often concerned about NSAID use in cats with concurrent chronic kidney disease (CKD), some studies have indicated safety at lower doses in cats with stable CKD. One study indicated safety with 0.01–0.03 mg/kg *q* 24 hr).[14]

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Implementing Feline Preventative Healthcare Guidelines

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Feline preventive care for all life stages can improve quality and length of life. In fact, cats are living longer lives, with many living into their teens or twenties.[1] However, many cats receive little to no veterinary care, and others receive only certain segments of care. Also, with many cats being surrendered or euthanized for behavior problems, we must also address the behavioral welfare of our feline patients. Even though preventive care guidelines have been developed by the AAFP, AAHA, and AVMA, what is the evidence for those recommendations? Addressing all of these concerns is critical to providing a successful preventive care plan for your feline patients from first appointments through end-of-life.

The sad reality and turning it around

We provide excellent care for only a subset of pet cats. The sad reality is that millions of pet cats receive little or no veterinary care, and suffer significant levels of unrecognized pain and illness.[2,3] Many cats are bored or stressed due in inadequate feline environments and stressful social situations.[4,5] Add to that the relinquishment and euthanasia each year of millions of cats that were once beloved companions because of undesirable or abnormal behaviors.[6,7] Despite the cat being the most popular pet in the United States and other countries, many receive inadequate care and suffer due to pain, sickness, and lack of understanding of their needs.

The good news is that most of the problems facing the domestic cat can be prevented or addressed if we understand cats and cat owners. We as veterinarians have a unique opportunity to improve the cat's physical and emotional health and the relationship between them and their people.

The benefits of preventive healthcare for cats

Health screening incorporated into veterinary practices provides for prevention, early detection, and client education. The plan is based on examination and individualized prevention and diagnostic testing for feline patients. Individualized preventive care is best planned by life stage and lifestyle, and by breed when appropriate. Diagnostic testing for early disease and monitoring of an individual's health trends improves longevity and quality of life. Educating clients about early signs and including them as important members of their cat's healthcare team is critical to recognize subtle changes and contact the veterinary practice early on.

The following list can help your clients understand the benefits of preventive healthcare for their cats.[8]

- Cats need preventive care because they have subtle signs pain and illness, which is a protective mechanism derived from predator avoidance in the wild.
- Improved quality of life and longevity
- Early disease detection, when easiest to treat or manage
- Pain prevention and early detection to prevent suffering
- Reduced expenses associated with urgent and sick care
- Development of baseline of the individual cat's "normals" for comparison when cats become ill
    - Weight, body and muscle condition scores -
    - Pain assessment
    - Diagnostic testing
- Increased trust and client bond with the practice
- Increase client-pet bond
- Prevent or decrease behavior problems and undesirable behaviors
- Decrease relinquishment and euthanasia of pet cats
- Increased health of owners because living with a pet cat is known to improve human health
- Opportunity for client education about their pet cat's needs and listen to owner concerns

A website and social media campaign can help owners understand the keys to recognizing pain and illness, the importance of preventive care, and how to prevent and address behavior problems. One important step is to help owners understand that cats mask signs of illness as a protective mechanism. If cats are only presented when ill, disease is advanced and much more difficult to treat and also more costly. Owners of indoor cats must be made aware that their cats need regular veterinary care too, because indoor cats commonly suffer from stress, obesity, and chronic conditions or health concerns based on their life stage, genetics, and lifestyle. Comparing cat health to human health can increase client awareness of cat's needs.

Studies indicate that many veterinarians and other veterinary professionals think we are doing much better with preventive care than we truly are.[9] Measuring successes and areas which need improvement are essential to further supporting feline patients.[9]

Caring for cats from birth to end of life

An "every consultation is a behavior consultation" approach

Asking cat owners at each and every visit whether they have any concerns about behavior or have noted any behavior changes can help detect both physical and emotional health concerns. Ruling out medical problems and addressing the home environment helps prevent and treat many behavior problems.

Reminding owners at the end of each appointment to contact us if behavior changes or concerns helps prevent surrender or euthanasia due to behavior problems, and allows for earlier intervention and correction of these problems.

These communications will also increase owner awareness that we can help with behavior problems, and greatly increase the value of our services in the clients' minds. Preventing and treating behavior problems is the glue that helps keep the pet cat with loving families.

Life stage care

A healthcare checklist used by the entire veterinary team for preventive care appointments can help ensure that all care is provided for each cat depending on life stage and lifestyle (See Table 1). This table has been slightly revised from those available through AAFP/ISFM and AAHA/AVMA Guidelines for preventive care. Genetic diseases should also be taken into considerations for purebred cats. For example, assessing for hypertrophic cardiomyopathy in Maine Coone and Ragdoll cats. Prevalence studies of different medical conditions such as degenerative joint disease, diabetes mellitus, and chronic kidney disease are being done to validate guidelines and information will be provided.

Table 1. Healthy Checklist for All Life Stages

Comprehensive exam: All cats of all ages

- Every 6 months helps to detect problems especially in cats, a species that has only subtle signs of disease.
- Cats with chronic conditions should be evaluated every 6 months. These include older cat diseases such as chronic kidney disease, hyperthyroid disease, diabetes mellitus, and degenerative joint disease.
- Cats that are overweight or obese or whose environment changes frequently should be seen more frequently.

History

Two essential questions are:

- "What changes in behavior have you noticed since the last visit/recently?" The importance of this question is based upon changes in behavior being the signs of feline sickness, illness, or stress.
- "What concerns do you have?" This allows us to listen to and address client concerns which may otherwise not be addressed.

Additional questions:

- Other pets in the household
- Diet(s) provided, amounts eaten, treats, is the cat fed with other pets
- Medications including parasite prevention – dose, frequency and when it was last given, are refills needed
- Dental care
- Behavioral concerns

Diagnostic panel

- If kittens have not been spayed or neutered, pre-anesthetic testing should occur prior to procedures.
- Adult cats between 2-7 years of age to have CBC, Chem 6, and urinalysis annually
- Senior cats, 7 and older, to have CBC, Chemistry profile with electrolytes, T4, BP, and urinalysis once yearly from 7-10, and then every 6 month
- CBC and UA to always include cytology
-

Fecal

- Kittens need at least 2 fecal floatations, and if positive for parasites, additional fecal testing may be indicated
- Adults and senior cats need anal fecal floatations unless they go outdoors.
- Outdoor cats need fecal floatations every 6 months.
- If cats have vomiting or diarrhea, additional fecal floatations and other testing should occur.

Feline Leukemia test

- All kittens should be tested for FeLV upon adoption if not done previously. Even if kittens have been tested previously, but have been exposed to other cats and kittens, repeat testing should occur at adoption.
- If an adult or senior cat is adopted with unknown status or if exposed to other animals since testing, FIV testing should be repeated.
- Due to the long incubation period of this virus, retesting should occur a minimum of 30 days after the first test. If there is no other cat in the household, and the kitten is healthy, FeLV testing can be done at 60 days along with FIV testing.
- Cats that spend time outdoors without strict observation should be tested annually when the FeLV vaccine is repeated.
- If living with an FeLV-positive cat or in an environment where the FeLV status is unknown, FeLV testing should occur annually.
- Sick cats should be tested for FeLV/and FIV.

Feline Immunodeficiency virus test

- All kittens should be tested for FIV upon adoption if not done previously. If an adult or senior cat is adopted with unknown status or if exposed to other animals since testing, FIV testing should be repeated.
- Due to the long incubation period of this virus, retesting should occur a minimum of 60 days after the first test for newly adopted kittens and cats.
- FIV testing should be repeated in fighting cats and in cats living with other FIV-positive cats. Testing should occur at the time of a fight and then 60 days later, or annually if in the same household with FIV-positive cats.

FIV testing should be performed if diseases associated potentially associated with FIV are present, such as severe gingivitis unrelated to periodontal disease.

Parasite prevention

- Prevention of heartworm, hooks, roundworms and fleas for all cats year round.
- Tick preventive for cats that go outdoors year round.
- Tapeworm treatment given monthly for cats that catch rodents (or treatment if have fleas)

Vaccinations

FVRCP

- All cats should receive FVRCP vaccinations.
- Kittens need FCRCP vaccination every 3-4 weeks until 16-20 weeks of age. If an intranasal vaccination is used, the first panleukopenia vaccination should be injectable.
- Repeat FVRCP vaccination one year after the last kitten vaccination, and thereafter every 3 years.

Rabies

- Kittens should receive the first vaccination at 12 weeks or older
- Repeat vaccination one year later
- Vaccinate every 1-3 years as mandated by the vaccination used.

Feline leukemia virus vaccination

- All kittens should receive FeLV vaccinations, starting as early as 8 weeks, and with a booster given 3-4 weeks later. This is because kittens are most susceptible and also owners often decide to get another cat and introduce it right away.
- Cats that go outdoors without supervision, live in a home with an FeLV+ cat, or cats with unknown FeLV status should receive FeLV vaccines.
- AAFP and ABCD Vaccine Guidelines recommend booster vaccinations every 2-3 years for cats over 3-4 years of age because of the lower risk in cats of this age.

Dental care

- Educate about teeth brushing and other dental preventive care at first appointments. Follow up on how going by phone and at 2nd appointments.
- Professional dental treatment annually or as frequently as needed. Must occur starting at stage 1 or prophylactically.
- Oral cavity assessment at each appointment.

Diet recommendation

- Start kittens on canned food at least as a portion of their diet.
- Nutritional recommendations based on life stage, energy expenditure, and health.
- Obesity prevention needs to start after neutering, and is highly important in adult cats.
- Client education to include diet, calculated calories, and how to feed cats because cats are solitary hunters, and not pack animals (not social eaters)

Microchip

- All cats should be microchipped.
- Scan at each preventive care appointment to ensure that functioning and has not migrated.

Pet insurance and preventive care plans

- Many owners are more willing to provide more extensive care without worrying about expenses when they have pet insurance for their cat.
- Some veterinary hospitals have preventive care plans which promote prevention and additional visits whenever the owner has a concern.

Always schedule the next visit or visits before the client leaves

- Vaccination series
- Professional dental treatment
- Medical progress examinations
- Chronic condition exam
- Semi-annual exam

Conclusion

Preventive care improves and extends quality of life for feline patients. Incorporating preventive care for all life stages prevents or detects common conditions of those life stages.

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My Cat's Got the Litter Box Blues

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House soiling, previously called 'inappropriate elimination' is the most common cause of surrender and subsequent euthanasia of pet cats.[1,2,3] The term 'inappropriate elimination' insinuates that the cat is doing something wrong, which is what most owners believe. Behavior problems, the most challenging being house soiling, are common causes of surrender or euthanasia and the most common cause of death in adult cats.[4]

House soiling means that the cat is urinating or defecating outside of the box, without any judgment of the cat. Although house soiling is often a frustrating condition for veterinarians, thinking of it as any other medical problem will facilitate diagnosis and treatment. Causes of house soiling can be divided into an underlying medical problem, feline stress, marking, or litter box issues. Primary veterinarians can resolve most of the problems using a diagnostic plan similar to what is done for any medical problem. Not only does diagnosis and treatment of house soiling keeps cats in homes, improving their welfare and the relationship with the human family, but it also enhances the owner's relationship with you and the veterinary practice. Adding prevention and treatment of house soiling problems to your services can greatly improve the welfare of feline pets.

Setting the stage for the client

Many clients don't see the need for diagnostics because their cat appears healthy. The owner often thinks the cat is acting out of spite especially if owners have been gone, not spending as much time with the cat, or have moved. In one study, 65.8% of the cat owners relinquishing a cat thought that their cat eliminated outside the litter box to spite them.[1] It is often necessary to help cat owners understand that cats do not act out of spite but rather because the cat's physical, social, or medical needs are not being met.[5] Often much human guilt is associated with behavior problems, but helping them understand that despite their love, it is difficult to care for a species different from our own. Fortunately, understanding the cat and its needs can help to resolve or at least greatly reduce the problem.

History

As with any medical problem, the history is of primary importance. In fact, identifying medical problems is the first step. Even if household stress is a cause, there can also be a concurrent medical problem leading to the house soiling.

Let the owner know that their history is a most important step to diagnosis and resolving the problem. Asking open-ended questions followed by more specific questions will yield a comprehensive history. Most people will talk about a vacation, a move, or addition of another pet when the problem started, thus their impression that spite is the cause. For us, the knowledge that something changed in the cat's life, and in a species that likes a sense of control and predictability in their environment and is often fearful of change, are important clues.

Important questions are when the problem first started, how frequently it happens, and what is different now from when the problem first started. Often owners will note that the cat first eliminated outside the box years ago, but it only happened once or twice. Often the cat has house-soiled in more than one home.

The problem may be related to another pet or person in the home, so it is important to ask about family members and all pets, as well as visitors. For example, in one case, the cat only urinated outside the box when the daughter came home from college with her 2 large dogs. Cats that are not bonded are a common cause of stress and house soiling.

Ask about litter boxes, their size, shape, placement, and whether they are covered or uncovered. Many cat owners recognize that they need multiple litter boxes, but often put them in the same location, usually the basement. If a cat cannot reach the box, is another cat is blocking the path or a dog is eating tasty treats from the litter box, or is the cat unable to make it downstairs anymore because of degenerative joint disease or another medical problem?

Asking owners to provide a simplified floor plan with location of litter boxes as well as other resources (e.g., resting areas, food, and water) can help identify problems that might not be recognized otherwise. This can occur at the first appointment but often is done as a component of a behavior consultation once medical problems have been ruled out. Pictures of litter boxes and videos of the cat using the box or an alternate location are also helpful.

People often are attracted to litters that will mask the scent of urine and feces, but the scent may be offensive to the cat. The owner may prefer crystal or pine or another substrate, but what is important is what substrate the cat prefers.

Cats are fastidious animals, but many owners don't scoop litter boxes daily, and boxes may not be cleaned completely for many months or longer.

Other history is also important, including the cat's ability to jump and climb, vomiting, appetite, and interactions with others in the household.

Physical examination, differential diagnosis, and diagnostics

A comprehensive examination will identify changes in weight, assess body and muscle condition scores, and include an orthopedic evaluation. With an increase in older cats due to advances in medical and home care, many of our patients have degenerative joint disease or other causes of difficult mobility (e.g., hypokalemia or other causes of weakness). Hyperthyroidism is a common cause of fecal soiling, but may lead to urine soiling as well. Any urinary tract or gastrointestinal disease may lead to house soiling.

Diagnostic testing should always include a urinalysis, complete blood count, and chemistry profile for urine soiling. In addition to these tests, fecal tests should be done for cats that are house soiling. Thyroid testing should be performed in cats 7 years and older, or if they have other signs consistent with thyroid disease.

Radiographs and abdominal ultrasound are also needed in many cases if obvious answers are not found with baseline testing.

Medical etiology

Treatment of specific medical conditions should occur in conjunction with making litter boxes easily accessible and more appealing to cats, in addition to providing them space where they don't need to interact with other animals to reach the boxes. Even if the medical problem is the primary cause, the cat may have found a preferable area to eliminate while ill, and this must be addressed as well.

Feline idiopathic cystitis

There is a strong link between feline stress and the chronic pain syndrome, feline idiopathic cystitis (FIC).[6,7,8] Also called feline interstitial cystitis, it is the most common cause of feline lower urinary tract disease, with 54-64% of cats presenting with lower urinary tract signs having idiopathic disease.[9] FIC was initially considered a disease of the bladder alone, but it is now recognized that the response is activated in the brain by the hypothalamic stress response system.[7]

Stressors include unfamiliar environments and individuals, and a lack of predictability and sense of control, either in the home or the veterinary practice. For example, a hospitalized cat may have a perception of poor predictability and a lack of sense of control if there are inconsistencies in caretakers, feeding and cleaning routines or periods of light and dark.[7]

A significant decrease in the frequency of FIC signs has been seen with environmental enrichment, familiarity, and a sense of control.[6,9] Based on this information, veterinarians can help cat owners recognize environmental stressors and how to improve the environment and sense of control for the cat.

Marking behavior

Marking behavior is common in unneutered cats, but may also occur in neutered cats. Marking is an important means of feline communication, and includes urine marking (spraying), fecal marking (middening), rub or cheek marking, and scratch marking. Cats communicate through scent marking and body posturing is used to avoid conflict and protect self. Marking in neutered cats usually indicates a stressful environment.[10] Providing a safe environment with place to hide, and easy and safe access to litter boxes without needing to see another cat and feline synthetic pheromone analog diffusers are important to reduce stress. Medication may also be needed temporarily to resolve the problem.

Environmental problems

Litter boxes

Most commercial litter boxes are too small for cats, since cats need to be able to turn around and scratch. Preferable are large storage containers and dog litter boxes. An opening can be cut out of the front of a high-sided plastic container to allow easier access for cats having difficulty jumping over the edge. High sides are needed for cats that are "high risers" or spray in the litter box.

Location, location, location

What may be more important that the number of boxes is the location of the litter boxes. Most people keep litter boxes in the basement and all right next to each other. They think they have 3 boxes, but the cat sees only one box if they are all in the same location. Having at least one litter box on each floor is also needed, especially for cats that have more difficulty going up and down the stairs.

Multiple litter boxes to a cat means that they need to be in different locations, and out of view of other litter boxes. If a cat is fearful of something blocking its pathway –such as another cat it doesn't like staring at him or her from the staircase or hallway to the litter boxes - the cat is likely to find a safer place to eliminate.

Cats are not the only ones who may block access to a box. If there is also a dog in the home, try to place litter boxes in places that are still easy access for the cat but difficult for the dog to get to. Children may also accidentally frighten a cat, and if a person tries to medicate or do something else to a cat while it is in the box, they will also not want to use the box. Fortunately, with boxes n different locations, the cat can choose which path to take and remain safe.

The fastidious feline

Cats are extremely clean animals, and they do not want to eliminate in dirty boxes. Litter boxes should be scooped at least once daily. They also need to be cleaned out at least once weekly with non-scoopable litter and every 2-4 weeks with scoopable litter. Before

replacing litter, use mild detergent or just hot water to clean the box. Having additional boxes allows one to rotate in a new box while one is being cleaned and dried.

Diabetic cats and those on subcutaneous fluids will need more frequent scooping and cleaning, as will cats with diarrhea.

Litter types

The pet stores have numerous types of litters marketed for humans. Many contain deodorizers, and may be made of pebbles, crystals, pine, corn, or paper. In the wild, cats use sand or dirt, and most cats prefer unscented sand litter.

Cleaning areas of house soiling

Many enzyme breakdown products are available on the market, but efficacy is not all the same. Anti-Icky Poo and Urine Off are excellent products to eliminate the smell of urine outside the box so that cats are not attracted back to that area.

Preventing house soiling

It is always easier to prevent house soiling than to treat it. Unfortunately, assumptions are often made that owners know how to purchase litter boxes and litter, and where to put the boxes. Nothing can be further from the truth. Providing cat owners with information on litter box size, types of litter, frequency of box cleaning and how to clean the box will help prevent problems. Educating owners to contact the veterinarian even if the cat misses the box just once will help them recognize that we know how to deal with behavior as well as medical problems.

Conclusion

Behavior problems, and especially house soiling, are a major concern to owners. With interest in helping owners resolve these problems, we become better veterinarians and better advocates for feline patients.

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Housing Cats at your Practice: Preventing Problems for Staff and Cats

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Most cats will need to be hospitalized at some point in their life, but the stressors of being in an unfamiliar environment and away from their people can negatively impact their welfare and recovery. We want a hygienic environment and the ability to check patients regularly; many cats however want a stable and quiet environment where they are not bothered, and just want to go back home. Our goal is to bring them back to health, but when the environment is stressful, cats may not eat. Add the stress of the cat owner into the picture, and we have a lot to address. Fortunately, understanding the stressors and when it is best for the cat to remain in the home environment makes all the difference in improving patient care.

Challenges associated with caging cats

The challenges to housing cats in a veterinary practice are the same as seen in shelters and boarding facilities. We are working with a patient who has strong fear responses associated with lack of familiarity and predictability, and their needs not being met. [1,2,3] Cats are social animals, and when they are separated from their owners for hospitalization or boarding, the disruption of the social bond also leads to the cat's stress.[4,5,6] Ensuring provision of familiar bedding, toys, and food is helpful, and cats often do better if owners have regular visiting privileges when their cat needs hospitalization.

The unfamiliar smells, sounds, sites, and handling also lead to stress. Stress is also caused with an inconsistent schedule. The cat may acclimate, but often it will take from 2 days up to 5 weeks for acclimation to an unfamiliar environment.[7,8,9] Stress is a serious factor in the return to health of the feline patient. There is increased risk of a break in upper respiratory infections[10] and stress-associated medical conditions such as feline idiopathic cystitis (FIC) can occur in hospitalized or even previously healthy boarding cats.[3,11] Lab abnormalities can also occur secondary to stress, making diagnosis and followup difficult.[12]

Recognizing stress in hospitalized cats

How can we tell if stress is occurring in a hospitalized cat? The difficulty is that the signs of stress associated with lack of familiarity and reduced sense of control during caging are usually inhibited normal behaviors rather than more overt abnormal behaviors.[1,2] They include decreased activity, appetite, eliminations, grooming, play, and sleep, and the problem is even more complicated because these signs can also be seen in sick cats.[1,2,7] Cats that demonstrate these more subtle signs of fear and stress may suffer more than cats that demonstrate blatant signs of upset.[2] Although inhibited behaviors are more common, some caged cats may become vigilant, watching every movement that occurs around them, and be alert to every sound. These cats cannot rest, because they must monitor the unfamiliar environment to protect themselves. It is also important to recognize that caged cats may become fearfully aggressive as a protective mechanism and to take them out of the cage within their carrier or cat bed.

The old adage of waiting until a hospitalized patient starts eating before sending them home should not be followed for cats. If all other signs are good, let the owner know why you are sending the cat home, and that they must contact the practice and bring the cat back if the cat does not start eating at home. Another excellent option is to let them take the cat home for the night, with a recheck appointment scheduled for the next morning.

Setting up hospital and boarding wards for success

Cat-only wards that prevent visibility of dogs and other species is important to reduce feline fear. Cats also become fearful if they see unfamiliar cats or those that they do not like. Back-to-back or side-by-side cages help prevent visibility of other caged cats.

Cats may also have increased stress if they observe other cats being examined.[13] If examination must occur in the ward, place a towel over half of the cage door so that the cat choose to see what is going on or not.

Regardless of the length of stay - a few hours to several days or even weeks – the cat must be provided with its essential needs, which include resting or hiding place, perch, litter box, food, water, and play.[6] Cats that like attention should also receive human attention. Both the size and complexity of the cage are important to meeting the needs of the caged cat.[6] Cages can be enlarged by adding vertical space or combining 2 smaller cages. Cages should be warm, non-slippery, and without the cat seeing its reflection, and laminate cages are preferred over stainless steel.If only stainless steel cages are available, tall cat beds and toweling should be used in the cage.

Getting the cat out of the cage

Removing a cat from a cage is one of the most threatening experiences for the cat, with increased potential injury for veterinary team members. Therefore, it is important to approach the cage from the side and not make eye contact with the cat. Calmly open the door and allow the cat to come towards you. If the cat chooses not too, remove the cat within the bedding or other hiding area the cat is in.

Cage cleaning

The old rules of cleaning the cage completely once or twice are no longer the best way. Cats mark their territory with facial pheromones, which makes them more comfortable in the environment, and it is important to avoid cleaning these marked areas until the patient or boarding cat goes home. It is best for the cat to remain in the cage for the duration unless it is soiled to the point that it cannot be cleaned without moving the cat to another cage. The preferred method is to spot clean the cage if it is not soiled.[14,15] Spot clean or clean around the cage with minimal disruption of the patient. Do not spray areas clean, but wipe them. Avoid wiping areas that are not soiled. Additionally, the towels or blankets in the cage should not be changed unless soiled, because doing so takes away the familiar scents and introduces unfamiliar scents. The same goes for litter boxes: Try to keep the same litter box with the cat during the cat's stay, scooping two or more times daily, but not washing out unless necessary. Instructions for spot cleaning are given in

Boarding cats in the veterinary practice

Many veterinary practices board cats or at least to provide medical boarding for those that need medication while owners are away from home. Some cats do better with cat sitters coming into the home environment, but many owners prefer to board their cats. Cats that are boarded for several days or longer need larger spaces. "Kitty condos" are excellent options for boarding cats. If these are unavailable, providing out of cage time in a safe place and during quiet times can be helpful for those cats that feel safe doing so.

When cats from multicat households are boarded, they should be placed together only if they show affiliative (bonded) behaviors, such as licking or grooming or sleeping while touching. Even if bonded, they need their own cat beds since even bonded cats like to spend at least 50% of the time by themselves.[16] It is also important to assess multicat interactions because those cats that are socially incompatible with their housemates may be able to manage the social tension between them when they have a whole house to occupy, but they may find being confined in a small boarding cage for 1 week or more highly stressful. Owners often want their cats to be housed together, but the decision has to be made with the best interests of the cats in mind, and, in some cases, being separated from each other is preferable from a feline perspective.

Decreasing owner stress

It is well recognized that owners are concerned about leaving their cat at a veterinary practice or an emergency facility. Offering to let them see where their cat will stay and how the cage is set up can relieve some of this stress, and allowing visiting privileges increases their comfort and the value of the experience. Letting owners know that their cat will be most comfortable with familiar bedding, toys, treats, etc. allows them to help as part of the team for their cat's care.

Clients are anxious for updates, and sending e-mails, pictures, and setting up times to call will help reduce staff and client stress.

Conclusion

Because of the challenges of hospitalization for feline patients and their owners, it is advisable to minimize hospitalization and to admit cats into veterinary practices only when absolutely necessary. When the cat must be hospitalized, it is important to provide an environment that respects natural feline behavior and aims to meet the behavioral needs of feline patients. Simple steps based on an understanding of the cat's needs can be taken to help reduce the stress of hospitalization or boarding, which not only benefits the welfare of the cat but also improves the practice's ability to treat and evaluate the cat and will result in an increase in safety and job satisfaction among staff members.

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The Cat Friendly Practice: A Win-Win for You, Cats, and Clients

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The Cat Friendly Practice Program (CFP) was developed to help veterinarians provide the best of health care, regardless of whether the practice is companion animal, feline only, or a mixed animal practice. CFP was launched by the American Association of Feline Practitioners in early 2012 and has grown rapidly with the primary goal being increased feline veterinary visits to increase health and welfare. Although the cat is the most popular pet in the US, millions of pet cats receive little to no needed veterinary care, and suffer unrecognized pain and illness.[1,2]

With the popularity of the cat as well as advances in feline health care, one would expect cats to have increased veterinary care. However, there has been a decline in patient visits since 2001. Active and new client numbers are down significantly in most practices, as are the number of patients seen weekly at most veterinary practices.[2] And the numbers continue to decline despite major efforts by all major veterinary organizations that see cats – AAFP, AAHA, and AVMA. Comparing 2011 to 2006, the number of cat-owning households that did not take their cat to the veterinarian increased by a staggering 24%.[3] Correlating with the decline in visits is a significant increase in cats with preventable diseases, including a 10% increase in dental disease, 13% increase in internal parasites, and 16% increase in diabetes mellitus.[4]

There are 2 major reasons the lack of veterinary care - the stress associated with getting the cat to the veterinary practice and owners not recognizing the value of preventive care. Veterinary organizations started recommending that cats be kept indoors around 2001 to improve their safety and longevity as well as to protect wildlife, and feline visits started their decline at that time. Owners erroneously think that indoor cats don't need care; of course, nothing is further from the truth and we must increase their awareness of medical conditions that occur in cats. The stress to a cat that is always in their home is also more significant than the cat exposed outdoor life. At the heart of the Cat Friendly Practice is the potential for building productive relationships with cat owners, which will result in improved care of the feline patient.

Participating practices that have become cat friendly have noticed a considerable difference, with increased feline visits and client value, decreased patient fear and owner stress, and a subsequent increase in income. When a practice takes the steps to become a Cat Friendly Practice, it creates a practice environment that values the feline patient's needs.

The first steps are to better understand the stress surrounding veterinary visits. With this information, we can recognize how to improve the hospital environment, the experience of getting the cat to the practice, and how the cat is handled in our hospitals. Becoming a Cat Friendly Practice can help turn around these problems and increase feline patients in your practice.

First impressions

Walk into your practice or the practice you work at with the mindset of a cat owner who loves their cat and is stressed about the experience. Do you see primarily dog pictures and brochures, and dogs in the waiting area? Think about what that loving cat owner feels when he or she walks in.

Regardless of practice type, let your clients know that you cater to cats with equal information about cats on your website, blogs, and Facebook. If you are "cat friendly", promote that. CFP practices are provided with large amounts of information for staff and client education, and this information can be freely used by CFP member practices to educate clients and promote their services.

It starts at home

When scheduling the first appointment, ask clients if they have a carrier, and if they have difficulties getting their cat into the carrier. Provide information to help them make the visit less stressful for their cat and them. If they don't already have a carrier, provide recommendations.

Choice of carrier

Hard sided carriers that can be taken apart in the middle are preferred. The cat can then remain in the bottom half of the carrier if it doesn't want to come out at the veterinary hospital. Even better is to have a hard sided carrier that has the option to open from both the top as well as the front. If the cat won't go into the carrier on its own, the cat can then be lowered gently through the top instead of shoved through the front opening.

Some clients prefer soft-sided carriers, either because they are lighter to carry or more comfortable for the cat. If used, care must be taken to prevent the carrier from collapsing or being pushed in on the cat. Also, the cat may be jostled more in a soft carrier, and increased care to keep the carrier steady is important by carrying gingerly. The biggest issue is getting the cat out of this type of carrier if it chooses to remain inside. Looming over the carrier or pulling the cat out often increases feline fear and potential fear-associated aggression. If a client prefers a soft-sided carrier, recommend one that has 3 openings, with a large opening that comes down in a U-shape in the middle.

Training the cat to the carrier

The first step in using carriers is to make the carrier a comfortable, secure place for the cat.

Educate clients to keep the carrier in a familiar place in the home to increase familiarity and reduce fear. Help them recognize how to make the carrier a safe haven, by leaving it out instead of only bringing it out for veterinary visits. If clients refuse to have it out all the time, minimally bring the carrier out a few days before the veterinary visit. The carrier should be cozy within, with a fleece of fluffy blanket. Place or toss treats or preferred kibbles daily into the carrier to entice the cat to enter. Reward the cat for use of the carrier.

Clients should also be taught to reward or reinforce desired behavior, and to *never* punish the cat– either verbally or physically. Encourage the client to bring favorite treats, toys, or grooming utensils as well, so that they can be used to entice the cat to come out of it's carrier and/or to reward or reinforce desired behaviors.

For the cat that is still stressed and wary of the carrier, and will not enter on its own, there are still options. First, the cat should never be yelled at or chased in an attempt to get it into the carrier. Place the cat into a small room where the cat cannot hide. Teach the client to calmly get the carrier, and bring it into the room, closing the door. Calmly put the cat into the carrier. Hard-sided carriers with an opening at the top are ideal for these cats because the owner can then gently place the cat through the top, instead of shoving the cat through the door.

There will always be patients that still remain anxious whether it is due to previous fearful or painful experiences, or how the owner reacts. Because anxiety can inhibit learning, cats with a history of being anxious on car rides and/or veterinary visits may require anxiolytic (anti-anxiety) medication. Alprazolam and gabapentin are anxiolytics, but acepromazine is not; it should not be used because dissociated aggression can occur. Some cats will become more reactive with alprazolam, but this does not occur with gabapentin.

Gabapentin is the speaker's drug of choice. Although gabapentin is an analgesic medication, it also works as an anxiolytic. Dose gabapentin at 10 mg/kg or 100 mg/cat 90 minutes – 3 hours prior to the veterinary visit. Some cats may need up to 150 mg/cat. It is tasteless and can be mixed into a small amount of canned food. The lecturer and many others use 100 mg per cat as their dose rather than the 10 mg/kg calculation, regardless of size of the cat. The speaker has used 50mg in geriatric cats that are cachectic. It can be sedating and it is best to let the owner know that the cat may sleep more after the visit.

Travel is best on an empty stomach to prevent motion sickness and so that the cat is more interested in treats at the veterinary practice. Both provide for a more positive experience. If needed, a small amount of canned food with gabapentin can be given. A synthetic feline facial pheromone (FFP) analog sprayed into the carrier at least 30 minutes before travel, has a calming effect on the cat.[5] Draping a blanket over the carrier can also help prevent fear and motion sickness. If the cat is still nauseous – lip-licking, drooling, or vomiting during transportation - maropitant (Cerenia) is recommended to prevent motion-sickness.[6]

The cat friendly hospital environment

Provide a quiet environment, with no offensive smells (dog odors, strong cleaning solutions, or perfumes). Use a synthetic feline pheromone analog to help calm feline patients. If at all possible, have a separate waiting area for cats or divide the waiting area into two, with back-to-back benches and taller shelves or plants between them to provide a visual barrier and separate waiting areas.

Regardless of how "cat-friendly" the waiting area is, it is best to take the cat and client directly into an exam room. In hospitals that also see non-feline patients, designating one or two exam rooms for cats helps reduce stress, and provides an environment that is for cats only. Other options are to dedicate one-half day to cat-only appointments or surgeries.

Performing all examinations and diagnostic testing in the examination room instead of the treatment area will help keep the cat less fearful and facilitate the procedures.

Unfamiliar scents can frighten and arouse cats. Providing familiar scents such as that of a favorite person can help a cat adapt to new situations. The synthetic feline facial pheromone analog, Feliway®, mimics the natural pheromone that is deposited when a cat rubs its face on objects, and has been shown to provide a calming effect in unfamiliar or stressful environments or situations.[7,8,9] The new product, Feliway Multicat, is now available in the US only, and is supposed to be helpful for introducing a new cat and reducing intercat conflict in multicat households.

Cats that require hospitalization often become inactive and inhibit normal behavior such as feeding, grooming, exploring, and playing.[10] Cats need both places to hide and places up high. Hiding places can be as simple as a sturdy cardboard box, or a cat bed with high edges to hide in. Vertical space provides vantage points to monitor the cat's surroundings and the approach of people and other animals.[11] Caging should always include comfortable bedding, preferably with the familiar scent from a favorite person. Whenever possible, separate cat wards from dog wards. Also, cages should not face each other so that cats cannot see other cats or any other animals. Feline synthetic pheromone analog sprayed into cages and boarding suites at least 30 minutes prior to use can calm feline patients and increase normal behaviors while caged.[12] Cats that are very anxious or fearfully aggressive are best isolated into an

empty isolation area; if not possible, place a towel on the front of the cage to screen out activity that may add to the cat's anxiety. Scheduled feeding and cleaning times are less stressful for feline patients.

Conclusion

Developing a Cat Friendly Practice can reduce stress for all involved, and increase cat visits to improve feline healthcare.

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Meeting the Environmental Needs of Indoor Cats

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The veterinary profession is responsible for both the physical and emotional health of our patients. Advances in feline medicine have increased the pet cat's physical health and longevity[1], but emotional and environmental health needs often go unrecognized. Inadequate feline environments frequently lead to boredom, stress, and obesity.[2,3] Behavior problems and normal feline behaviors that people consider undesirable can also occur when cats' needs are not met. Environmental stressors can even lead to physical health problems, such as feline idiopathic cystitis. These problems occur due to the disparity between who cats really are and the impression that many owners have, which is that they are low maintenance and easy to care for pets.

The cat is a paradox – although fairly adaptable and social animals under the right conditions, cats have retained many of the behaviors of their wild ancestor, *Felis lybica*.[4,5] In fact, pet cats are still more similar to their wild ancestors than to other species and require an environment that provides for their needs. Understanding the cat, its normal behaviors, and its needs can often prevent or resolve stress, boredom, and behavior problems. Regardless of the age and physical health of the cat, and regardless of whether the cat is indoors only, indoor/outdoor, at home or at the veterinary practice, providing for the cat's environmental needs is not optional but rather essential for its welfare.[3]

Feline welfare and the veterinary responsibility

Within the past decade, a large number of worldwide veterinary organizations have rewritten their veterinary oaths to emphasize welfare. Animal welfare is defined by the AVMA as: "…how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behavior, and if it is not suffering from unpleasant states such as pain, fear, and distress. Protecting an animal's welfare means providing for its physical and mental needs." Many feline patients are not allowed to express innate behaviors, often leading to fear and stress - to poor welfare.

Understanding the cat and its needs

Cats as solitary hunters

Because cats are solitary hunters of several small prey daily, they must maintain their physical health and avoid danger. They do so through two major protective mechanisms – territoriality to maintain safe space and having a heightened fear response. Familiar territory provides cats with a sense of control over their physical and social environment.[6] Having a sense of control - even if it is not exerted - makes the cat more comfortable and reduces stress.[7]

A primary goal of communication between cats is to protect territory and avoid physical altercations.[8] They communicate through body and facial posturing, as well as via their senses. Scent marking is most important for cats, with scent and pheromonal signals used as distance communication to keep other cats away without the need for physical contact. Scent marking occurs via facial and body rub marking, scratching, urine spraying, or middening (fecal marking). Spraying in neutered cats is usually secondary to stress in the environment.

Cats possess heightened a heightened fear response as a protective response to fear.[9] If cats are forced to leave their familiar territory or a threat enters their territory, they respond to this confrontation by avoidance or hiding, with fighting only occurring if there are not other options to protect self. Fear commonly occurs when a cat is taken outside its environment and brought to the veterinary hospital. Providing a place to hide for both inpatients and out-patients can prevent fear-associated aggression.

Providing choice in the environment through multiple resources - hiding, perching, feeding, water, and toileting areas - in multiple locations in a multi-cat household will reduce fear and provide cats with a sense of control and more secure environment.[3] This is important regardless of whether it is the home environment, veterinary practice, cattery, or shelter.

Feline environmental needs

Safe space

Hiding is a coping behavior that cats often display in response to changes in their environment.[10] In the home, this could be an unfamiliar person or pet. Problems often occur with a newly adopted cat being introduced to already existing household cats without gradual introduction. Even if it is not a newly introduced cat, it is not unusual for cats that live in the same household not to like each other and choose to rest in a safe place away from others. Even affiliate cats – cats that like each other – prefer to sleep alone and out of sight of others approximately half the time.[6] Appropriate sleeping areas are also good hiding places, such as a box, a cat bed with high sides, or a carrier with soft bedding such as fleece.

In the veterinary hospital, a safe place is necessary for both in-patients and out-patients. The carrier – especially if the cat has positive experiences and familiarity with it in the home environment – is an excellent safe place. Allowing the cat to rest in the

bottom half of the carrier during examinations and providing either the carrier or another hiding place during hospitalization or boarding will increase feline safety and security, and decrease fear-associated aggression.

Elevated resting areas

Increasing overall space by providing cat trees, perches, shelves, or other vertical space helps prevent conflict between cats.[3] Cats can also monitor or oversee the environment from a vertical space.

Scratching

Scratching is a normal feline behavior that marks territory with both scent and visible markings. It also is done to sharpen claws, remove old sheaths, and to stretch muscles. Providing scratching posts with preferred texture, such as sisal rope or natural wood, as well as in multiple locations helps prevent furniture destruction. Posts should be placed in locations where cats prefer to scratch – usually next to a most prominent piece of furniture, but sometimes also where new scents occur (e.g., the front or back door).

Normal feeding behavior of the solitary hunter

Cats are not pack hunters, but rather solitary hunters, eating 10-20 small meals per day, with repeated cycles of hunting to catch their small prey. Not all attempts to catch prey are successful (some suggest that up to 50% of the hunt cycles are not successful).[11] Think about how much time and energy the cat utilizes just to survive!

Compare that to what happens with many owned cats. People usually control the feedings, often providing 1-2 meals daily of highly palatable food. The inability to control access to food is associated with feline stress.[12] The sedentary house cat expends very little energy and time hunting, and more time eating. In some countries, including the US, many cats are kept indoors. Whether to protect the cat itself or wildlife, failure to provide opportunities for predatory behavior may deprive cats of mental and physical activity, and may contribute to development of obesity and other health problems.[11,13]

Because people are social eaters usually enjoying meals together, they often provide multiple cats with food either in one bowl or in bowls placed side-by-side, not recognizing that this causes competition for food resources and stress for the cat. One can understand why some cats may eat large volumes very rapidly, often overeating, and perhaps regurgitating. Stress is usually the short-term result, and obesity and obesity-associated diseases are more long-term outcomes.

Regardless of how much cats are fed, the hunting instinct still exists; cats often bring in these unwanted “presents” to their people. Cats are also crepuscular animals, hunting primarily at dawn and dusk, when their prey is usually present. This sometimes leads to waking owners during the wee hours of the morning, which can be quite annoying for humans. Often owners inadvertently reinforce this behavior in their attempt to quiet the cat so that they can go back to sleep, leading to a long-term and frustrating problem for owners. Client education can prevent this problem as long as we welcome clients to discuss their frustrations or concerns about their cats with us.

As veterinarians, we have the opportunity and responsibility to educate clients about normal feeding behavior of the cat as part of the nutritional advice we provide. This will help prevent both medical and behavioral problems, obesity, and stress in the home environment. This can be done by simulating “hunting” through the use of food toys or puzzles, tossing kibbles, or hiding them around the house. This more normal feeding behavior will increase exercise, reduce boredom, and help prevent obesity.[15] Providing feeding areas in multiple locations which are out of sight of each other will prevent competition for food resources.

Drinking behavior:

Cats in the wild drink water in locations separate from food. Some cats prefer running water, and some still water. Provide water dishes in multiple locations and away from food.

Play behavior

Queens teach kittens to hunt through play behavior. The rough tussle and tumble of kittens help them hone their hunting skills. Kittens and even adult cats, especially if housed singly, may want to play with their owner’s hands and feet in the same way. When young, people often think this is cute, and unknowingly reward the behavior. Play aggression can lead to human injury and zoonotic disease. Playing with an interactive toy minimally once to twice daily can prevent this problem. Cats learn to anticipate and prefer the routine of playing daily at a certain time, even if toys are rotated. Cats playing together also provides an outlet for this behavior. Self play is also important, and can be provided through puzzle feeder toys or other favored toys (e.g., hair scrunchy, foil or paper ball).

Toileting areas

Litter boxes should be placed in multiple locations around the home, but away from food, water, and sleeping areas. It is not uncommon for cat owners to prefer to place 2 or more litter boxes in the basement next to each other. This poses multiple problems – usually there are noisy appliances and equipment in the basement, the boxes next to each other don’t provide easy access to a box if a more confident cat is blocking a timid cat, and a cat with degenerative joint disease or another condition making it difficult to get downstairs – that can lead to a cat soiling outside the litter box.

Many litter boxes are also too small for cats. Cats prefer larger boxes so that they can turn around, dig, and eliminate. Boxes should be 1.5 times the size of the cat from the tip of the nose to the base of the tail. Dog litter boxes and plastic storage containers with an opening make excellent cat boxes.

Some cats will eliminate in any type of litter. Others prefer a soft consistency, such as sand over pebbles. Deodorizers or scented litter since as pine are developed to attract consumers and not the cat. Some cats find them offensive. Most cats do well with unscented clumping sand litter.

Scooping boxes a minimum of once daily and changing boxes completely when needed (weekly for clay or non-clumping litter and once every 2 or more weeks for clumping litter) will also help to prevent house soiling problems.

Single vs. multiple cat households

Cats are social animals, but their social system is flexible, meaning that cats can live alone or in groups called colonies if there are sufficient resources.[5,11] Cats that like each other demonstrate affection towards each other by rubbing against or grooming each other, or sleeping in close physical contact.

Cats usually do not readily welcome unfamiliar cats. In a study of 1,286 relinquished cats, relinquishment was associated with the number of pets in the household, as well as new cats being added into the home environment.[14] Introductions must be gradual, and with all resources available in multiple locations to prevent the need to pass an unfamiliar cat.

Just because cats come together for feeding or to sleep on the same bed, it doesn't mean that they like each other or that stress isn't occurring in the feline household; in many households, cats come together because the primary resources are placed in one location. Since cats are more likely to rest or sleep alone, multiple comfortable resting areas should be provided. Inter-cat conflict and behavior problems often occur because household cats don't have multiple resources in multiple places, and therefore cannot avoid the other cat(s).

Multiple resources with easy access, and out of view of other resources must occur. This includes hiding places and use of vertical space to allow cats to be apart if they so choose. Vertical space increases overall space and provides for the cat to oversee the environment. Litter boxes, food, and water stations that are placed in different locations so that individual cats don't need to see each other reduces competition for resources, bullying, and stress.[12] Serious consideration should be taken before adopting a new cat if cats already exist in the home. Clients should be educated to let cats choose their own affiliates, and be made aware that the greater number of cats in a household, the greater the chance of behavior problems.

Conclusion

The dilemma of what cat owners want and what cats need can both be met when behavioral health is incorporated into veterinary practice. When we understand cats and treat them as the species they are, we can enrich their lives and increase their welfare, further enhancing the bond we share with them.

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