Review Article Compte rendu

Basic triage in dogs and cats: Part I

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Abstract

Background

Emergency cases can present at any time of the day or night. All small animal practitioners need to have the skills to triage and stabilize common emergency cases even if they ultimately aim to refer the patient to another facility.

Objectives and procedures

The first part of this 3-part review article series covers respiratory distress and seizures. A stepwise approach to categorize and stabilize these cases is outlined, along with helpful tips to optimize the referral experience, if indicated.

Results

Having a strong methodical approach to animals in respiratory distress optimizes treatment. Similarly, achieving cessation of seizures, along with having a good understanding of the causes of seizures, allows for patient stabilization.

Conclusion and clinical relevance

Do NOT refer emergent cases before completing basic stabilization. Many emergency cases do not require emergent referral and can be worked up by the primary veterinarian or sent to a referral clinic on an appointment basis after appropriate stabilization steps are completed.

Résumé

Triage de base chez les chiens et les chats : Partie I

Contexte

Les cas urgents peuvent se présenter à tout moment du jour ou de la nuit. Tous les médecins vétérinaires en pratique des petits animaux doivent avoir les compétences pour effectuer un triage et stabiliser les cas urgents fréquents même s'ils prévoient ultimement référer le patient à un autre établissement.

Objectifs et procédures

La première partie de cet article de revue en 3 parties traite de la détresse respiratoire et des convulsions. Une approche progressive pour catégoriser et stabiliser ces cas est présentée, avec des conseils utiles pour optimiser l'expérience de référencement, si nécessaire.

Résultats

Avoir une approche méthodique solide lors de cas de détresse respiratoire chez les animaux permet d'optimiser le traitement. De manière similaire, être capable de maîtriser les convulsions tout en ayant une bonne compréhension de leurs causes, permettent une meilleure stabilisation du patient.

Conclusion et pertinence clinique

Ne PAS procéder au référencement de cas urgents avant d'avoir terminé une stabilisation de base. Plusieurs cas urgents ne nécessitent pas d'être référé en urgence et peuvent être pris en charge par le médecin vétérinaire primaire ou transféré à une clinique de référence après la prise d'un rendez-vous une fois qu'une stabilisation adéquate ait été complétée.

(Traduit par Dr Serge Messier)

Can Vet J 2024;65:162–172

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Introduction

Most veterinarians and veterinary staff carry out triage unconsciously. Triage is a system by which patients are sorted or separated based on their needs for medical care in situations when all patients cannot be examined immediately (due to factors such as limited resources and/or staff, or large numbers of patients).

Although victims have been sorted based on injury severity for > 2 centuries (1), "triage" was first used in medicine during World War I, when the approach was as follows:

> *"…a single case, even if it urgently required attention, should wait if it would absorb a good deal of time. In the same time frame a dozen others might be treated. The greatest good for the greatest number of people was the rule"* (1).

Patients with the best chances of survival were treated or operated on first, whereas those with lower chances of survival were not treated, to preserve time and resources (2).

The civilian medical world adopted the idea of triage and has applied it in busy emergency rooms. Civilian triage is geared towards treating the sickest first, whereas more stable patients will receive medical care when possible.

Veterinary medicine has adopted the human civilian concept of identifying and prioritizing treatment of critically ill patients. This is not true "triage," as we do not select and treat patients with higher chance of survival and ignore those with limited or no chance of survival. Veterinarians conducting triage prioritize animals that need immediate care *versus* those that are more stable and with conditions that will not be jeopardized by delayed treatment.

Triage assessments involve a rapid, but thorough, physical examination coupled with a classification system to categorize patients (3). A standardized veterinary triage list (3) was adapted and modified into a flow chart (Figure 1). In that chart, the color red denotes the need for immediate medical care, followed, in order of decreasing immediate need, by orange, yellow, and green (most stable) groups. Each group classification includes respiratory, cardiovascular, neurologic, gastrointestinal, obstetric, urogenital, trauma, and general illnesses.

First-line veterinarians in general and emergency practice often conduct basic triage and stabilize animals from red or orange groups before referral. This article is the first in a series of 3 reviews that outline the most frequently encountered emergency situations leading to referral in dogs and cats and provide guidelines on stabilizing patients for safe transit. A simplified triage flowchart (Figure 2) describes how to work from the most to the least life-threatening conditions among those most commonly encountered and referred.

Section 1: Acute respiratory distress

Respiratory distress should *not* be immediately referred without being stabilized. Dogs and cats in overt respiratory distress may die suddenly in your clinic or during transportation to a referral center. Figure 3 provides an overview of stabilization of canine and feline respiratory emergencies.

Step #1: Oxygen

When you have identified respiratory disease in a dog or cat based upon your triage examination, the first priority is to provide oxygen therapy with minimal stress. In most cases, initial oxygen administration *via* flow-by oxygen therapy is the fastest option (Figure 4) and facilitates concurrent examination. Placing a small dog or cat into an oxygen cage or chamber is an effective, low-stress option, but limits the ability to examine the animal. Most general practices do not have a dedicated oxygen cage (Figure 5 A), but many have a plastic door to place on a cage to contain oxygen (Figure 5 B) or may have smaller, exotic-animal incubators suitable for a small dog or cat.

Oxygen can be provided without a true oxygen cage. Alternatives include placing a cat-sized or small dog-sized carrier into a plastic bag filled with oxygen (Figure 5 C), using an Elizabethan collar covered with plastic wrap to contain oxygen, covering an existing cage door to create an oxygen chamber, or using a plastic box as an oxygen chamber (Figure 5 D). Intranasal cannulas can also be used in dogs (particularly for longer-term hospitalization) but are usually too large for cats.

Oxygen chambers are the easiest and least stressful option to provide oxygen to small dogs or cats. However, if a dog or cat is too large relative to the cage or if a dog is panting, it may quickly become hot or humid in the cage. Check the temperature regularly with a thermometer or your hand. Opening the oxygen cage door quickly decreases oxygen concentrations; therefore, an oxygen cage is not appropriate if you need frequent access to the animal.

Step #2: Categorize the type of respiratory distress

Once you have provided oxygen, categorize the respiratory distress as UPPER airway or LOWER airway.

Upper airway disease

Upper airway disorders are usually accompanied by loud breathing (stertor or stridor), inspiratory dyspnea, visible anxiety, and sometimes, cyanosis (4,5).

Background

Dogs. Upper airway disorders are more common in dogs than in cats. The most common disorders in dogs are brachycephalic airway syndrome, laryngeal paralysis, and collapsing trachea. Brachycephalic airway syndrome occurs in breeds such as pugs and bulldogs, laryngeal paralysis occurs in Labrador retrievers and other large-breed dogs such as Newfoundlands and golden retrievers, and collapsing trachea occurs in small-breed dogs such as Yorkshire terriers.

Cats. Upper airway disorders are relatively rare in cats but are commonly due to oropharyngeal masses. Masses occur secondary to infectious diseases such as viral infections, are neoplastic, or, in kittens or younger cats, may be nasopharyngeal polyps (6–8). In 1 study, 20% of cats with upper respiratory tract infections had dyspnea; > 1/2 also had sneezing and ocular or nasal discharge (7). Although uncommon, cats can present with laryngeal paralysis (8) due to trauma (iatrogenic after surgery or anesthetic interventions) or secondary to neoplasia (either paraneoplastic

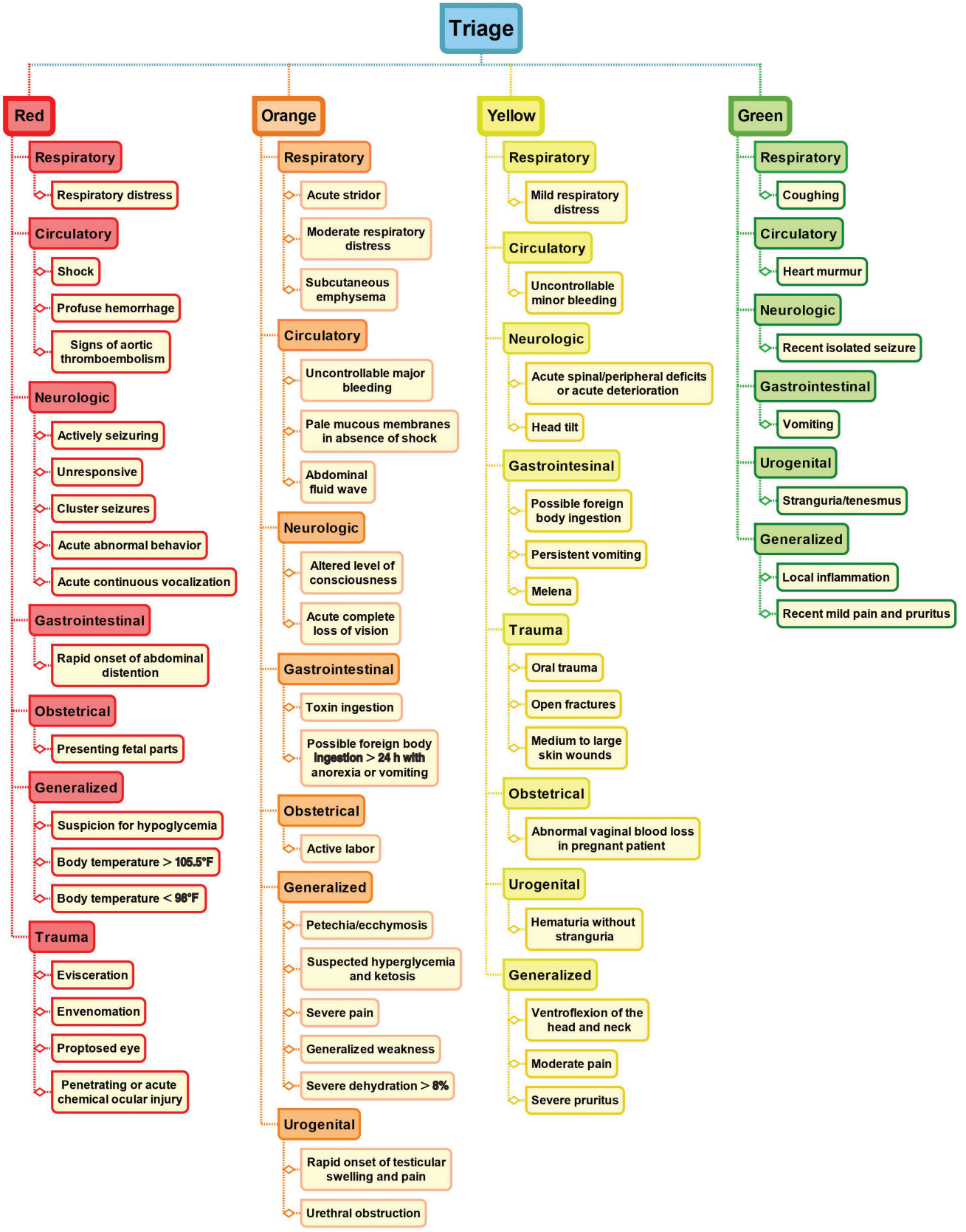

Figure 1. Veterinary triage list.
Adapted from Ruys *et al* (3).

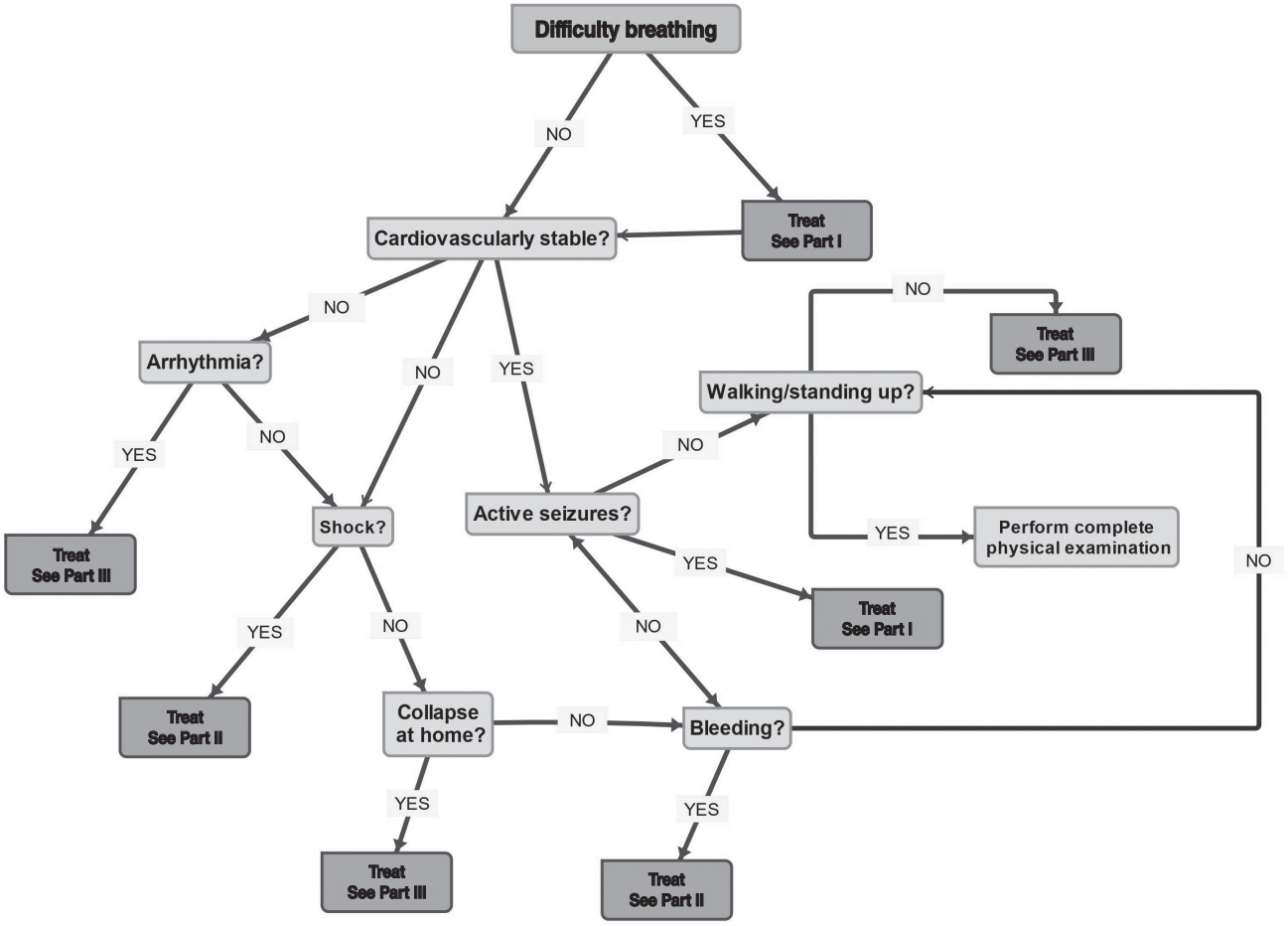

Figure 2. Simplified triage flow chart.

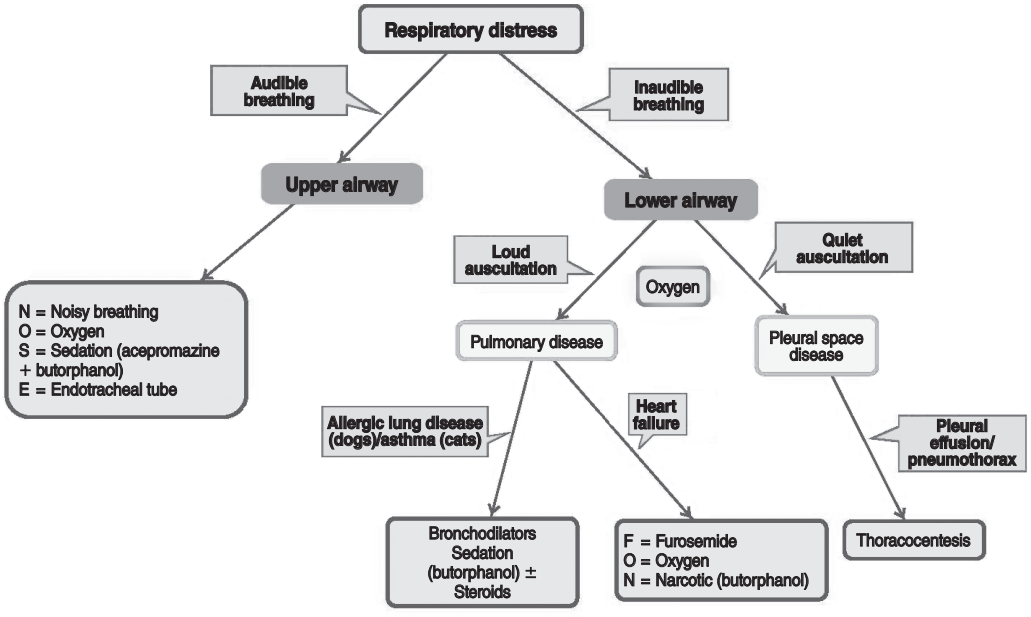

Figure 3. Stabilization of respiratory distress in dogs and cats.

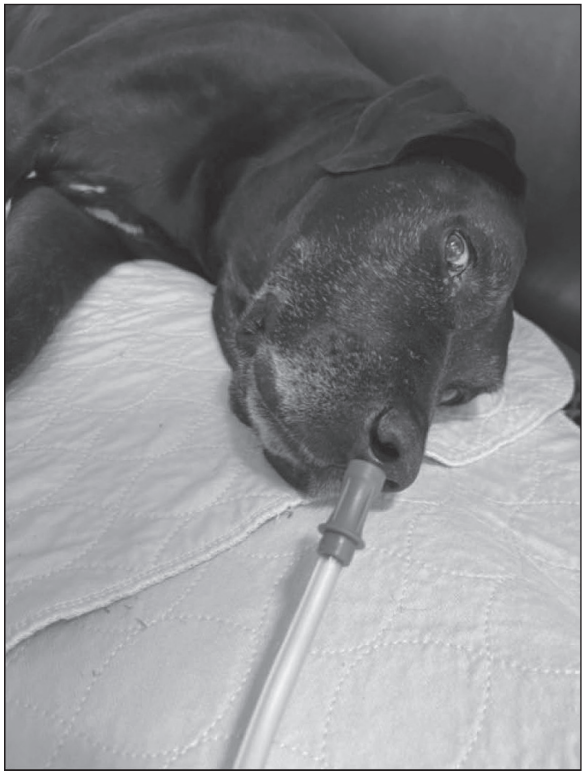

Figure 4. Flow-by oxygen therapy in a dog.

effects or primary neoplasia in the laryngeal or oropharyngeal region) (8,9).

Emergency stabilization

Acute treatment of upper airway disease can be achieved by following the mnemonic **NOSE**: **N**oisy breathing means **O**xygen, **S**edation, and **E**ndotracheal tube placement (intubation), if needed.

Oxygen. Administer oxygen with minimal stress, as described in Step #1.

Sedation. Sedation can be achieved with butorphanol (0.2 to 0.5 mg/kg IV or IM) and/or acepromazine (0.01 to 0.2 mg/kg IV or IM). Butorphanol has a rapid onset of activity but acepromazine can take 20 to 30 min to reach full effect; refrain from re-dosing acepromazine prematurely. For acepromazine, > 0.5 mg/kg will not increase sedation. Dexmedetomidine is also used for sedation (2 to 10 μg/kg in dogs or 5 to 20 μg/kg in cats, IV or IM). It is given as a constant-rate infusion (CRI) (1 to 3 μg/kg per hour) after a bolus for sustained sedation. Dexmedetomidine may cause emesis in cats, especially if given IM.

Endotracheal tube placement. If there is no improvement or worsening after oxygen and sedation, the animal may need to be intubated. Do not wait to intubate in severe cases. Propofol (IV to effect) is easiest, or else alfaxalone (1 to 3 mg/kg, IM or IV to effect). Alternatively, ketamine-diazepam, IM or IV to effect (dogs: 5 mg/kg ketamine with 0.1 to 0.4 mg/kg diazepam; cats: 10 mg/kg ketamine with 0.5 mg/kg diazepam) will facilitate endotracheal tube placement.

Keep the animal relaxed and comfortable with repeated doses of propofol (or other injectable anesthetics) as needed for *at least* 30 to 60 min. Avoid inhalant anesthetics due to risk for hypotension or respiratory depression. Many cases of upper airway disease can be extubated and will have improvement or resolution of clinical signs. However, some will have respiratory distress after endotracheal tube removal (despite sedation) requiring re-intubation pending definitive diagnostics and treatment. If an "awake" animal tolerates the tube, leave it in place.

Administer flow-by oxygen into the distal end of the endotracheal tube or 100% oxygen from an anesthesia circuit. Do not occlude the tube completely with flow-by oxygen, as animals must exhale. Oxygen therapy is often not required unless there is concurrent lower airway disease; establishing an airway with an endotracheal tube often relieves the distress.

Practice tips

1. If there is an upper airway obstruction, check for hyperthermia, as these obstructions interfere with cooling. Dogs or cats will pant or have open-mouthed breathing when overheated (mimicking respiratory distress). Obesity, stress, and being in an oxygen cage can cause hyperthermia.
2. Some animals will have concurrent oropharyngeal inflammation secondary to their disease process or how hard they are breathing. An anti-inflammatory dose of steroids (dexamethasone sodium phosphate 0.07 to 0.14 mg/kg) can be given IM or IV.

Lower airway disease

Lower airway disease in dogs commonly increases respiratory rate, with an occasional cough, whereas cats often lack an obvious cough (5). Dogs and cats can have open- or closed-mouth breathing ± markedly increased respiratory effort. Unlike upper respiratory cases, where thoracic auscultation is difficult due to referred upper airway noise, auscultation of the thorax is important in lower respiratory disease to divide cases into "loud" *versus* "quiet" auscultation.

"Loud" auscultation

Dogs or cats with "loud" thoracic auscultation (*i.e.,* crackles and wheezes) have pulmonary parenchyma involvement. In dogs, the most common diseases are i) *non-cardiogenic pulmonary edema,* ii) *cardiogenic pulmonary edema,* or iii) *pneumonia* of bacterial or viral origin. In cats, the 3 most common diseases are i) *non-cardiogenic pulmonary edema,* ii) *cardiogenic pulmonary edema,* or iii) *feline asthma.* Cats rarely have *pneumonia.*

Background

Pulmonary edema usually occurs when fluid fills the interstitial space between the alveolus and capillary, limiting oxygen diffusion. With non-cardiogenic pulmonary edema, fluid buildup occurs secondary to increased permeability of capillary walls, leading to fluid extravasation into the pulmonary interstitium. Cardiogenic pulmonary edema occurs when increased fluid volume in capillaries increases hydrostatic pressure, with fluid moving into interstitial tissue or the alveolus.

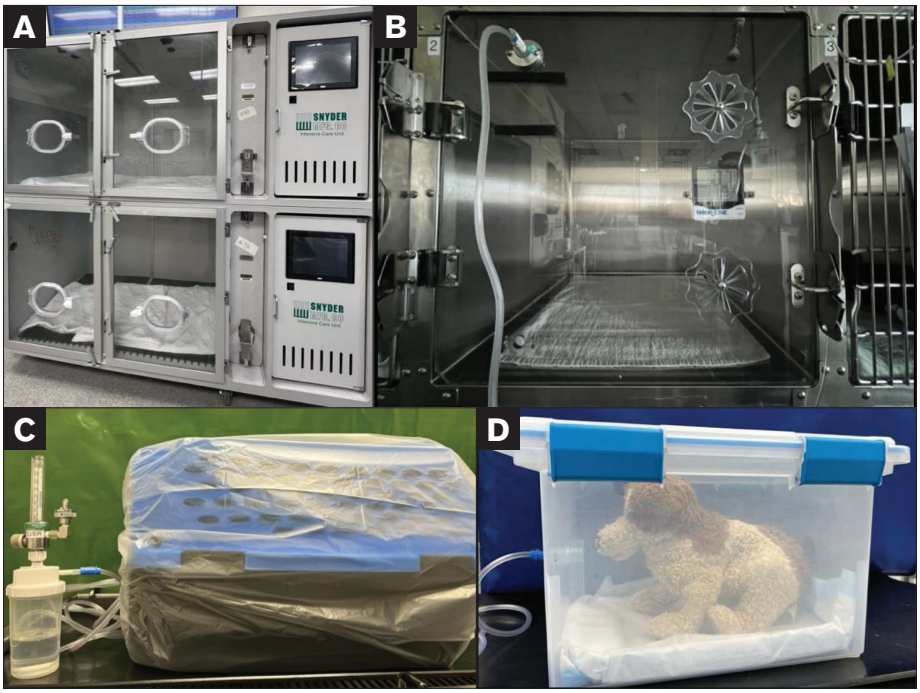

Figure 5. A – Commercial oxygen cage. Note the screen on the right, which allows for control of temperature, humidity, and oxygen concentration. B – Cage door converting a standard cage to an oxygen chamber. The monitor on the right-hand side of the cage reports temperature and humidity. C – Pet carrier enclosed in a plastic bag with oxygen tubing, creating a makeshift temporary oxygen chamber. A hole should be placed on the back side of the plastic bag to vent carbon dioxide and heat. D – Alternative oxygen cage created from a plastic container with holes inserted to allow oxygen into the container. It is important to also create exhaust holes (> 1) to vent carbon dioxide and heat.

Dogs. *Non-cardiogenic pulmonary edema* in dogs has been reported after toxin inhalation (*e.g.,* smoke or ozone), prolonged seizure activity, electrocution, blood transfusion, drowning, and systemic inflammatory diseases (pancreatitis, neoplasia, anaphylaxis) (10,11). However, the most common cause of non-cardiogenic pulmonary edema [38% (7) to 45% (12)] is secondary to upper airway obstruction (*e.g.,* tracheal collapse, brachycephalic airway syndrome, or choking). It is more common in younger dogs but can occur at any age (10,11).

Cardiogenic pulmonary edema tends to occur in middle-aged or older dogs, but heritable heart disease can cause earlier onset of congestive heart failure. The most common type of heart disease in dogs is myxomatous mitral valve disease (13,14), although dogs go into heart failure secondary to dilated cardiomyopathy. Breeds commonly affected with myxomatous valve disease include the Cavalier King Charles spaniel, dachshund, Chihuahua, and shih tzu (13). Large- and giant-breed dogs (including Doberman pinschers) commonly have dilated cardiomyopathy. Dogs with mitral valve disease consistently have a heart murmur at the time of diagnosis of heart failure but rarely have an arrhythmia (14); dogs with dilated cardiomyopathy infrequently have a heart murmur but often have an arrhythmia [atrial fibrillation; see Section 1 in Part III of this review (15) and (16,17)].

Pneumonia can occur in dogs of any age and may cause a fever and/or an elevated white blood cell count on a CBC (18,19). Pneumonia in dogs can be community or hospital-acquired bacterial or viral pneumonia (*e.g.,* canine infectious respiratory disease complex), fungal pneumonia, or aspiration pneumonia. Brachycephalic dogs are predisposed to aspiration (18), but aspiration can occur in dogs of any age or breed, especially with a comorbidity causing vomiting or regurgitation or a history of sedation or anesthesia. Obtain a complete history, including regarding recent travel, mingling with other dogs in a boarding-type situation, or recent vomiting or regurgitation. A complete physical examination to identify signs such as draining skin lesions indicative of fungal disease can provide valuable clues.

Cats. *Non-cardiogenic pulmonary edema* in cats has been reported after toxin inhalation (*e.g.,* smoke or ozone), prolonged seizure activity, electrocution, blood transfusion, drowning, and systemic inflammatory diseases (pancreatitis, neoplasia, anaphylaxis) (10,11,20). It is more common in younger cats but can occur at any age (10,11).

Cardiogenic pulmonary edema tends to occur in middle-aged or older cats [*i.e.,* aged 5 to 11 y (21)], although certain breeds, such as the Maine coon, are believed to have heritable heart disease and can go into heart failure at 1 to 5 y of age (21). The most common heart disease in cats is hypertrophic cardiomyopathy (HCM), although cats rarely have congenital cardiac malformations or valvular disease. In 1 large study of cats and heart disease, up to 82.4% of those with HCM had an auscultable murmur (21), although anecdotally, it is not uncommon

that cats presenting acutely in heart failure may not have had a murmur previously auscultated. Some cats with HCM will have an arrhythmia (12.7%) or gallop rhythm (11.2%) (21).

Feline asthma can occur at any age but classically occurs in young, indoor-outdoor cats. Clinical signs are acute in onset, with or without previous shorter bouts of similar signs. Asthmatic cats will often have a history of open-mouthed breathing and/or coughing (often attributed to retching or "gagging up hairballs"). Feline asthma is an inflammatory condition leading to airflow obstruction secondary to bronchoconstriction and increased bronchial mucous production resulting from antigen-induced IgE-mast cell interactions (22).

Pneumonia can occur in cats of any age, but infectious pneumonia is most common in younger cats (especially those from shelter backgrounds) infected with calicivirus and/or feline herpesvirus. When viral pneumonia is suspected, cats often have a history of upper respiratory congestion and nasal discharge (7). Cats with feline asthma can also have secondary bacterial pneumonia.

Emergency stabilization ("loud" auscultation)

Pulmonary parenchymal diseases commonly causing loud auscultation are differentiated based on radiographic pattern and location. Patients with severe dyspnea should NOT undergo radiography until after stabilization. Point-of-care ultrasound may differentiate congestive heart failure from other lung diseases causing dyspnea (23) and determine if a dog with a heart murmur has congestive heart failure (24), but may be too stressful before stabilization.

To alleviate respiratory distress in dogs and cats before obtaining radiographs or ultrasound imaging, consider giving the following "cocktail:" oxygen, 1 dose of furosemide, and 1 dose of butorphanol (Table 1). If feline asthma is strongly suspected, inhaled corticosteroids and/or inhaled bronchodilators can be used in lieu of or in addition to injectable steroids and bronchodilators (25,26) (Table 1).

Table 1. Emergency treatment options for lower respiratory disease in a dog or cat characterized by "loud" lung sounds.

Presumed cause	Emergency treatment	Comments
Non-cardiogenic pulmonary edema	**Oxygen therapy**	Oxygen cage, flow-by oxygen, or other oxygen chamber.
		These cases require ≥ 24 h to improve and they may initially worsen. In severe cases, mechanical ventilation can be used. No treatment aside from oxygen is proven to work.
		Butorphanol (0.2 mg/kg) to reduce anxiety.
		Consider bronchodilators (terbutaline, 0.01 mg/kg, SC).
		Furosemide's diuretic effects are not helpful.
Cardiogenic pulmonary edema	**F** Furosemide	2 mg/kg, IM or IV, every 20 to 30 min, to a maximum of 6 to 8 mg/kg.
		Furosemide increases fluid removal in renal tubules and has bronchodilatory effects.
	O Oxygen	Oxygen cage, flow-by oxygen, or other oxygen chamber.
	N Narcotics	Butorphanol (0.2 mg/kg IV or IM).
Feline asthma	**Oxygen**	Oxygen cage, flow-by oxygen, or other oxygen chamber.
	Bronchodilators	Terbutaline (0.01 mg/kg) SC or IM, or inhaled bronchodilator from a metered dose inhaler (*e.g.,* albuterol) (25,26).
		Bronchodilators quickly resolve clinical signs.
	Steroids	Dexamethasone sodium phosphate (0.07 to 0.14 mg/kg IV, IM, or SC) or inhaled steroid from a metered dose inhaler (25,26).
		Injectable steroids can worsen cardiac disease and take > 60 min to take effect; avoid if heart disease suspected.
Pneumonia	**Oxygen**	Bacterial, viral, and fungal pneumonia are treated with antibiotics, supportive therapy, and anti-fungals, respectively.
		Treatments do not provide acute stabilization.

Practice tips

1. One dose of any medication listed in Table 1 will not have detrimental effects and may help to stabilize a dog or cat, even without a diagnosis.
2. Based on clinical observations, IM furosemide in dogs and cats works approximately as quickly as IV furosemide and can be much less stressful in dyspneic animals.
3. Butorphanol, the bronchodilatory effects of furosemide, and other bronchodilators anecdotally have rapid effects (usually within 10 to 15 min). Reduction of capillary fluid volume (cardiogenic pulmonary edema) with furosemide and maximal effects of steroids take longer (≥ 30 to 60 min or more, in the authors' experience).

"Quiet" auscultation

When dogs or cats with lower airway disease have "quiet" auscultation, the most common differential diagnoses are *pneumothorax* or *pleural effusion*. These animals often have a paradoxical respiratory pattern (exaggerated abdominal effort alternating with exaggerated chest excursions). Perform thoracocentesis to relieve signs and determine fluid *versus* air. Obtain radiographs in minimally affected animals; however, if the animal is dyspneic, perform thoracocentesis BEFORE radiography! Point-of-care ultrasound can confirm fluid or air with less stress than radiographs but should not replace immediate thoracocentesis in severely affected animals (27,28). Negative taps have minimal adverse effects.

Background

Dogs. *Pneumothorax* in dogs can be spontaneous or secondary to trauma. Spontaneous pneumothorax is rare in dogs; it occurs

with bullae or bleb formation in the lungs, pulmonary neoplasia or other chronic lung disease, and migrating pulmonary foreign bodies (29). Certain breeds, *e.g.,* Siberian huskies, are prone to spontaneous pneumothorax, but it can occur in any breed (29). Traumatic pneumothorax is more common in dogs, often after motor vehicle accidents or bites (30,31).

Pleural effusion can occur in dogs of any breed or age and may be caused by toxins (*e.g.,* anticoagulant rodenticide-hemothorax), transudate from heart failure, chylothorax, trauma, neoplasia, or pyothorax. A heart murmur or fever in addition to history can suggest a cause, but fluid analysis is definitive.

Cats. *Pneumothorax* in cats is either traumatic or spontaneous; the latter is rare but results from primary lung diseases such as blebs or bullae that spontaneously rupture. Spontaneous pneumothorax also occurs secondary to chronic lung diseases such as inflammatory airway disease (*i.e.,* asthma), neoplasia, lungworm infection, heartworm infection, or pneumonia ± pulmonary abscess formation (32,33). Trauma in cats can occur with blunt force injury to the chest wall, bite wounds or other penetrating injuries of the chest wall, or after iatrogenic damage to the trachea or airways during anesthesia.

Pleural effusion in cats has various causes, most commonly congestive heart failure (40.8%) and neoplasia (25.8%), with 24% of cases due to pyothorax, chylothorax and feline infectious peritonitis (34). As in dogs, fluid analysis is definitive.

Emergency stabilization ("quiet" auscultation)

The only way to stabilize a cat or dog with pleural effusion or pneumothorax is therapeutic thoracocentesis (Box 1). This can be done blindly or *via* ultrasound guidance and may require sedation (*e.g.,* butorphanol, 0.2 mg/kg, IV or IM). More definitive diagnostics and treatment are predicated on recovery of fluid or air and cytology of pleural effusions. Quantify air or fluid recovered and save fluid samples in both purple-top and red-top tubes.

If a pneumothorax is continuous (negative pressure indicating completion of thoracocentesis does not occur), a thoracostomy tube may be required (consult other resources for placement technique).

Practice tips

1. "Quiet auscultation" does not mean that nothing can be heard; lung sounds are typically audible but more blunted and quieter than expected based on respiration rate and effort.
2. A history of coughing or retching/vomiting occurs with pneumothorax in both species.
3. Blood biomarkers tested in point-of-care kits, such as N-terminal pro B-type natriuretic peptide (NT-proBNP), may differentiate cardiac *versus* non-cardiac causes of disease in dogs (35) and cats (36–38), but blood collection may be unsafe in dyspneic animals. There is some overlap of NT-proBNP values in dogs with respiratory distress from cardiac and non-cardiac causes, resulting in false positives and negatives, even at the ideal NT-proBNP cut-off value (81.1% sensitivity and 73.1% specificity) (35). High NT-proBNP levels can overdiagnose feline heart disease (72% specificity; thus, 28% of positives do not have heart disease) (36).

Box 1. How to perform thoracocentesis.

1. Position animal in sternal recumbency with flow-by oxygen. Sedate if necessary.
2. Clip fur between the 4th to 12th rib spaces on lateral thorax.
3. Sterile skin preparation.
4. Use a 19- or 21-gauge butterfly needle or a 2.5-centimeter, 18- to 22-gauge needle with attached IV extension tubing. The needle must be long enough to reach thorax. Do not use a needle smaller than 20 gauge for viscous fluid.
5. Attach 3-way stopcock to butterfly or extension tubing. Turn stopcock off to tubing and attach a 10-milliliter or larger syringe to stopcock.
6. Use ultrasound to locate fluid or find 7th to 9th rib space.
7. Insert the needle to the hub perpendicular to the skin in the 7th to 9th rib space at the widest point of the chest, or where the ultrasound revealed fluid. After the needle is inserted, position the needle until it is roughly parallel to the body wall.
8. Turn the stopcock off to the environment and apply gentle traction to syringe.
9. When syringe is full, turn stopcock off to animal and empty syringe (collect fluid samples).
10. Continue suctioning until negative pressure occurs, indicating end of tap in that area.
11. If you are using ultrasound, check for visible fluid in another location. If you are tapping blindly, enter another rib space in the 7th to 9th range, either cranial or caudal to your current rib space or on the contralateral hemithorax, and attempt another tap. Thoracocentesis is completed when minimal fluid is visible on ultrasound or after 2 negative taps on both sides.

Preparing to refer a dog or cat with respiratory distress

- The time to refer a dog or cat with respiratory signs is *after* treating respiratory distress. Avoid transporting an animal in fulminant respiratory distress (they may die).
  - — Follow the NOSE protocol for upper airway disease.
  - — Tap the chest when there is pleural effusion or pneumothorax and remove as much fluid or air as possible.
  - — Administer treatments in described Table 1.
- Before transportation, give additional butorphanol and/or other medications to sedate.
- Record doses and timing of all drugs given, plus results of any thoracocentesis (volume of fluid or air removed and side).
- When animals are very oxygen-dependent (usually with lower airway disease), transportation with a portable oxygen tank (or inside a carrier within a plastic bag filled with oxygen) may be useful for long trips, if local regulations and liability concerns permit. Consider a portable oxygen concentrator for transport (Figure 5 C, D).
- If a continuous pneumothorax and recurrent respiratory distress are present, insert a thoracostomy tube (to be emptied by a staff member or trained owner during transit).
- Alert referral institution to the incoming patient and its status.

Section 2: Seizures

A seizure is a clinical manifestation of abnormal electrical activity in the brain (39). Status epilepticus (SE) is commonly defined as seizure activity for > 5 min, or ≥ 3 seizures within 24 h without complete return of normal mentation between episodes (40,41). Cluster seizures (CS) are ≥ 2 seizures within 24 h with normal mentation between episodes. This section focuses on emergency situations involving a patient in SE or with CS.

Clinical signs in emergent cases range from patients in SE actively having a seizure to those that had a seizure before presentation. Seizures can include whole-body convulsions, hypersalivation, altered mentation, urination and/or defecation, or vocalization. Hyperthermia or lung crackles (seizure-induced non-cardiogenic pulmonary edema) are caused by seizure activity. Seizures in cats are often more violent.

After seizure activity (postictal phase), patients may be ambulatory but ataxic, have neurologic deficits and altered mentation, or be completely comatose and nonresponsive. Patients can also present as seemingly normal or mildly hyperactive, especially after CS.

Step #1: Is the animal having a seizure now?

If yes, *treat the seizure*.

Topical toxin

If a cat was given a topical medication (*e.g.,* permethrin, fipronil) that can cause seizures or tremors, bathe them with dish soap and lukewarm water to limit uptake.

- Methocarbamol, 50 to 150 mg/kg initial IV bolus (titrate up; do not exceed 330 mg/kg per day). If only oral form is available, dissolve in water and give rectally.
- Administer benzodiazepine (*i.e.,* diazepam or midazolam, 0.25 to 0.5 mg/kg IV).

No IV catheter

- Midazolam, 1 mg/kg IN. Diazepam, 1 mg/kg given rectally (up to 2 mg/kg if on concurrent oral phenobarbital).
- Repeat doses as needed every 2 to 3 min, maximum 3 times.

IV catheter

- Diazepam or midazolam, 0.5 mg/kg IV (in dogs).
- Repeat doses as needed every 2 to 3 min, maximum 3 times.
- Start long-acting antiepileptics, regardless of response to benzodiazepine.
- Levetiracetam, 60 mg/kg IV as loading dose. If only oral form is available, give orally (if patient can swallow) or rectally (42).
- Phenobarbital, 16 mg/kg loading dose (4 doses of 4 mg/kg every 0.5 to 4 h).
- If seizures persist, CRI of diazepam or midazolam, 0.1 to 0.5 mg/kg per hour for at least 6 h (then taper if no seizures).
- Propofol CRI, 1 to 3.5 mg/kg up to 6 mg/kg, slow IV to effect, to induce anesthesia. Give 25% of the calculated dose every 30 s until seizures stop, followed by a CRI (0.1 to 0.25 mg/kg per minute) for 6 to 12 h. Then, taper by 25% every 2 to 4 h, to recovery (43).

Propofol can cause hemolytic or Heinz body anemia in cats. Minimize dose and duration.

Table 2. Common categorical reasons for seizures in dogs and cats.

Systemic causes	Intracranial causes
• Hypoglycemia/hyperglycemia	• Tumors (lymphoma, meningioma, glial cell tumors, metastatic, *etc.*) (45)
• Electrolyte abnormalities: hypocalcemia; hypo- or hypernatremia	• Cerebrovascular disease including infarct or hemorrhage (rare in cats)
• Toxin ingestion Dogs: antifreeze, recreational drugs, fluorouracil, sago palm, mushrooms, ivermectin, rodenticides, xylitol Cats: permethrin, fipronil, pesticides (44)	• Trauma • Meningoencephalitis • Congenital malformations • Idiopathic epilepsy • Toxin
• Liver disease (*e.g.,* portosystemic shunt) (46)	• Infectious diseases Dogs: *Toxoplasma,* blastomycosis, cryptococcosis, distemper, *Neospora, etc.* Cats: Feline infectious peritonitis, FeLV, FIV, *Toxoplasma,* cryptococcosis, blastomycosis, *etc.* (47,48)
• Kidney failure (*e.g.,* uremic encephalopathy)	
• Anemia or severe hemoconcentration	
• Severe thrombocytopenia leading to intracranial bleeding	
• Thiamine deficiency (cats)	

Step #2: Why is the dog or cat having a seizure?

Once the animal is stabilized, determine the seizure cause; *i.e.,* systemic/metabolic or intracranial (Table 2).

Background

Signalment and history are important. Seizures can have hereditary components, particularly for golden or Labrador retrievers, border collies, German shepherds, Bernese mountain dogs, and vizslas. Some etiologies have age associations (*e.g.,* idiopathic epilepsy and brain tumors in younger and older dogs, respectively). In cats, intoxication is more common at 2 to 3 y, brain tumors at 7 to 8 y, and metabolic causes at 10 to 11 y of age (44–48). Regardless, seizures are possible in any species or breed at any age.

Obtain a rapid but thorough history regarding previous seizures, anti-seizure medications, seizure onset, seizure duration, what the animal was doing and how it was acting before the seizure, other medical conditions, and potential toxin ingestion. Common categorical causes of seizures are presented in Table 2.

Emergency stabilization (systemic/metabolic causes)

In addition to antiepileptic treatments, baseline electrolytes, blood glucose, PCV/TP, and possibly a chemistry panel are highly recommended. Not all metabolic causes can be treated before referral; however, treat hypoglycemia and hypocalcemia immediately.

Hypoglycemia. Hypoglycemia can *cause* a seizure or occur after prolonged seizure activity and cause seizure *persistence.* If blood glucose is < 60 mg/dL, give 25% dextrose (2 mL/kg IV) and recheck in 3 to 5 min. If hypoglycemia persists with seizures, repeat the dextrose dose [see Table 4 in Section 1 in Part II of this review (49)].

Hypocalcemia. Hypocalcemia causing a seizure is most common during pregnancy or lactation. In addition, hypoparathyroidism (dogs) and other systemic diseases can decrease calcium concentrations and cause seizures. Give 10% calcium gluconate (1 mL/kg IV) slowly over 15 min, monitor with ECG, and decrease the rate of administration if bradycardia or arrhythmia are present.

Step #3: Other stabilization steps

Temperature

Check body temperature, as prolonged seizures can cause severe hyperthermia.

Emergency stabilization. Consider cooling measures if temperature is > 40.6°C [see Box 3 in Section 1 in Part II of this review (49)] and stop cooling measures at 39.4°C. Once a seizure is controlled, body temperature usually decreases.

Increased intracranial pressure

Dogs or cats with prolonged seizure activity develop cerebral edema, which elevates intracranial pressure. Alternatively, intracranial disease (*e.g.,* tumor) can increase intracranial pressure, causing seizures. Regardless of cause and effect, elevated intracranial pressure is suspected in obtunded or stuporous animals with pupils that are fixed, dilated, or nonresponsive to light, or when there is bradycardia (< 60 bpm in dogs or < 140 bpm in cats) with high blood pressure (> 160 mmHg systolic).

Emergency stabilization. Give mannitol (0.5 to 1 g/kg IV) slowly over 15 to 30 min (use a blood filter as mannitol crystallizes rapidly) or give hypertonic saline (7.2% NaCl; 4 to 5 mL/kg IV) over 5 min. Stop all other IV fluids when administering mannitol or hypertonic saline. Beware that hypertonic saline can cause hypernatremia; monitoring electrolyte concentrations, especially with repeated dosages, is advised. Use both mannitol and hypertonic saline with caution in hypernatremic animals, since both can cause fluid shifts into the vascular space that can rapidly drop sodium concentrations.

Lung crackles

If a dog or cat has auscultable crackles or increased respiratory rate and effort even after a seizure has stopped, the top concerns are seizure-induced non-cardiogenic pulmonary edema (*i.e.,* neurogenic pulmonary edema) or aspiration pneumonia. There may be a history of concurrent disease (*e.g.,* cardiogenic pulmonary edema).

Emergency stabilization. Treat any respiratory distress (see Figure 3 in Section 1).

Practice tips

The owner of a dog or cat with SE or CS must understand the following:

1. Lifelong anti-seizure medications are likely required (unless seizures are due to a toxin).
2. The long-term objective is to reduce seizure frequency and intensity, not eliminate seizures (unless toxin-induced).
3. Medications (usually oral, perhaps multiple) will need to be given daily at regular times. Transdermal phenobarbital is an option for cats that are difficult to medicate orally (50).

Preparing to refer a dog or cat with status epilepticus or cluster seizures

- Refer *after* seizures have stopped and blood glucose and body temperature are stable.
- Administer at least 1 dose of a long-acting antiepileptic before transfer.
- If possible, ensure a patent IV catheter is in place before transfer.
- Do not transport a hypoglycemic animal. If the animal is hypoglycemic on presentation and transport will exceed 30 to 60 min, provide dextrose for oral or IV administration during transit.
- For reduced mentation, consider giving mannitol before referral to reduce intracranial pressure.
- Communicate with referral institution to obtain an estimate and set client expectations.

Refer to Part II of this review [Basic triage in dogs and cats: Part II (49)] for information on stabilization of bleeding and animals that have acutely collapsed. CVJ

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