A Pattern-Based Approach to Respiratory Distress

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Dyspnea is the sensation of "air hunger", a somewhat anthropomorphic term for respiratory distress. Dyspnea can be a sign of life-threatening hypoxemia, and thus should prompt immediate evaluation and therapy. While definitive diagnosis of respiratory disease may require invasive or time consuming diagnostic testing; history, physical exam and basic diagnostic aids are often sufficient to determine appropriate stabilization and emergent treatment of the dyspneic pet.

Because respiratory reserve capacity has been depleted, animals in respiratory distress are "fragile". While true for both dogs and cats, it is even more important in cats. Cats hide respiratory signs well as they limit their own activity; in fact, many retrospective studies of respiratory disease in cats have determined that as many as a quarter of cats present with no signs before an acute, severe bout of distress or even sudden death. When dealing with these animals, remember the axiom of "first do no harm". Invasive or stressful diagnostics should be postponed until the patient is deemed stable. Stabilization usually includes oxygen supplementation. This can be accomplished in a number of ways, including use of face mask, oxygen cage, flow-by oxygen, oxygen attached to a bag placed over the head, or nasal cannula. Severely anxious animals may benefit from sedative administration. If clinical presentation and brief exam suggests a specific diagnosis, appropriate immediate lifesaving treatment is indicated. For example, animals with a history of known heart disease presenting with mixed inspiratory and expiratory dyspnea, and crackles on auscultation can benefit from immediate therapy with diuretics and perhaps vasodilators such as nitroglycerin. In patients with inspiratory dyspnea and decreased lung sounds ventrally where pleural effusion is suspected, thoracocentesis may provide immediate relief.

There are a variety of approaches to the animal with respiratory distress. In general, respiratory distress can be caused by 1) upper airway disease, 2) lower airway disease, 3) pulmonary parenchymal disease, 4) pleural space disease, 5) chest wall and/or muscular disease, or 6) non-respiratory diseases and conditions. Localization of the disease process is key to both initial management and initial diagnostic testing.

A variety of non-respiratory conditions can lead to rapid, labored, or otherwise altered respiration. For instance, severe abdominal distention (e.g., gastric dilatation volvulus, severe ascites) can result in diagrammatic compression and limit inspiratory capacity. Severe anemia or hemoglobin abnormalities like methemoglobinemia cause tissue hypoxia and apparent respiratory distress. Metabolic disease (e.g., diabetic ketoacidosis) or neurologic disease can likewise result in dramatically altered respiratory patterns. Pain, hyperthermia and many other conditions may cause tachypnea in the absence of respiratory disease. Many of these conditions are readily apparent based on history, brief physical examination, or very minimal basic laboratory data (e.g., packed cell volume, urine dipstick).

Respiratory distress due to chest wall disease or muscular disease are also usually easily identified and separated from other causes of respiratory distress. Flail chest usually follows trauma. Multiple broken ribs result in a segment of chest wall that is pulled inward on inspiration and pushed outward on expiration, a finding that is easily recognized on physical examination. Muscular paralysis of the diaphragm and/or intercostal muscles can result in respiratory distress. The diseases which result in this type of paralysis (eg, botulism) usually result in generalized paralysis that is easily recognized on examination.

Pattern based approach to respiratory distress

The remainder of the talk will focus on approach to animals with respiratory distress due to disorders of the upper and lower airways, pulmonary parenchyma, or pleural space.

Physical examination often allows localization of distress. While all components of the physical examination can have relevance to the pet with respiratory distress, the author finds simple observation of the distressed animal to be most useful. Simply stand back and carefully observe respiration with attention to the phase of respiration during which distress occurs. Palpation, percussion, and auscultation follow observation.

Approach to the pet with loud inspiratory distress

Noisy inspiratory distress generally signals upper airway disease. Although nasal and nasopharyngeal disorders may result in stertor or other changes in respiratory pattern, they generally do not result in distress since a dog (or even a cat) can simply breathe through his mouth. Conversely, disorders of the larynx or trachea can cause distress. Most upper airway related distress is due to airway obstruction. Obstruction can be dynamic (e.g., laryngeal paralysis, cervical tracheal collapse) or fixed (e.g., tumors, foreign bodies, granuloma). Brachycephalic airway syndrome may have both dynamic and fixed components of obstruction. The noise and effort associated with dynamic upper airway collapse is largely confined to inspiration, while fixed obstruction results in noise on both phases of respiration. Although noise occurs during both inspiration and expiration, inspiratory distress predominates with a fixed obstruction. Generally, unless the obstruction is very severe, it is easier to exhale air past a mass or foreign body than to inhale around it.

For the pet presenting with noisy inspiratory distress, history and signalment can be particularly useful in formulating differential diagnoses. For the older retriever-breed dog with inspiratory stridor and distress, laryngeal paralysis is the mostly likely differential, particularly if there is a history of voice change or prior episodes of exercise induced stridor. Although laryngeal paralysis is less common in cats than dogs, it certainly does occur in this species. In small breed dogs of any age, tracheal collapse is the leading differential if inspiratory distress is accompanied by a history of paroxysmal cough. Foreign body is a frequent cause of acute onset of distress in a previously healthy young dog. For the older animal with evidence of fixed obstruction, tumor occluding the airway is likely. The author has found Cuterebra larvae in the trachea of a number of cats with noisy, inspiratory distress.

In any case, for the severely distressed pet oxygen administration and sedation may be life saving. Oxygen can be administered as described; oxygen cages are not ideal if the dog will need frequent monitoring or manipulation. Dogs with upper airway obstruction may appear more "panicked" than dogs with other forms of respiratory distress, and sedation can be a key to stabilization. However, sedation is not always effective and complete airway collapse may ensue. If these therapies fail to stabilize the pet, intubation may be lifesaving and provides the opportunity to visually inspect the larynx and surrounding structures. Tracheostomy is only beneficial if the area of obstruction can be bypassed with the tracheostomy tube.

Diagnostic evaluation of the upper airways (following stabilization) will include observation of laryngeal function under sedation, cervical and thoracic radiographs, and examination of the nasopharynx, larynx, and trachea visually and/or with endoscopy. Because relief of severe upper airway obstruction can lead to non-carcinogenic pulmonary edema, thoracic radiographs are appropriate even when upper airway obstruction is confirmed as the cause of initial distress. Tracheal collapse is rarely confined to a single segment, so both inspiratory (cervical and thoracic) and expiratory (thoracic) radiographs are indicated. Other tests may be indicated in some pets.

Approach to the pet with expiratory distress

Expiratory distress is observed primarily in disease of the lower airway, with the classic example being feline asthma. Asthma is essentially a non-entity in dogs. In dogs, expiratory distress due to dynamic airway obstruction is more likely to be related to marked intrathoracic tracheal collapse or to bronchomalacia. Although most dogs with collapsing trachea present with paroxysms of cough, they occasionally present for overt respiratory distress, collapse, and cyanosis. The condition occasionally causes death by asphyxiation due to complete collapse of either intra- or extrathoracic tracheal segments. For dogs presenting with this type of collapse, temporary intubation and rapid placement of tracheal stents can be life-saving. Only intraluminal stents are suitable for use in the intrathoracic trachea. Bronchomalacia, collapse of weakened cartilage on expiration, can result from severe bronchitis. . Expiratory wheezes are suggestive of airway narrowing as is found in bronchospasm or bronchomalacia. Bronchi are not amenable to stenting, and thus chronic medical therapy is the only management option; these dogs have a guarded prognosis at best. Chronic, progressive fixed obstruction of major lower airways (e.g., tumor) allows time for compensation and is unlikely to result in acute respiratory distress. Plugging of major or multiple airways by mucus or debris can and does lead to acute respiratory distress.

Diagnostic evaluation of the lower airways begins with good thoracic radiographs. Cats with asthma may demonstrate normal radiographs, or a bronchiolar or bronchointerstitial pattern. Additional findings in severe asthma include a flattened diaphragm and/or collapse of the right middle lung lobe. Collapse of the intrathoracic trachea is best documented on expiratory films, while evaluation of the pulmonary parenchyma is best accomplished with inspiratory thoracic radiographs. Tracheal collapse is detectable radiographically on ~60% of the time. Fluoroscopy can sometimes identify collapse that is missed on plain films. Often, visual examination via bronchoscopy is also indicated. Bronchoscopy is the most sensitive means of detecting and grading collapse of both trachea and bronchi and can identify bronchial foreign bodies, tumors, or sites of extraluminal compression. Bronchoscopy also facilitates directed sampling of airways via bronchoalveolar lavage for both cytology and culture. Eosinophilic lavage indicates asthma or parasites in cats, and parasites or eosinophilic bronchopneumopathy in dogs. Airway infection is a common cause of cough and respiratory disease, but an uncommon cause of respiratory distress unless the pulmonary parenchyma is also infected. Nevertheless, abnormal airways are more susceptible to secondary bacterial pathogens and therefore bacterial culture is often indicated.

Approach to the pet with mixed inspiratory-expiratory distress

Mixed inspiratory and expiratory distress is most often due to pulmonary parenchymal disease. There are important exceptions to this rule; these exceptions include pulmonary fibrosis (a restrictive parenchymal disease) or the combination of diseases in multiple locations (e.g., intra and extra thoracic tracheal collapse). The pulmonary parenchyma consists of the terminal and respiratory bronchioles, interstitium, alveoli and vasculature. Diseases of these tissues are varied, but prominently include infection (i.e., bacterial, viral, fungal, protozoal, or parasitic), inflammation (e.g., acute respiratory distress syndrome, eosinophilic pulmonary infiltrates, aspiration pneumonia), neoplasia (primary or metastatic), pulmonary edema (cardiogenic or non-cardiogenic), fibrosis (reactive or idiopathic), and vascular disease (e.g., thromboembolism, vascular leakage). Signalment and history are often very useful in prioritizing differential diagnosis. For example, a young, unvaccinated puppy would be more likely to have a viral pneumonia than neoplastic lung disease, and a dog with pneumonia is usually systemically ill. Physical exam findings are also useful in sorting differential diagnosis for dogs with lung disease. For example, crackles on inspiration are suggestive of pulmonary fibrosis,

pneumonia, pulmonary edema or hemorrhage. When loud, course crackles are heard in the absence of an alveolar radiographic pattern a diagnosis of pulmonary fibrosis is likely.

Oxygen administration is often crucial for stabilization of hypoxemic animals with respiratory distress due to pulmonary parenchymal disease. Sedation is less likely to benefit the dog with distress due to parenchymal disease than it is the dog with distress due to dynamic airway collapse but can still be useful in the very anxious patient. For dogs with a history of known heart disease or findings of a prominent heart murmur or dysrhythmia, diuretic therapy (i.e., furosemide) and vasodilation (i.e., nitroglycerine) may be administered pending further diagnostics. If respiratory arrest appears imminent, sedation, intubation, and ventilation may be indicated. The variety of diseases associated with parenchymal lung disorders usually necessitates further diagnostic investigation before additional treatment is initiated.

Inspiratory thoracic radiographs using an appropriate technique (long grey scale) form the mainstay of evaluation. The entire film is evaluated, including attention to size and shape of the cardiac silhouette and pulmonary vasculature as well as the presence, location, and intensity of interstitial, bronchial, and alveolar lung patterns. An alveolar pattern suggests that the small airways and alveoli are filled with fluid; water, pus, or blood. A perihilar alveolar distribution suggests cardiogenic pulmonary edema, while a crainioventral distribution is suggestive of bacterial pneumonia. The right middle lung lobe or the caudal portion of the left cranial lung lobe are most often affected by aspiration. A miliary interstitial pattern is suggestive of fungal pneumonia or metastatic lung disease, while a nodular interstitial pattern is suggestive of neoplasia, abscessation, granuloma, or eosinophilic infiltrate. A diffuse unstructured interstitial pattern associated with respiratory distress may be found in dogs with interstitial pneumonia, including non-infectious interstitial fibrotic conditions. When non-respiratory disease and upper airway disease are ruled out, respiratory distress in a dog with normal thoracic radiographs is suggestive of either very early disease (e.g., acute aspiration) or pulmonary thromboembolism. Other imaging techniques may be useful depending on results of thoracic radiographs. For instance, dogs with an obscured or enlarged cardiac silhouette should likely be imaged via echocardiography. Although they require some restraint, imaging techniques have the advantage of being relatively safe in the dyspneic dog while providing a wealth of information.

Often, invasive diagnostic techniques are required for pets with lung disease. For dogs with a productive cough and suspected pneumonia, tracheal lavage can provide good samples for cytologic evaluation and culture with minimal risk. Brochoscopically guided or blinded bronchoalveolar lavage allows sampling of the deeper airways when a definitive diagnosis is not apparent with less invasive techniques but is relatively contraindicated in the dyspneic pet; it should only be performed with potential benefit outweighs risk. Fine needle aspiration of the lungs is minimally invasive and relatively safe but diagnostic utility is limited unless there is an identifiable mass lesion or severe infiltrative lung disease present. More invasive techniques (e.g., lung biopsy) are rarely attempted in a markedly dyspneic pet. Minimally invasive tests such as CBC, chemistry profile and urinalysis rarely provide a specific diagnosis but they may suggest certain pulmonary disease conditions. For example, marked proteinuria and hypoalbuminemia could suggest that otherwise unexplained respiratory distress may be due to pulmonary thromboembolism (loss of antithrombin through the kidney predisposes to thromboembolic events).

Approach to the pet with quiet inspiratory distress

Quiet inspiratory distress is most often due to pleural space disease. This includes pleural effusion, pneumothorax, or mass effects within the pleural space. Pleural masses include tumors, granuloma, abscess, or even abdominal organs in cases of diaphragmatic hernia. Often, lung sounds are muffled in these animals, at least in some locations (e.g., ventral muffling with effusion, muffled sounds over areas of mass). Percussion may identify areas or hypo (effusion, mass) or hyper (air) resonance in the thorax. Again, signalment and history may also help order differential diagnosis; for instance, the recently traumatized dog is more likely to have pleural hemorrhage, pneumothorax, or diaphragmatic hernia than a thoracic tumor. A young, outdoor cat might have mediastinal lymphoma associated with FeLV infection.

Oxygen supplementation is certainly indicated for the pet with quiet inspiratory distress, but just as oxygen alone may not be sufficient to stabilize the dyspneic dog with airway obstruction it may not be sufficient for the dog with pleural disease. Thoracocentesis prior to further investigation can be life-saving in these pets by removing pleural effusion or air. When using a 20g butterfly catheter, the technique is relatively safe even if effusion or air are not present so attempts at thoracocentesis are unlikely to do harm and may provide tremendous benefit in these patients. If large quantities of air are removed from dogs, immediate placement of a large bore thoracostomy tube is indicated. After attempts to stabilize with oxygen and/or thoracocentesis, thoracic radiographs again become the diagnostic mainstay for animals with pleural disease. If effusion is identified, samples should be obtained for classification and possible further evaluation (e.g., culture). Other specific diagnostic tests will be chosen based on results of these first evaluations. For example, if a bloody fluid is identified from a dog without known trauma, coagulation should be evaluated; if a transudate is identified, serum albumin should be measured, if opaque white fluid without a strong smell is identified, triglycerides can confirm chylothorax.