

Nursing the Respiratory Distress Patient
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INTRODUCTION

Dyspnea is one of the most stressful emergency presentations that face as veterinary technicians. We are taught in emergency medicine to treat first what kills first, and respiratory distress can degenerate to respiratory arrest quickly without appropriate interventions. Unfortunately, we as technicians can hasten that degeneration if we are not careful with handling and judicious in the timing of those interventions. These patients are among the most fragile we treat, balancing a fine line between life and death. We must treat them with care to ensure we tip the balance in our patients' favor at every opportunity.

The American Thoracic Society defines dyspnea as "the subjective experience of breathing discomfort that originates from interactions among various physiological, psychological, social, and environmental factors." Dyspnea shares common neurologic pathways as those associated with pain in human patients and it is reasonable to believe that veterinary patients also experience distress and unpleasant sensations when suffering from respiratory difficulties. Therefore, gentle handling, and the use of chemical agents to relieve distress and pain is indicated in this patient population.

BASIC RESPIRATORY ANATOMY AND PHYSIOLOGY

The respiratory system consists of the upper and lower airways, the lung parenchyma, and the pleural space. The upper airways include the nose mouth, naso- and oro-pharynxes, and the trachea. The lower airway consists of the bronchi, which each provide oxygen to one lung and branch into bronchioles – the smallest part of the respiratory system that does not participate in gas exchange. The terminal bronchioles lead to bundles of alveoli where gas exchange occurs.

This system is designed to provide oxygen to the bloodstream and remove the cellular waste product carbon dioxide via ventilation. Inhalation brings oxygen into the alveoli where it diffuses into the bloodstream and is carried throughout the body attached to hemoglobin found in red blood cells. Carbon dioxide also uses hemoglobin to travel through the body: from the tissue beds where it is produced as a waste product of cellular respiration and metabolism to the lungs where it diffuses from the pulmonary capillary beds into the alveoli and is subsequently exhaled from the body. The diaphragm and the intercostal muscles of the thorax control inhalation and exhalation so pathology of either of these muscle groups can lead to problems with ventilation. In order to allow for the proper expansion of the alveoli within the lungs the thorax must be able to expand and increase the intra-thoracic space; fluid or air in the pleural space or within the thoracic cavity will severely limit the ability of a patient to increase the intra-thoracic space sufficiently to inflate the alveoli and perform ventilation. Because movement of air is also dependent on a pressure gradient between the atmosphere and the interior of the thorax, any defect in the thoracic wall can impact ventilation as well.

While ventilation refers to the exchange of oxygen and carbon dioxide via the lungs, oxygenation is the amount of oxygen attached to hemoglobin in the bloodstream, which we can measure via pulse oximetry. Oxygenation is key to avoiding hypoxemia, or low levels of oxygen in the blood, which, in turn, can lead to hypoxia – low levels of oxygen in the tissues – and shock, the end stage of which is cellular death.

ASSESSMENT

As with any emergent patient, the first step in treatment is a thorough assessment of the patient's status, focusing on the ABC's of triage: Airway, Breathing, and Circulation. Patients in respiratory distress may show several signs, one of the most common being an orthopneic posture. This is characterized by a sternal body position, with an extended neck, and elbows abducted in an effort to open and expand the airways as much as possible to increase ventilation. Often patients who exhibit this posture may be open-mouthed breathing as well. Flaring nostrils, or a sucking in of the lips may also be observed. Asynchronous, or paradoxical, movement of the thorax and the abdomen may be seen; the abdomen and the thorax should move in concert, both expanding and contracting with inhalation and exhalation, respectively. If the thorax and abdomen are moving in opposite directions during the ventilatory cycle, it

is an indication that the patient is using extra musculature to aid in expanding the lungs and can be a sign that exhaustion of the respiratory muscles is imminent.

The vast majority of patients who present in respiratory distress will benefit from oxygen administration on presentation. This can be accomplished in many fashions and must be aimed at reducing a patient's stress and anxiety. Many patients object to masks being placed over their nose, but may tolerate flow-by oxygen. It is difficult to reach high levels of oxygen supplementation via this method, however, and much oxygen can be wasted. An oxygen hood can be very helpful in your emergency triage area. There are many commercial options available, or an ad hoc hood can be created with an e-collar covered with plastic wrap through which the end of an oxygen tube is fed. If this option is used, be sure that a corner of the wrap is left open to allow for venting of exhaled carbon dioxide. Some practitioners may use an anesthesia induction box to provide short-term, emergency oxygen supplementation for smaller patients. This can be a good option in an emergency when handling of a patient may lead to additional stress, potentially causing the patient to decompensate. The ideal environment is an oxygen cage where the oxygen levels can be set to the desired concentration, and venting and temperature control is provided. These cages can provide high levels of oxygen supplementation while allowing observation of the patient without additional handling.

Recognizing breathing patterns is a key component of assessing patients in respiratory distress. **Table 1** shows breathing patterns with correlating affected regions of the respiratory anatomy affected, and the potential cardiac and respiratory causes of the breathing pattern. The veterinary technician plays a key role in these observations and reporting findings to the veterinarian so that appropriate interventions can be instituted in a rapid fashion. For example, if a restrictive breathing pattern is observed – characterized by inspiratory effort and asynchronicity – a thoracocentesis must be performed rapidly to restore the patient's ability to expand their alveoli appropriately and allow for ventilation. There is little harm in performing a negative thoracocentesis if pneumothorax is suspected, or if there is a suspicion of fluid build-up in the pleural space and experienced clinicians can perform this life-saving procedure rapidly. Therefore, a high index of suspicion must be maintained for pleural space or intrathoracic conditions that may respond to centesis in order to intervene quickly and early in those cases.

Breathing pattern	Affected region	Causes
Rapid, labored, synchronous, inspiratory effort	Pulmonary interstitium	Cardiac <ul style="list-style-type: none"> • Pulmonary edema due to CHF Pulmonary <ul style="list-style-type: none"> • Interstitial pneumonia • Neoplasia • NCPE • Parenchymal bleeding
Rapid, labored, asynchronous, inspiratory effort	Pleural space	Cardiac <ul style="list-style-type: none"> • Pleural effusion Pulmonary <ul style="list-style-type: none"> • Diaphragmatic hernia • Diaphragmatic paralysis • Hemothorax • Pleural effusion • Pneumothorax
Expiratory effort	Lower airway	Cardiac <ul style="list-style-type: none"> • Alveolar flooding due to CHF Pulmonary <ul style="list-style-type: none"> • Acute bronchoconstriction • Alveolar fluid accumulation • Tracheobronchial inflammation
Loud, slow, and noisy	Upper airway	<ul style="list-style-type: none"> • Elongated soft palate • Laryngeal disease • Obstruction • Tracheal disease

Table 1. Breathing patterns and affected regions. (Adapted from Rudloff)

Additionally, veterinary technicians must be cognizant of non-respiratory “look-alikes” that may have dyspneic-like symptoms, without a respiratory basis such as metabolic acidosis, anemia, hypovolemia, pain, neurologic lesions, and hyperthermia. Panting must also be differentiated from dyspnea. Both a panting patient and a dyspneic patient may exhibit tachypnea, but a panting patient will not show signs of distress related to air hunger as their ventilation (the amount of gas exchanged with each inhalation and exhalation) remains normal. Dyspnea or “air hunger” ranks among the most difficult experiences in human patients. We can extrapolate that our patients also suffer from a form of pain when in respiratory distress. Therefore, it is advisable to administer sedative and/or anxiolytic medications such as low-dose opioids or benzodiazepines to help patients relax. This relaxation and reduction of anxiety will also allow further diagnostics and therapies to commence, without exacerbating a patient’s distress. While many veterinary technicians may rush to set up the radiography suite for diagnostics, it is advisable to wait until a patient has been stabilized and is breathing with less difficulty before proceeding to obtaining radiographs. A good diagnostic imaging modality that can be used while the patient is receiving supplemental oxygen, and that also allows a patient to maintain a posture that is most comfortable for them is ultrasound and practitioners experienced in TFAST (Thoracic Focused Assessment with Sonography for Trauma) can use it to diagnose many pleural space and intrathoracic pathologies.

In addition to observation, patients should be carefully auscultated for lung sounds on presentation. Crackles or “wet” sounding lungs may indicate pneumonia or pulmonary edema. Wheezes are due to narrowed airways and may indicate airway obstruction of some kind (mucus, inflammation, foreign object). Absence of lung sounds is a particularly alarming finding and should be immediately brought to the veterinarian’s attention. There are many diseases and conditions that may lead to an absence of lung sounds including pneumothorax, hemothorax, pyothorax, or even a lung lobe torsion or diaphragmatic hernia. Observation of breathing patterns, auscultation, and even TFAST can be performed while the

patient is in an oxygen-rich atmosphere (oxygen hood, oxygen cage, flow-by) and with minimal handling or additional stress to the patient.

MONITORING THE DYSPNEIC PATIENT

It can be challenging to monitor very fragile patients in as hands-off a manner as possible to avoid further stress and distress. While we are providing oxygen, many patients will tolerate a pulse oximeter probe on their ear, which can provide us with a measurement of oxygen saturation. If we are able to provide enough oxygen to saturate 92% of the hemoglobin in a patient's bloodstream, we can avoid hypoxemia (assuming the patient is not anemic). While far from perfect, pulse oximetry is an excellent tool for monitoring trends and changes in a patient's oxygen saturation levels. To monitor ventilation (and many other parameters), capnography is an excellent tool. Capnography does not require intubation: you can place a capnometer on a mask and get a reading that will be close to the end tidal carbon dioxide reading you would receive from an intubated patient. Accuracy of this measurement is improved with a tight-sealing mask, which many dyspneic patients will not tolerate. Another option for measuring end tidal carbon dioxide – and monitoring ventilation – is to modify a nasal prong device to accept side-stream capnography tubing. An example can be found here: <http://ehced.org/wp-content/site/tutorials/etco2.pdf>

The methods described above are indirect methods of measuring oxygenation and ventilation. The gold standard for measuring both oxygenation and ventilation is collection of an arterial blood sample for a measurement of arterial blood gases. Unfortunately, most patients in respiratory distress cannot be properly restrained for arterial puncture – or venipuncture – without causing additional stress and discomfort. Since many of these patients will require intravenous medication administration, IV catheter placement is an ideal time to collect blood samples. Although these will be venous samples, they can still be used to check electrolyte and serum chemistry values. Also, venous blood gases are an acceptable alternative for assessment of carbon dioxide levels and acid-base status, but cannot be used to accurately assess oxygenation. No attempt at venipuncture should be made until the patient is breathing with less difficulty and showing decreased levels of distress.

Patients in respiratory distress may have higher than normal body temperatures because of the inability to inhale enough air quickly enough to cool themselves. Keeping these patients in a temperature-controlled environment, preferably with active cooling like fans, ice packs, or air conditioners is mandatory. Patients with laryngeal paralysis especially seem to benefit from a fan blowing directly on the face. Serial temperature monitoring can help guide treatment and alert the veterinary technician to changes in the patient.

Other non-invasive monitoring parameters depend on close, careful, and constant observation of these patients. These patients often require intensive nursing care, as their condition can deteriorate rapidly with disastrous outcomes. Changes in posture – from sternal to lateral, or lateral to orthopneic – can be an early indicator of imminent respiratory muscle exhaustion and the need to intubate to support ventilation and prevent respiratory arrest. Changes in breathing patterns, particularly if a breathing pattern shifts from synchronous (both the thorax and abdomen moving in the same direction during inhalation/exhalation) to asynchronous is another sign of exhaustion and the patient may require intubation soon. Serial auscultation can help guide therapy and indicate the need for additional thoracocenteses.

COMMON CONDITIONS LEADING TO RESPIRATORY DISTRESS

When considering underlying conditions that may lead to a patient presenting with respiratory distress, it is helpful to localize potential problems using the anatomy of the respiratory system to help localize the area of the problem. This can be done through observation of breathing patterns (see **Table 1**), as well as history and auscultation.

Airway Issues: Starting in the upper airway, conditions such as Brachycephalic Syndrome, collapsing trachea, and laryngeal paralysis (LarPar) are common presentations in the veterinary emergency clinic. These are conditions that obstruct the upper airway and lead to decreased ventilation and oxygenation. Often, they can also lead to hyperthermia, as obstruction restricts airflow and patients are not able to dissipate heat. These patients may exhibit stertor if the obstruction is more rostral: a snoring sound on

either inspiration or expiration. Patients with LarPar or laryngeal obstruction will exhibit stridor: a high-pitched sound on inspiration. Both stertor and stridor may cause loud referred sounds during thoracic auscultation. Emergency treatment of airway obstruction includes oxygen supplementation, and administration of sedative or anxiolytic medications. If the obstruction is a foreign body, or a complete blockage of the upper airway, emergency tracheostomy may be needed until the obstruction can be removed. In extreme cases, obstruction of the airway can lead to non-cardiogenic pulmonary edema (NCPE) and these patients must be monitored carefully for changes in breathing patterns, posture, mucus membrane color, oxygen saturation, or other signs that may indicate an exacerbation of their respiratory distress.

Chest Wall Issues: If the thorax cannot adequately expand and contract, ventilation will be compromised. Fatigue or exhaustion of the respiratory muscles (intercostals and diaphragm) may be involved and will be seen in paradoxical or asynchronous breathing patterns. Trauma may lead to penetration of the thorax, causing a pneumothorax as air rushes into the hole in the chest wall; this is a life-threatening emergency and must be treated immediately with thoracocentesis and possibly chest tube placement. Blunt trauma may cause a flail chest, where a segment of broken ribs cannot move in conjunction with the rest of the rib cage causing extreme pain and an inability to properly ventilate. Neuromuscular diseases (myasthenia gravis, brain or spinal cord lesions) and neurotoxins (Coral snake venom, botulism) may lead to respiratory muscle dysfunction and failure. These patients may require intubation and manual ventilation (or mechanical ventilation) to give the respiratory muscles time to recover, or to allow repair of any chest wall defect.

Pleural Space Issues: If fluid, air, or space-occupying masses infiltrate the pleural space, the lungs cannot adequately expand to allow for proper ventilation. Thoracocentesis should be performed emergently in cases where pleural space conditions are suspected and serves both a therapeutic and diagnostic purpose, as fluid obtained can be evaluated cytologically to determine its nature, or the presence of air can alert the veterinary care team to search for chest wall defects. Patients will display an asynchronous breathing pattern (especially feline patients) with tachypnea and are often orthopneic as well. After thoracocentesis is performed close monitoring is required to ensure that fluid or air does not continue to accumulate in the pleural space.

Lung Parenchyma Issues: Pneumonia is the condition most commonly thought of in terms of diseases of the lung tissue itself. Pneumonia is inflammation of the lung parenchyma caused by an infectious agent (bacteria, virus), a fungus, or by aspiration of fluid into the lungs (drowning, near drowning, aspiration of GI contents). In the veterinary hospital setting, aspiration pneumonia of stomach contents is common following surgical procedures, or in patients with laryngeal paralysis who are unable to protect their airway. When auscultating these patients, loud lung sounds may be heard and may be accompanied by crackles or rhonchi (“wet” sounds). Often patients with pneumonia have a history of worsening cough and may present with a fever (though many pneumonias are not pyretic). Emergency treatment focuses on oxygen supplementation, antibiotic therapy (if bacterial pneumonia is suspected), and supportive care.

Pulmonary edema is another parenchymal issue that may present as an emergency. Pulmonary edema is an accumulation of fluid in the lung parenchyma, around the alveoli, which leads to a reduction in ventilation (exchange of oxygen and carbon dioxide). Pulmonary edema can be divided into cardiogenic and non-cardiogenic causes and both will lead to respiratory distress (see **DIFFERENTIATING** below). Emergency treatment of either cardiogenic or NCPE includes oxygen supplementation in an effort to increase oxygenation. Patients in severe distress, or those who are unable to maintain adequate oxygenation, intubation and manual or mechanical ventilation may be indicated. Other treatments are dependent on the source of the edema and may include diuretics, vasodilatory medications, and bronchodilators.

DIFFERENTIATING BETWEEN CARDIAC AND RESPIRATORY CAUSES OF DYSPNEA

History collection is a key part of determining the underlying cause of a patient’s respiratory distress and can help the veterinary team differentiate between cardiac and pulmonary causes of dyspnea.

Radiography will also be a key method of differentiating causes of respiratory distress, which can be frustrating to the emergency practitioner as we must wait to obtain radiographs until the patient is more

stable and breathing with less effort. Some general principles can help guide the veterinary team in the absence of radiographs, however. Clients may report a cough that has acutely worsened, which points to a primary pulmonary tree problem such as tracheal collapse, bronchitis, or pneumonia. On the other hand, a cough due to heart failure is generally of acute onset, soft, and worsening over days to weeks. Patients with heart disease are often cachexic (losing muscle mass and body condition), while patients suffering from a primary respiratory disease are generally able to maintain their body conditions. Patients with primary cardiac dysfunction may have a history or presenting signs that include a heart murmur or gallop rhythm, ascites, exercise intolerance, or syncope. Primary cardiac disease patients generally have a normal or below normal core temperature, while respiratory patients will have a normal or increased temperature.

Once the patient is stable enough for radiographs there are several signs that can be seen that will help differentiate between primary cardiac and respiratory disease. An excellent tool is calculating the vertebral heart score (VHS). **Box 1** shows the procedure to follow to obtain this measurement from a lateral radiograph. While not specific in some breeds due to thoracic conformation, a VHS less than 11.4 in a dog can help rule out cardiac causes of respiratory distress. In cats, a VHS of less than 7.9 can help rule out heart disease (in conjunction with other exam findings).

If your team has access to echocardiography, it is the gold standard diagnostic tool for assessment of cardiac function and can be utilized at the cage-side, making it a very valuable tool in the emergency department for differentiating between primary cardiac and primary respiratory dysfunction.

Calculating Vertebral Heart Score (VHS)

- Using a lateral radiograph (left lateral for feline patients), measure the long axis of the heart from the top of the left atrium to the tip of the apex of the ventricle
- Measure the short axis of the heart at the widest part of the left and right heart chambers at the level of where the atria and the ventricles meet and perpendicular to the long axis
- Transpose the long axis and the short axis measurements onto the vertebral column, aligned with the cranial edge of T4 and extending along the vertebral column caudally
- Count the number of vertebrae the each measurement covers and add them together to obtain the VHS

*Normal VHS in dogs = 8.7 – 10.7**

Normal VHS in cats = < 8

Box 1. Vertebral Heart Score calculation. *Boxers, bulldogs, Boston terriers, Cavalier King Charles spaniels, Labrador retrievers, pugs, Pomeranians, and whippets have been found to have much higher scores (on average) than other breeds.

CONCLUSION

Low stress handling and oxygen supplementation are the key points to remember when caring for respiratory distress patients.

REFERENCES

Available on request