Respiratory Emergencies

Lisa L. Powell, DVM, DACVECC
(collaboration with Roberto Novo, DVM, MS, DACVS)
University of Minnesota Veterinary Medical Center

Respiratory diseases are a common presenting complaint in our small animal veterinary patients. Diseases that affect the pulmonary system can present as acute respiratory distress, or may have a chronic course. Many cases may present as an acute exacerbation of a chronic, underlying disease process. The primary goal in these cases is rapid assessment of the cause of the respiratory distress to avoid the detrimental effects of prolonged hypoxia. However, as the diagnosis is being pursued, stabilization, including oxygen administration, is vital to help support the patient.

Respiratory failure is defined as ineffective gas exchange in the lungs by the respiratory system. This may be caused by the inability to deliver adequate amounts of ambient air to the alveoli (ventilatory disease) or due to problems with gas exchange across the alveoli-pulmonary blood vessel (lung parenchymal disease). Pleural space disease causes respiratory distress due to the inability of the lungs to expand and fill with ambient air. Hypoventilation leads to hypercapnia and hypoxemia, while interference with gas exchange usually results in hypoxemia only. This is due to the increased ability of carbon dioxide to diffuse into the alveoli from the pulmonary blood vessels during gas exchange. However, with very severe pulmonary parenchymal disease, hypercarbia may develop.

The conditions most often encountered in our patients result in airflow obstruction, prevention of normal expansion of the lungs (ventilatory failure), ventilation-perfusion abnormalities (interference with alveolar gas exchange), and alteration of pulmonary circulation (thromboembolism).

Signs of Respiratory Insufficiency and Failure

Insufficiency

- Very slow or fast breathing rate
- Fast and shallow breathing (restrictive disease)
- Slow and deep breathing (obstructive disease)
- Fast and deep breathing (acidosis)
- Arrhythmic breathing patterns (medullary disease – CNS)
- Abnormal breathing sounds
  - Low-pitched snoring (big airway obstruction)
  - High-pitched squeaking (very severe, big airway obstruction)
  - Mid-pitched “wheezing” (small airway obstruction)
  - Crepitation (some airway fluid)
  - Fluid rales (lots of airway fluid)
  - Absent sounds (regional—lobar disease; generalized—pleural space disease)

- Increased breathing effort
- Percussion (more resonant—air ; less resonant—fluid or tissue)
- Radiographic evidence of pleural or parenchymal lung disease
- Arterial blood gas evidence of poor ventilation ($PaC0_2$ > 50 mmHg)
- Hypoxemia: $Pa0_2$ < 80 mmHg (21% inspired oxygen at sea level)
- Low hemoglobin saturation: SaO_2 < 91 % (21% inspired oxygen at sea level)

Failure
- Severe or extreme variation of any of the above signs
- Apnea
- Restlessness or anxiety
- Open mouth breathing or gasping
- Cyanosis
- PaCO2 above 60 mmHg
- PaO2 below 60 mmHg or SaO2 below 90% (21% inspired oxygen at sea level)

Initial Evaluation of the Patient in Respiratory Distress

Is the animal attempting to breathe? If not, the patient should be endotracheally intubated and ventilated. If yes, is it effective? If it is not effective, is it life-threatening? If the animal has respiratory disease, can it be localized? (upper vs. lower airway, bronchiolar, alveolar, pleural space)

General Signs of Respiratory Distress

Generally, animals in respiratory distress have an increased respiratory rate [>30 breaths per minute (bpm)]. As the animal becomes more distressed, they become anxious and open mouth breathe. These animals have a distinctive posture, with reluctance to move form a sternal position with the neck extended and the elbows abducted (orthopnea). If the animal's membranes are cyanotic, then extreme decompensation is present.

If these animals have a history of a cough, noisy respiration, or exercise intolerance, then the distress episode may be an exacerbation of a chronic condition.

Localization of Disease

It is essential to localize the cause of the respiratory distress with a rapid assessment of the patient. This is essential for successful management of these patients. Respiratory disorders can usually be localized to the upper airway, pleural cavity, or pulmonary parenchyma. These can be localized by observing the patient's pattern of respiration and through careful auscultation. Patterns of respiration should be confirmed by placing a hand on the chest wall to be sure that the period of inspiration and expiration have not been confused due to concomitant marked abdominal excursions.

Upper Airway Obstruction

The *upper airway* is defined as the oropharynx, larynx, and extrathoracic trachea. The typical respiratory pattern observed in patients with upper airway obstruction includes a marked inspiratory effort with a prolonged inspiratory time. Inspiratory wheezes and stridor may often be heard. Auscultation of the thorax reveals a referred upper airway sound (remember sound waves will travel down the trachea) with normal lung sounds. Auscultation of the upper airway reveals louder airway sounds, in the same patterns as auscultated on the thorax. The neck should be palpated for masses, tracheal collapse, or subcutaneous emphysema. Historic voice change may be suggestive of laryngeal involvement.

Differential diagnoses: laryngeal paralysis, brachycephalic airway syndrome, laryngeal edema, laryngeal collapse, tracheal or pharyngeal foreign body, tracheal collapse, laryngeal/tracheal trauma, nasopharyngeal polyp, neoplasia, obstructive laryngitis, granuloma, and abscess.

Pleural Cavity Disease

In these patients, a marked inspiratory effort is typical, but may be of shorter duration (short, shallow breaths) and often have a concurrent abdominal component. Expiration is effortless. No abnormal upper airway sounds are heard or auscultated. Thoracic auscultation may reveal muffled or absent lung sounds (absent ventrally and enhanced dorsally). With pleural effusion there is decreased resonance by percussion, and there is increased resonance with pneumothorax. Cats with a cranial mediastinal mass may have decreased compressibility of the anterior thorax. Cats with pleural effusion may not auscult as muffled lung sounds, and pleural space disease should always be suspected in any dyspneic cat.

Differential diagnoses: pleural effusion, pneumothorax, neoplasia, and diaphragmatic hernia.

Pulmonary Disease

These patients may have involvement of the intrathoracic airways, alveoli, insterstitial space, or pulmonary vasculature. There is a marked expiratory effort with airway obstructive diseases (acute bronchitis in cats). Increased expiratory and inspiratory efforts may be seen with other diseases. Crackles and wheezes are generally auscultated.

Rule-outs: cardiogenic and noncardiogenic edema, feline asthma, lung contusion, aspiration pneumonia, pulmonary thromboembolism, severe infection (bacterial or mycotic), and decompensation of chronic diseases (neoplasia, chronic bronchitis, and parasitic disease).

Other Abnormal Breathing Patterns

Tachypnea: in the absence of other signs of distress, this may be a normal response to nonrespiratory problems (pain, hyperthermia, stress, cardiovascular shock, anemia).

Minimal thoracic excursions: motor unit diseases can interfere with normal respiratory muscular function causing hypoventilation/hypercarbia (myasthenia gravis, tetanus, tick paralysis).

Cheyne-Stokes respiration: normal or hyperventilation following periods of apnea or hypoventilation; generally associated with disorders that affect the respiratory center in the brain or respiratory control.

Diaphragmatic breathing: the diaphragm assumes most of the control of ventilatory movement; associated with lower cervical cord damage or damage to the respiratory centers of the CNS.

Initial Management of the Patient in Respiratory Distress

All Patients

- Minimize stress. Benign procedures such as radiography, blood collection, and catheter placement can be fatal in animals in respiratory distress. Stabilization should precede any further diagnostic evaluation. Sedation can be beneficial in some patients.
- Increase inspired oxygen concentration. All patients in distress benefit from oxygen therapy. However, this should not replace immediate thoracocentesis in animals with suspected pleural space disease (pneumothorax or pleural effusion).
- Treat cardiovascular shock and acute anemia.

Upper Airway Obstruction

Reestablish airflow.

- Sedation. Especially with laryngeal paralysis, brachycephalic airway syndrome, laryngeal edema, laryngeal collapse, and tracheal collapse.
- Rapid-acting corticosteroids. Especially with laryngeal edema, brachycephalic airway syndrome, laryngeal paralysis, laryngeal collapse, and tracheal collapse.
- Remove obstruction. Especially foreign bodies.

Pleural Cavity Disease: TAP, TAP, TAP!!!!!!

Allow expansion of lungs.

- Thoracocentesis
- Chest tube. If thoracocentesis alone is inadequate (3-strikes-and-you're-out rule)

Pulmonary Disease

- Increase inspired oxygen concentration. All cases.
- Fluid therapy. With caution if edema is suspected.

Consider:

- Bronchodilators. Bronchial asthma, acute bronchitis, allergic bronchitis, thromboembolism post-adulticide therapy for heartworm disease, and smoke inhalation. Consider especially if expiratory wheezes are ausculted.
- Diuretics. With edema only. (although one dose never hurt anyone!)
- Rapid-acting corticosteroids. Bronchial asthma, acute bronchitis, overwhelming inflammation. (Long-acting corticosteroids should not be administered until a diagnosis has been made.)

- Antibiotics. Bacterial pneumonia. (Whenever possible, samples should be obtained for cytology and culture prior to administration of antibiotics.)
- Nebulization of medications for pneumonia therapy: Nebulization of antibiotics for treatment of gram negative pneumonia has been advocated by some veterinarians, although no studies have been done showing improved efficacy vs. use of parenteral antibiotics. Nebulization of mucolytics is not recommended as bronchospasm and pulmonary irritation has been reported to occur. For treatment of pneumonia, nebulization of saline is effective in keeping pulmonary secretions hydrated and to facilitate expectoration. In addition to oxygen therapy and intravenous fluids, nebulization for 10 minutes every 6 hours followed by chest coupage is effective in the treatment of severe pneumonia.
- Positive pressure ventilation. Inadequate response to increased inspired oxygen concentrations and medical therapy. (50:50 rule)

Feline Asthma or Canine Chronic Pulmonary Disease

- Emergent therapy of the allergic bronchitis patient may include the use of inhaled medications, such as albuterol and inhaled corticosteroids, in addition to injectable corticosteroids and oxygen therapy.
- Albuterol can be administered via inhalation therapy every 30 minutes for up to 4 doses. Caution should be used when using albuterol in conjunction with parenteral brochodilators such as terbutaline or aminophylline.
- *Chronic therapy for cats with feline asthma:* For mild symptoms, it is recommended to use an inhaled corticosteroid, such as Flovent®, twice daily. Albuterol should be on hand for acute exacerbations of respiratory signs. Cats with daily symptoms that are more severe but not constant should be provided with oral prednisone in addition to the Flovent® twice daily and the albuterol as needed. The prednisone can usually be tapered after 10 days, when the Flovent® starts to exert its effects. Long-term therapy of cats with severe symptomatic asthma includes Flovent® twice daily, albuterol up to four times a day, with additional oral prednisone in some cases.
- *Dogs with chronic airway disease/bronchitis:* Inhalant therapy with both corticosteroids and bronchodilators in dogs with chronic airway disease can be beneficial in patients that are difficult to control with oral medications alone. Use of an albuterol inhaler can be used intermittently for acute exacerbations of disease.
- *Procedure for MDI + Spacer Use:* The following protocol has been established by Dr. Padrid (Padrid, P. "Feline Asthma". *Vet Clin N Amer Small Anim Pract*, Nov 2000: 30(6); 1279-1293) when prescribing inhaled medications with the use of MDI's + spacers:
    1. Attach the MDI to the spacer and depress the MDI twice to fill the spacer with medication.
    2. Place the face mask gently over the patient's mouth and nose.
    3. Allow the cat or dog to breathe normally for 7-10 breaths, or for about 30 seconds.

Increasing Inspired Oxygen Concentration

- **Face Mask**
  - allows access to the patient
  - may be stressful
  - 50-60% oxygen can be achieved with flow rate of 8-12 L/min.
- **Oxygen Cage**
  - patient inaccessible
  - least stressful
  - 40% oxygen can be achieved with flow of 2-3 L/min once the cage has been filled
  - oxygen levels go back down to room air (21%) when the cage is opened
  - expensive to maintain high oxygen levels in cage
- **Nasal Catheter**
  - excellent patient accessibility
  - placement may be too stressful until patient is stabilized
  - well tolerated once placed
  - 40% inspired oxygen concentration with flows of 1-2 L/min

- **Transtracheal Catheters**
  - jugular catheter can be placed into the tracheal rings using sterile technique as with a transtracheal wash
  - excellent for patients with upper airway obstruction
  - 60-80% oxygen can be delivered with flow of 1-2 L/min
- **Endotracheal Tube**
  - allows maximum control of oxygen delivery and positive pressure ventilation
  - may be able to bypass upper airway obstruction
  - awake patients do not tolerate presence of tube: rapid induction
    - oxymorphone and diazepam IV; pentobarbital IV; propofol IV
  - 100% oxygen can be delivered with flow of 0.2 L/kg/min
- **Tracheostomy Tube**
  - provides same advantages as endotracheal tube
  - tolerated by awake patients
  - placement usually requires anesthesia or heavy sedation
  - frequent care is necessary to prevent obstruction of tube with secretions
  - DO NOT inflate cuff!
  - DO NOT suture tracheostomy tube to patient!
- **Plastic Tents with High-Flow Oxygen**
  - may be tolerated by some patients
  - animal may get out from under the tent
  - excessive oxygen loss through opening, requiring high oxygen delivery rate

Humidification of Administered Oxygen

Oxygen is anhydrous, therefore resulting in drying of the airways. Passover or bubble-through humidifiers can increase the moisture content, but are inadequate when used as the sole means of hydration (except with nasal catheters). Nebulization is also effective. If endotracheal or tracheal tubes/catheters are used, sterile saline can be instilled directly at a rate of 0.4 ml/kg/hr. It is also critical to maintain adequate patient systemic hydration.

Ventilation Therapy

Some patients who have not responded to increased oxygen concentrations may require *positive pressure ventilation (PPV).* PPV is indicated if a PaO_2 of at least 60 mmHg cannot be maintained with an inspired oxygen concentration of 50% or less. There are detrimental effects of prolonged exposure (2-3 days)of inspired oxygen concentrations of greater than 80%. Ventilation therapy is also indicated in patients with neuromuscular disorders that are not able to ventilate on their own. A $PaCO_2$ of greater than 60 mmHg is an indication for ventilatory support.

Further Diagnostic Evaluation

- Blood gas measurement (arterial vs. venous)
- Thoracic radiography
- Tracheal wash
- Cardiac evaluation (echocardiography and EKG)
- Thoracic ultrasound
- Computed tomography