Respiratory Emergencies - The Blue Patient

Jennifer J. Devey, DVM, Diplomate ACVECC
Saanichton, British Columbia, Canada
jenniferdevey@gmail.com

Respiratory distress most frequently is associated with a condition that is causing hypoxia although these patients may also be hypercarbic. Respiratory distress is a more appropriate term to use in veterinary medicine than dyspnea which is defined as the subjective awareness of altered or uncomfortable respiratory functioning. Patients may be experiencing problems with getting oxygen into the alveoli which can be a result of upper airway obstructive or disruptive abnormalities or chest wall integrity problems such as fractured ribs, sucking chest wounds or a diaphragmatic hernia. It can be caused by difficulties with lung expansion caused by pleural space disease (pneumothorax, pyothorax, chylothorax) or lower airway problems such as pulmonary edema and pneumonia.

Physical Examination

Increased respiratory rate can indicate respiratory distress. This obviously needs to be differentiated from unrelated conditions such as pain or anxiety. Increased respiratory effort should always be taken as a sign of respiratory distress. Open mouth breathing and simply being able to easily observe chest wall movement and auscult lung sounds (unless an electronic stethoscope is being used) should be considered abnormal until proven otherwise.

The patient's posture should be noted. Dogs and cats with increased respiratory effort secondary to injury or disease often are unwilling to lie down although the cat may sit in sternal but refuse to curl up or lay in lateral recumbency. Any cat lying in lateral recumbency with signs of respiratory distress should be assumed to be close to arrest until proven otherwise. Nostril flaring indicates increased respiratory effort but does not necessarily indicate pathology.

Wheezing, crackles, and stridor all indicate abnormalities. The presence of stridor should alert the clinician to the fact that there may be an almost 80% airway occlusion. The trachea should be evaluated in all patients. Once the trachea has been ausculted the neck should be palpated noting tracheal position and tracheal/peritracheal integrity. The presence of subcutaneous emphysema in the cervical or thoracic region in a cat that has a history of a recent anesthetic or trauma to this region often is associated with a ruptured trachea. This can be associated with a pneumomediastinum and pneumopericardium, which can become a tension situation if there is no escape valve to the exterior of the animal. Auscultation of the trachea is often a more direct window into lower airway pathology than transthoracic auscultation.

The breathing pattern should be closely observed. Symmetry of chest movement and the presence of any abdominal component to the breathing pattern should be noted. Rapid shallow respiration typically is associated with pain (especially related to chest wall trauma) or pleural space disease where the patient is unable to expand its lungs. Pneumothorax, hemothorax, chylothorax, and pyothorax all can be associated with a restrictive breathing pattern. If paradoxical chest wall movement is observed a flail chest should be suspected. Increased chest wall expansion often is associated with lower airway disease although can indicate a collapsing trachea. Prolonged or forced expiration is associated with trapping of air in the lower airways such as occurs with allergic bronchitis or other diseases causing bronchospasm. Respiratory muscle abnormalities are associated with a significantly increased effort on inhalation with decreased chest wall expansion. This is most commonly seen with neuromuscular diseases and diaphragmatic hernia. Patients with paradoxical abdominal movement have severe respiratory compromise. These patients also should be assumed to be close to collapse due to exhaustion and ventilatory failure until proven otherwise.

The chest should be ausculted for the presence of breath sounds, areas of dullness, crackles or wheezes in at least 4 quadrants (upper and lower right and left sides). Crackles indicate alveolar exudate – typically pulmonary edema or pneumonia. Crackles may be very difficult to auscult in cats. Wheezes are consistent with obstructive lower airway disease. Foreign bodies in the lower airways also can cause similar sounds. Areas of dullness may indicate severe pulmonary infiltrate, pleural fluid, intrathoracic masses, or the presence of abdominal contents in the thorax. The heart should always be ausculted after ausculting the lungs since once the ear has accustomed itself to louder sounds quieter sounds can be more difficult to hear. Because of the narrow chest wall of the cat, lung sounds can be referred easily across both hemithoraces making it difficult to pick up unilateral abnormalities in this species.

Gastric distention secondary to aerophagia can lead to significant respiratory compromise or even cardiovascular collapse and the abdomen should be examined with this in mind.

Cyanosis is an indication of hypoxemia or a PaO_2 of less than 60 mm Hg. Cyanosis can be difficult to detect if the patient has a hemoglobin less than 5 g/dl or with certain fluorescent overhead lights.

Radiographs
Radiographs are an essential component of the evaluation process for the patient with respiratory compromise; however, they should not be a priority in the unstable patient. Stabilizing the patient is always the first priority. Care should be taken to ensure positioning does not compromise the patient's ability to breathe. The radiograph should be evaluated systematically to ensure abnormalities are not missed. The bones, soft tissues surrounding the thorax, pleural space, trachea and large airways, lungs, mediastinum, heart, great vessels and diaphragm all require assessment. In patients with upper airways diseases the cervical trachea and pharynx may require radiographic evaluation. Sedation may be required for diagnostic radiographs but this should be done with extreme caution in the compromised patient. Dynamic studies often provide valuable information.

Ultrasound
Point of care thoracic ultrasound can provide a rapid, efficient means of diagnosing pathology and has been shown to be more sensitive than a stethoscope. Five anatomic locations are interrogated. Pleural and pericardial effusion can easily be diagnosed. Lack of a glide sign indicates a pneumothorax and the presence of hyperechoic lines ("lung rockets") is consistent with pulmonary disease including contusions, pulmonary edema, pneumonia, and neoplasia.

Respiratory Support
Respiratory support of the critically ill or injured patient can be divided into oxygen support and ventilatory support. The end goal of respiratory support is to ensure adequate oxygen reaches the blood and carbon dioxide is removed from the blood. Oxygen should be considered a first line drug and should be provided to any patient that presents with an increased respiratory rate or effort or evidence of cyanosis.

Oxygen
Oxygen can be provided in a variety of forms. An oxygen source, baggie, plastic wrap, Elizabethan collar, and red rubber tubes are all that are necessary to provide oxygen to almost any patient. It is recommended that a direct oxygen source be available; however, if an anesthetic machine is used then a "Y"- shaped adapter should be used to bypass the anesthetic circuit. A "Y" connector is placed in the tubing before it enters the circle. A piece of tubing connects the "Y" to the circle and the second arm of the "Y" is connected to the oxygen tubing to the patient. A hemostat or C clamp is used to clamp off the oxygen to the patient or to the circle system depending on what is required. Nasal and tracheal oxygen should always should be humidified, although nasal oxygen may be able to be delivered for up to 24 hours not humidified. Hood, mask and flow-by oxygen should not be humidified.

Oxygen is most easily provided by using oxygen tubing that is connected directly to the oxygen source. The end of the tube is placed in front of the patient's nose or mouth. The flow rate is 1-10 L/min, depending on the size of

the patient, but it may need to be decreased based on patient tolerance. A mask also can be used but is often much less well tolerated and may cause increased stress unless the patient is recumbent. If a mask is used the rubber fitting should be removed. Many animals will tolerate having their heads or even most of their bodies placed inside a plastic bag. The oxygen tubing is placed through a small hole in the front of the bag and the back of the bag is left open to allow gas to escape. This is particularly useful in the obtunded patient because high concentrations of oxygen can be provided (75-95%) while allowing other procedures to be performed (blood drawing, placement of catheters, x-rays etc.) An oxygen hood can be made by covering the ventral 75% of an Elizabethan collar with plastic wrap. The Elizabethan collar should be 1 size larger than would normally be used for that size of patient. The oxygen tubing is placed along the inside of the collar and taped in place ventrally. Oxygen concentrations of up to 80% generally can be achieved. Flow rates of approximately 1 L usually provide an adequate FiO_2. Flow rates should be adjusted based on patient comfort, clinical status, pulse oximetry, and blood gases. Oxygen hoods generally are not tolerated by the panting dog as the hood rapidly becomes overheated and over-humidified.

Nasal oxygen is the most effective way to provide oxygen to the patient. For small patients 3.5 to 5 Fr tubes are used. For medium-sized dogs 5-8 Fr tubes are used and for larger dogs 8 to 10 Fr tubes are placed. Cats will usually tolerate 5-8 Fr tubes. The nasal catheter is typically measured from the tip of the nose to the lateral canthus of the eye so that the tip will be in the nasopharynx (nasopharyngeal catheter). Clinically animals tolerate the oxygen better if the tip is at this location as opposed to being in the nostril. A narrow bore red rubber or other pediatric feeding tube is placed in the ventral nasal meatus and sutured or stapled to the patient's nose and on the side of the face or on the bridge of the nose between the eyes. At flow rates of 100 ml/kg/min the FiO_2 will be a minimum of 0.4 and may reach as high as 0.65. Nasal oxygen should be avoided in the patient with severe nasal or pharyngeal disease and in the patient with severe thrombocytopenia. Sneezing will elevate intracranial pressure and nasal tubes should be avoided if this is a concern.

Oxygen cages also can be used to provide oxygen to patients but have several drawbacks and should be used only if other forms of providing supplemental oxygen are contraindicated. The biggest problem is the inability to evaluate the patient except through observation. Each time the door to the cage is opened the oxygen level drops substantially. This can lead to significant patient anxiety and respiratory compromise. The oxygen flow rates required to operate the units effectively makes this a costly alternative. On occasion, due to the stressed nature of cats with respiratory problems an oxygen care is essential. It would be ideal in these circumstances to use a small volume 'cage' such as a pediatric incubator.

Gastric Decompression

Patients with significant gastric distention that appears to be causing significant respiratory compromise or hemodynamic instability may require immediate gastric decompression. This can be accomplished either by transabdominal trocarization or orogastric intubation. Immediate decompression of a severely distended stomach can lead to cardiovascular collapse and ideally should be avoided until fluid resuscitation has been initiated.

Ventilatory Support

If the patient does not respond to supplemental oxygen rapid sequence induction, intubation, and ventilation should be considered. Suction should be readily available. Response to therapy usually can be gauged by monitoring respiratory rate and effort, presence of cyanosis, pulse oximetry readings, and blood gases.

Tracheostomy

A tracheostomy is indicated in the patient with an upper airway obstructive disorder that cannot be relieved, when airway control is indicated but an endotracheal tube is not possible or not desirable, in patients with severe bronchopneumonia, and in the patient who requires prolonged ventilatory support. If the thought occurs to you that a tracheostomy is indicated then one probably should be placed! Other indications include situations when an endotracheal tube cannot be inserted in a patient with an obstructed or near obstructed airway, when the obstruction is rostral to where the proximal portion of the tracheotomy tube ends, when it is necessary to assess

and treat the bronchoalveolar (pulmonary) tree such as delivery of medications and aspiration of exudate, and when it is necessary to decrease the dead space and airway resistance, in order to decrease the work of breathing.

There are no absolute contraindications but there are several relative contraindications. If the tracheostomy is the only breathing route for the patient then the patient must be monitored around the clock since coughing mucus into the tube will cause a complete airway obstruction and suffocation. Appropriate humidification and suction equipment as well as replacement tubes must be pleasant. A tracheostomy may not be ideal when the patient has a coagulopathy, when suction equipment does not exist, and in situations when an endotracheal tube may suffice.

A tracheotomy can be performed most easily on an anesthetized patient. The patient is placed in dorsal recumbency and a towel or IV fluid bag is placed under the neck which pushes the trachea ventrally. An incision (approximately 5-8 cm or 2-3 inches long) is made on the ventral cervical midline about midway between the cricoid cartilage and the thoracic inlet. The "strap" muscles (sternohyoideus) are separated using blunt or sharp dissection and the trachea is exposed. The trachea is elevated into the incision using thumb and fingers. An incision is made between 2 tracheal rings at the level of rings 3 to 6 extending about 40% of the circumference of the trachea and a tube is placed in the incision. Traction sutures are then placed through the 1 ring cranial and 1 ring caudal to the tracheotomy and tied with the knot approximately 8-10 cm or 3-4 inches from the trachea. These sutures are used for opening the trachea when the tube needs to be exchanged. A tube approximately 1-1.5 sizes smaller than what would be used for orotracheal intubation is placed.

Commercial tracheostomy tubes can be used or a clear endotracheal tube can be modified. To modify an endotracheal tube the plastic connector is removed from the end of the tube. Two cuts are then made in the tube 180 degrees apart. The cuts are made long enough so that the tube that remains intact is the right length for the patient (i.e., reaches from the tracheotomy to the thoracic inlet region). Do not cut the cuff inflating mechanism. The 2 wings that are created can be cut short if needed. The tube connector is placed back into the tube. Two holes are created the end of each wing and umbilical tape or IV tubing is placed through the holes and tied around the back of the neck of the patient. The tube is not secured in any other form to the patient. Two or 3 sterile 4x4 squares are placed between the tube and the tracheotomy incision.

Choosing an inappropriately-sized endotracheal tube can lead to a significant problems for a patient if they are breathing spontaneously. One study showed an increase in the work of breathing of 34% and increase in airway resistance of 25% if the diameter of the endotracheal tube was decreased by only 1 mm. When picking an appropriately-sized tube estimation by digital palpation of the trachea was shown to be the most accurate method.

Sterile saline (2-10 ml depending on the size of the patient) should be instilled or the patient should be nebulized (preferred) q2-4 hours to help lubricate respiratory secretions. The tube should be suctioned q6-8 hours after instilling saline and hyperoxygenating, and should be aseptically changed q6-12 hours or as needed. When suctioning larger patients the operator should inhale a normal breath and hold the breath. When the operator comfortably feels the need to breathe suction should be discontinued. For small patients the breath should be exhaled then held. When the operator comfortably feels the need to breathe the suction should be discontinued. Oxygen can be provided via the tracheostomy by placing a sterile red rubber catheter through the tracheostomy tube. Care should be taken to ensure the oxygen tube is not too large and does not obstruct exhalation. When the tube is no longer needed the tracheotomy incision is left to heal by second intention. It should not be bandaged until the tracheotomy incision is healed to avoid developing subcutaneous emphysema.

Thoracentesis

Pleural space disease (pneumothorax, hemothorax, pyothorax, chylothorax) often can be diagnosed based on the presence of a rapid shallow respiratory pattern, loss of airway sounds, or hollow sounds on percussion of the thorax. Any patient who is suspected of having pleural space disease should have a thoracentesis performed prior to taking radiographs. The stress of the radiographic procedure in a patient with severe pleural space disease may lead to respiratory arrest. Thoracentesis is performed between the 7^{th} and 9^{th} intercostal spaces. The thoracentesis

is performed in whatever position the patient is the most comfortable (sternal, sitting, lateral recumbency). Thoracentesis should always be performed bilaterally unless the patient is known to have unilateral disease. The area is clipped and prepped and if the patient is painful local anesthesia should be instilled in the skin and down to the pleura. The needle is introduced slowly until the pleura is penetrated at which point the needle is angled parallel to the chest wall with the bevel pointed medially. This will prevent injury to the lung as the pleural space is evacuated. If negative suction is not achieved a chest tube will need to be placed.

Chest Tubes

Chest tubes can be placed under sedation and local anesthesia or under general anesthetic. In most dogs chest tubes can be placed under sedation and local anesthetic. General anesthesia is required in most cats. If general anesthesia is required the patient should be intubated and ventilated. The size of the chest tube should be the approximate diameter of the mainstem bronchus in a patient with a pneumothorax since this is conceivably the largest hole that could exist. It also helps prevent having the tube clog with viscous fluids or blood clots. Smaller diameter tubes may be chosen for patients with a chylothorax or pyothorax.

In the case of a pneumothorax a 3-way stopcock can be placed in the tube and the tube can be aspirated on an intermittent basis; however, this is only advised if it is anticipated that the patient will only accumulate small volumes of air. Ideally continuous underwater suction should be used on chest tubes until it is established that the air leak is resolving.

Analgesia must be provided to every patient with a chest tube. This can be effectively provided using local or regional blocks a mixture of lidocaine and bupivacaine. Intercostal nerve blocks for 1-2 rib spaces either side of the tube can be performed or intrapleural analgesia can be provided by administering the local anesthetics via the chest tube into the pleural space. Local anesthetics should always be either warmed to body temperature or mixed (1:9) with sodium bicarbonate to decrease the sting. Parenteral narcotics should be provided if local anesthetics are not providing sufficient analgesia.

Continuous Positive Pressure Airway Support

Continuous positive airway pressure helps to decrease the work of breathing and improve gas exchange. It is defined as maintaining the pressure above atmospheric pressure throughout the respiratory cycle. This can be used as a bridge in patients that do not fully respond to oxygen support but positive pressure ventilation is not an option or if it is felt that some assisted ventilation may help avoid the need to positive pressure ventilation. A modified form of CPAP can be fairly easily provided to most awake dogs. A fairly tight fitting mask attached to an anesthetic circuit is placed on the patient. The pop-off valve is tightened down and the oxygen flow rate is increased until the pressure on the circuit registers at 5 cm H_2O. The patient breathes this oxygen under high pressure.

Nebulization

Nebulization therapy should be used for treating patients with pneumonia and bronchoconstrictive disease (i.e., feline allergic bronchitis). It is provided using a commercial unit or oxygen delivered at high flow rates through a nebulizer. The nebulized fluid can be delivered via face mask, into a baggie placed over the patient's head, or into an enclosed chamber if the patient will not tolerate the flow directed at the face. Saline (0.9%) is an excellent mucolytic if nebulization is being used to loosen secretions. Bronchodilators such as albuterol and terbutaline as well as corticosteroids such as fluticasone can be given by nebulization to asthmatics.

References available on request.