Clinical examination of any animal with respiratory difficulty should include auscultation of the thorax. Sometimes it is difficult to hear air movement in all or part of the lung fields. If lung sounds cannot be heard in one localized area of the chest, this suggests absence of air movement through one particular lung lobe, such as might occur with a consolidated lung lobe or neoplastic mass. If the sounds are dull all over the chest, one might consider pleural disease such as pleural effusion, pneumothorax, or diaphragmatic hernia. In some cases, a fluid line may be ausculted above which air movement can be easily heard, but below which the sounds are dull. Pleural effusions tend to cause dull lung sounds in the ventral part of the thorax, while in animals with pneumothorax the dull sounds are more dorsal. Unilateral changes in auscultation can suggest the presence of a mass lesion or diaphragmatic hernia, or can occur in the presence of loculated fluid. In animals with pleural space disease, the heart sounds are usually quiet, in addition to the lung sounds. This is in contrast to animals with pericardial disease, in which the heart is quiet but the lungs are normal.

Heart disease is an important cause of pleural effusion, especially in cats, therefore the heart should be carefully ausculted in each case. Although some cats with congestive heart failure have normal cardiac auscultation, most will have evidence of a murmur or an arrhythmia. Discovery of an abnormal sound on cardiac auscultation elevates heart failure on the list of differentials and provides the clinician with an important therapeutic direction.

Clinical signs in animals with pleural space disease include:
Increased respiratory rate and effort, “restrictive” breathing pattern
Dyspnea
Cough may occur
Dull or diminished lung sounds on auscultation
Fever may occur
Weight loss and lethargy

**Differential diagnoses for pleural space disease:**

Fluid (Pleural effusion)
- pyothorax
- non-bacterial exudates eg FIP
- chylothorax
- hemothorax
- transudates (pure and modified) eg right heart failure
- neoplastic effusions

Air (Pneumothorax)
Thoracocentesis

Thoracocentesis should be performed in any animal that has evidence of pleural effusion on clinical examination or on a thoracic radiograph, and in any animal with a clinically significant pneumothorax that is affecting respiratory function. Thoracocentesis is a readily available and practical technique that is often of immense diagnostic as well as potentially life-saving therapeutic value, and in most cases no other technique or therapy can be substituted for its use. Since all fluids within the pleural cavity appear the same soft-tissue density radiographically, it is vital to obtain samples in order to reach a diagnosis. Large amounts of pleural fluid or air are likely to significantly impair respiration, so their removal can often be a life-saving procedure. In the case of an animal with pyothorax, drainage of even moderate amounts of purulent fluid may also be life-saving by minimizing the risk of sepsis. In an emergency when an animal presents in respiratory distress, obtaining radiographs may be time-consuming and stressful. In this instance, diagnostic and therapeutic thoracocentesis may be performed immediately to rule out a pneumothorax or pleural effusion, since this procedure is easy and may be life-saving. This is of particular importance if auscultation of the chest reveals dull or absent lung or heart sounds.

Sedation is not usually required in dogs, but some cats may require short-acting or reversible sedatives in order to carry out thoracocentesis. The dog or cat is restrained by one or two assistants in a sternal position if possible. It can be more difficult to perform a successful thoracocentesis if the animal is in lateral recumbency, since fluid will tend to drain downwards towards the dependent side. The usual site for thoracocentesis is the 7th or 8th intercostal space, which can be located by counting backwards from the 13th rib. If fluid is present in the pleural space, the needle is inserted low down, near the costrochondral junction, to maximize the chance of obtaining a sample. If a pneumothorax is thought to be present, the needle should be inserted more dorsally in the intercostal space. The clinician should attempt to insert the needle cranial to the rib, since the intercostal blood vessels run caudal to the rib.

Once the site has been located, it should be clipped and scrubbed. The needle and extension tubing are attached to the 3-way stopcock and the syringe. The needle is then inserted perpendicular to the skin and advanced slowly through the intercostal muscles. Once the needle is in the intercostal muscles, an assistant can begin to create some negative pressure using the syringe. As soon as the needle passes through the pleura into the intercostal space, fluid will be seen within the tubing, and the needle should then be kept stationary as fluid is aspirated into the syringe. If a pneumothorax is present, when the needle penetrates the intercostal muscles the assistant will find the syringe filling with air. The needle should be kept stationary as long as fluid or air continue to be obtained. If a scraping or bumping sensation of the needle is felt, the needle should be withdrawn...
slightly. Eventually negative pressure will be reached and the needle can be removed. The same procedure may then be repeated on the other side of the chest.

In some patients, especially if fluid is loculated within the pleural cavity by fibrin tags and fibrous adhesions, it can be difficult to clear all of the fluid by aspirating from one site. These animals can be very frustrating to treat since multiple sites must then be used, either selected at random or using thoracic radiographs for guidance. In these cases, ultrasonographic guidance can be very helpful, by helping to locate fluid pockets within the chest.

Thoracocentesis is not a particularly stressful or painful procedure, but some animals in respiratory distress (especially cats) may object to the restraint that is required. If excessive struggling occurs in the dyspneic animal, this can be life-threatening. Sedation or anesthesia may be vital in this situation in order to allow thoracocentesis. If the clinician elects to use chemical restraint, respiration must be observed carefully, and ideally the animal should be intubated and ventilated with oxygen if it is anesthetized.

The incidence of complications with thoracocentesis is generally low, and primarily relates to damage by the needle within the thoracic cavity. Lacerations of lungs leading to pneumothorax, or coronary vessels leading to hemorrhage, may occur. This can be minimized by careful control of the needle tip, and by reducing struggling by the animal. Coagulopathies are a relative contraindication of thoracocentesis - but sometimes the procedure cannot be avoided, especially in the case of life-threatening pleural hemorrhage. Occasionally air may escape into the pleural cavity through the needle, but this usually leads to only minor pneumothorax.

Emergency management of animals with pleural space disease
- Provide oxygen supplementation
- Rest the patient and avoid stress
- Obtain vascular access if it does not induce too much stress
- Perform thoracocentesis, analyze fluid
- Thoracic radiographs if possible after thoracocentesis

Fluid analysis:
- Cell counts
- Cytology
- Aerobic and anaerobic culture
- Biochemical analysis if indicated (triglycerides)

Differential diagnosis of hemorrhagic pleural effusions

When the thoracocentesis yields pleural fluid that initially looks like blood, several possibilities should be considered. The first consideration is to decide whether the effusion represents hemorrhage, or a hemorrhagic pleural effusion. The simplest way to answer this question is to run a quick PCV/TS on the fluid. Because hemorrhaging animals may be anemic, if they are bleeding into the pleural space the resulting fluid may have a lower than expected PCV. Thus, it is important to compare the PCV of the pleural fluid with a concurrently obtained PCV/TS on the patient’s peripheral blood. True hemorrhage will have a PCV close to (at most 10% different) from
that of the patient’s blood. If the fluid represents active hemorrhage, the top differential diagnoses include:

- Trauma
- Coagulopathy
- Neoplasia

However, many pleural effusions that initially look like blood in fact turn out to be hemorrhagic fluid when they are analyzed. In these cases, the PCV of the fluid is much lower than that of the patient’s peripheral blood. The top differential diagnoses in cases with hemorrhagic pleural effusions are:

- Neoplasia
- Bacterial infection/pyothorax
- Diaphragmatic hernia
- Lung lobe torsion
- Idiopathic

Further fluid analysis should also include nucleated cell counts and cytology. High nucleated cell counts may occur in the presence of inflammation or neoplasia. Cytology may be diagnostic for neoplasia if the tumor exfoliates well, for example in the case of lymphosarcoma. However, some neoplasms, such as hemangiosarcoma, may not exfoliate well. Bacterial infection may result in extremely high nucleated cell counts, as high as 70,000-100,000 cells/mm³, most of which will be neutrophils. Lung lobe torsions tend to be associated with moderate elevations of nucleated cell counts, most of which will be macrophages.

**Chylothorax**

Chylothorax is the presence of pleural effusion caused by leakage from the lymphatic system. Classically, the etiology is thought to be from occlusion, damage or rupture of the thoracic duct. Chylothorax is usually recognized by the presence of white or cloudy pleural fluid, the cytology of which usually includes at least some small lymphocytes. Diagnosis of chylothorax is confirmed by submitting the fluid for triglyceride testing. Triglyceride levels greater than 100 mg/dl are diagnostic for chylothorax. Clinicians often opt to compare serum and pleural effusion triglyceride levels. This can be useful, particularly if the patient has recently been anorexic, which would result in low plasma and pleural effusion triglycerides.

**Lung lobe torsion**

Lung lobe torsion is an uncommon cause of respiratory distress and pleural effusion in dogs. The lung lobe twists at the hilus, initially compressing the thin-walled veins draining the lobe, then eventually compressing and occluding the bronchus and the muscular arteries. Initial compression of the veins draining from the lung lobe causes engorgement and swelling of the lobe with blood. As the hydrostatic pressure increases in the vessels in the lung lobe, pleural effusion begins to develop as hemorrhagic fluid leaks from the surface of the lung. Occlusion of the bronchus results in gradually progressive absorption atelectasis, until eventually the lobe is completely free of air, contributing to severe hypoxia in the patient. Finally, occlusion of arterial blood flow results in lack of oxygen delivery to the lung lobe, followed by inflammation and necrosis. If untreated, severe
systemic inflammatory response syndrome may ensue, which is often associated with ARDS and death.

The most common lung lobe to twist is the right middle lung lobe. Cranial lung lobes are also occasionally affected, and in fact a lung lobe torsion can occur in any of the lung lobes. Lung lobe torsions are particularly common in deep-chested dogs, with a high predisposition in certain sight-hound breeds especially Afghan hounds and Borzois. Interestingly, Pugs are also over-represented. However, lung lobe torsions can occur in any breed of dog. The etiology is not well understood. In the presence of a pleural effusion, it is thought that lung lobes that are floating in fluid may be predisposed to twisting at the hilus. However, lung lobe torsions can also occur in animals that do not have pleural effusions. Since the presence of a torsed lung lobe can then cause a pleural effusion, it can often be difficult to determine which came first.

There is a well-recognized association between lung lobe torsions and chylothorax. This may reflect the concurrent predisposition of certain breeds to develop both conditions, in particular Afghan hounds and Borzois. However, there is likely a connection between the two conditions, as they usually occur at the same time. Chylothorax may be caused by damage to the thoracic duct due to increased pressure related to the lung lobe torsion. Therefore, the lung lobe torsion may occur first, causing a chylothorax. Alternatively, an idiopathic chylothorax may occur first, followed by torsion of a lung lobe that is floating in the fluid. If there is a chylothorax present at the time of diagnosis of the torsed lung lobe, the outcome following surgical lobectomy is variable. In many dogs, timely removal of the lobe results in rapid improvement and resolution of the chylothorax. However, certain breeds (especially Afghan hounds) have a particularly poor prognosis when faced with this combination of problems. Although they usually survive surgery and lung lobectomy, chylothorax tends to recur and be refractory to treatment.

Clinical signs of lung lobe torsion include dyspnea, muffled lung sounds, fever, and cough. The diagnosis should be suspected if the pleural effusion is hemorrhagic in character, especially if the cytology is predominantly macrophages. Fluid should be submitted for triglyceride concentrations in order to decide whether or not chylothorax is present, even if it does not appear to be white or creamy at initial presentation. Radiographic findings include alveolar disease that is localized to one lung lobe. Often the bronchus to the affected lobe is twisted, in an abnormal anatomic location, or abnormally truncated. Imaging modalities that may be used to confirm the diagnosis can include ultrasound and thoracic CT.

Treatment of lung lobe torsions

Once a lung lobe torsion is diagnosed, the only option for treatment is surgical. It is very important to remove the necrotic lung tissue before the condition progresses to SIRS, organ failure and death. A thoracotomy must be performed as soon as possible to resect the torsed lung lobe without untwisting it at the hilus. If a chylothorax is present pre-operatively, then many surgeons will prefer to include preemptive surgical treatment of the chylothorax at the time of the thoracotomy. Various surgical options for the chylothorax can be utilized, including combinations of thoracic duct ligation and pericardiectomy. Additional procedures that may be considered, especially in high risk breeds such as Afghan hounds, include omentalization of the thorax, and placement of a
pleuroport for chronic drainage of fluid from the pleural space.

The post-operative course is characterized by significant ongoing pleural effusion for the first 48-72 hours. It is not unexpected to see production of up to 3 or 4 liters of pleural fluid per day during this time. The post-operative fluid is serosanguineous in character, and tends to have a low to moderate neutrophilic component due to inflammation caused by the surgery. There is often a considerable amount of protein loss, initially during the surgical procedure and then ongoing losses into the inflammatory pleural effusion. Typically, the amount of fluid gradually decreases over the first 48 hours. The chest tube can be removed once the amount of fluid decreases to less than 5 ml/kg/day. If the fluid becomes chylous (cloudy or creamy, lymphocytic component), or the volume produced does not decrease, then the longterm prognosis is worse for that patient.

Post-operative care includes fluid therapy to replace ongoing losses, colloid support and blood product transfusions. It is important to quantify the amount of fluid being lost per day through the chest tube, and to make sure to keep up with those losses using appropriate fluids. Patient monitoring should include frequent evaluation of physical parameters, and also PCV/TS, heart rate, blood pressure and urine output. Remember that the PCV is often higher than expected in dogs of the sight hound breeds. If the PCV and heart rate begin to increase, and/or blood pressure and urine output decrease, then administration of higher volumes of intravenous fluids should be considered. Colloids should be used judiciously in patients that are hypoproteinemic. Blood products may be indicated in the presence of anemia or coagulopathy.

Pain management is very important because of the post-operative pain associated with the surgical site and also the presence of the chest tube. Typically, parenteral drugs are needed, but care must be taken to avoid adverse drug effects. Drugs often used alone or in combination include methadone, hydromorphone, fentanyl, morphine, ketamine, and/or lidocaine. NSAIDs may be helpful as long as there is no evidence of renal compromise. The alpha-2 agonists may also be considered as long as the animal is cardiovascularly stable; however there is such a high incidence of instability in these patients that this category of drugs is probably best avoided.

Many of these animals have experienced anorexia and significant protein catabolism over a prolonged period of time, and therefore they are often cachectic. This is especially true of the sight-hound breeds. Therefore, nutritional support (parenteral or enteral if tolerated) can be important in the immediate post-operative period because these animals often do not eat for a few days, especially if they are receiving narcotic drugs for pain management. Dietary fat restriction is often advocated in dogs with chylothorax, but this should not be confused with calorie restriction, which can become an important consideration in cachectic sight hounds. Data is lacking supporting the efficacy of dietary fat restriction in treatment of chylothorax, therefore it may not be necessary to modify the type of food in the immediate post-operative period.

REFERENCES AVAILABLE ON REQUEST