Pleural Space Disease

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The pleural space is defined as the area between the lungs and the chest wall. Normally there is no soft tissue or free air present in this space. A very small amount of fluid (undetectable on radiographs or ultrasound) may be present within the thoracic cavity. Clinical signs of pleural space disease include tachypnea or difficulty breathing with classically rapid/shallow breathing considered the most common. It is important to recall that pleural effusion is a sign rather than a specific diagnosis. Physical examination findings may include respiratory distress and muffled heart/lung sounds. Occasionally, lung sounds may appear normal. It may be possible to percuss a ventral dullness. Other findings may reflect the underlying disease process (ie gallop, murmur, fever, trauma). Diagnosis of pleural effusion may be made either through thoracocentesis, or imaging (usually radiographs, but fluid may also be visualized on ultrasound). Radiographic signs of pleural effusion include decreased detail ('white out"), scalloping of the ventral lung borders, fissure lines between lung lobes and an obscured cardiac silhouette. Chronic pleural effusions may result in the radiographic appearance of "rounded" lung margins. Therapy of pleural effusion is directed at both improving respiratory status by removing fluid/air and at identifying the underlying cause.

Thoracocentesis is performed by clipping and sterilely preparing an area between the seventh and ninth rib at approximately the costochondral junction. Occasionally, the site may be lower or higher based upon suspicion of fluid (lower) or air (higher). The animal should be gently restrained in a sternal or standing position. Typically, in cats and small dogs a butterfly catheter, stopcock and 5-30 ml syringe are used. In large cats and most dogs, a longer needle is required. Aseptic technique is recommended. A distinct "pop" is felt upon entering the pleural cavity. Volumes of fluid and air retrieved should be recorded. Animals with chronic effusions are MUCH more likely to develop a pneumothorax following thoracocentesis. Samples of fluid should be saved for cytology and culture (if indicted). Fluid analysis is often very helpful in determining the cause. Fluid may be characterized as a transudate, modified transudate, or exudate. A transudate is defined as s clear acellular fluid with a low specific gravity. Pure transudates are relatively rare but may occur secondary to severe hypoalbuminemia or overhydration. Modified transudates are the most common type of pleural effusion and may be caused by heart failure, neoplasia (lymphoma or metastatic) or systemic inflammatory conditions (eg pancreatitis). Causes of exudates include pyothorax or feline infectious peritonitis. Other effusions include chylothorax or hemothorax.

Pure transudate: Usually develops in hospitalized pets or animals with chronic protein-losing conditions. Fluid looks similar to water and is relatively acellular. Treatment includes thoracocentesis, colloid support, diuretics as well as therapy for the underlying condition.

Heart failure: Right-sided heart failure may result in significant

accumulations of pleural fluid. Usually, physical examination shows other signs of heart failure, including pericardial effusion, such as abnormal heart sounds, tachycardia or jugular venous distension. Cytological findings may be dependant on duration but usually are mildly inflammatory (non-degenerate neutrophils, macrophages, reactive mesothelial cells). Treatment is directed at therapy of heart failure and may include diuretics (furosemide, spironolactone/ hydrochlorothiazide) and vasodilators.

Neoplastic: Neoplasia is a common cause of pleural effusion. Some neoplasms exfoliate well (lymphoma, some carcinomas). Pleural effusion from animals with neoplasia may contain neoplastic cells, although the lack of cytological criteria for malignancy does NOT exclude neoplasia from the differential list. Usually, neoplastic effusions are modified transudates. Therapy for neoplastic effusion includes periodic thoracocenteisis, intra-cavitary therapy (eg. Cisplatin, bleomycin, carboplatin) or shunting.

Infectious: Pleural effusions may be infectious in origin. Affected animals usually have systemic signs of sepsis (lethargy, fever, leukocytosis or leukopenia). Cytology from infectious effusions show degenerative neutrophils, and intra and extra-cellular bacteria. Infections may be aerobic or anaerobic. Anaerobic infections may be particularly foul smelling. In cats, bite wounds are considered the most common source of infection, while in dogs, bite wound and penetrating foreign bodies (sticks/plant awns) are frequently responsible. Occasionally, pleural effusions are identified secondarily to bacterial pneumonias. Therapy for pyothorax involves drainage (usually via chest tube) and antibiotics based upon culture and sensitivity. Some animals may require surgical intervention for resection and drainage of affected tissues. The prognosis for pyothorax is frequently good if the pet does not present in a moribund condition. Pleural effusions secondary to pneumonia may be sterile.

Feline Infectious Peritonitis may cause pleural effusion. Affected cats will usually have elevated total globulin levels in their plasma and also a high protein (usually greater than 4.0 gm/dl) level in the pleural effusion. Cytologically, reactive macrophages and neutrophils are present, but in small number. There is no effective therapy for FIP.

Hemothorax may result from anticoagulant rodenticide toxicity (eg brodifacoum), trauma or neoplasia. In animals with anemia and pleural effusion it is considered prudent to check coagulation status (ACT or PT/aPTT) prior to thoracocentesis. Therapy of hemothorax is dependent on the underlying cause and may include plasma transfusion, vitamin K therapy, surgery or rest. Small volume traumatic or toxic hemothoraces that are not affecting ventilation may be left alone to reabsorb.

Chylothorax is another possible cause of pleural effusion. Chylous effusion appears milky white and is made up of lymphocytes. The etiology of chylous effusion is not clearly established but may be related to dilation of the lymphatics (lymphangiectasia), heart failure or heartworm or neoplasia. Most cases appear to be idiopathic. Diagnosis is made by identifying a high triglyceride value in the fluid. (or the ratio of cholesterol/triglyceride in the fluid/serum) Treatment may include periodic thoracentesis or surgical intervention (thoracic

duct ligation) if no primary cause is identified. In the past, low fat diets and medium chain triglyceride have been recommended, but recent experimental evidence suggests that this may not be as beneficial as earlier suggested.

Miscellaneous causes of pleural effusion include pancreatitis, immune diseases, diaphragmatic hernia, pulmonary thromboembolism or recent abdominal or thoracic surgeries.

Pneumothorax may also occur in small animals. Most cases are traumatic and will generally quickly resolve if managed conservatively with needle thoracocentesis. Animals with severe or recurrent pneumothorax after trauma may require chest tube placement. Practically, animals requiring more than 3 thoracocenteses or those with > 20-50ml of air/kg are candidates for chest tube placement. Occasionally, spontaneous pneumonthoraces develop. In these cases, the underlying lesion is usually a bulla or a bleb and surgical exploration is often required to resect the diseased lung. Metastatic or primary lung tumors may also result in a spontaneous pneumothorax.

Pneumothorax is also a COMMON iatrogenic complication of thoracocentesis in animals with chronic pleural effusion resulting in thickening of the pleura. This may be a devastating complication as the pleura is unlikely to heal on its own (eg. Without operative management).

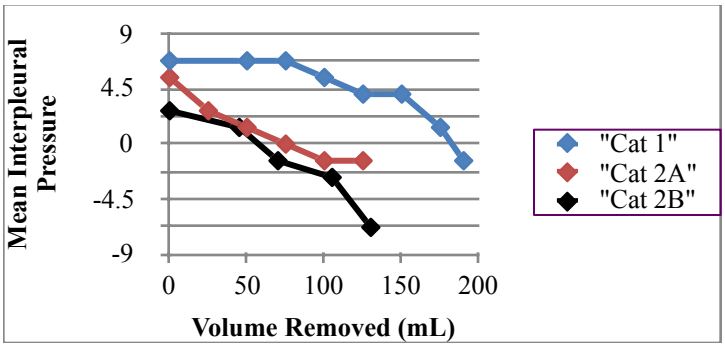
Pressure determinations are potentially useful in the ICU and ER, and may be considered as point-of-care evaluation of physiologic responses to critical illness or injury. Most critical care units have easy access to some sort of electronic pressure transducer for measurement of direct arterial pressure, or at least a water manometer. Measurements of any body cavity pressure may be obtained via manipulations of these devices. The utility of the measurement of any pressure specific gradient varies, but in most cases significant amount of knowledge can be gained by monitoring pressures. Additionally, for hospitals involved in teaching students or house officers, a more physiological understanding may help further cement knowledge of a specific fact. For example, visually observing a large volume pleural effusion drain spontaneously from the chest cavity will reinforce the idea that pleural pressure is positive to atmosphere when the effusion is large.

PLEURAL PRESSURE

Pleural pressure may be monitoring during thoracocentesis for pleural effusion or pneumothorax or continuously if a thoracostomy tube is in place. As a brief review, pleural pressure in a healthy dog or cat is negative in relation to the atmosphere. This negative pressure gradient helps promote/maintain lung inflation, and facilitate a lower work of breathing. A small amount (< 5 ml) of effusion is present in the pleural space. However, the pleural space is dynamic with extravascated fluid being rapidly reabsorbed via lymphatic and capillaries. Pleural space disease may be acute or chronic, with most effusions being somewhat chronic. As pleural effusion forms, there is collapse of the lung parenchyma, and also an *increase* in intra-thoracic pressure. As respiratory distress develops, the intra-pleural pressure less negative or positive to the atmosphere. While typically as clinicians we assume that removal of isolated pleural effusion will result in immediate improvement in lung function, this is not

always the case. In people, two separate categories of non-recruitable lung associated with pleural effusion are recognized, the first termed lung entrapment, which is a condition, which develops in associated with active pleural inflammation or neoplasia. Immature fibrin and overlying inflammation prevent re-expansion and contribute to the failure to recruit lung after thoracocentesis. During longer standing effusions, there is thickening and constriction of the visceral pleural and thickening of the parietal pleura. This may lead to the development of "trapped lung" or lung that is tightly constricted by overlying visceral pleura, and can not adequately re-expand, even in the presence of negative intra-thoracic pressure. Entrapped lung is likely more common in veterinary patients, as most effusions are associated with more active inflammation. However, the non-recruitable lung has been much less evaluated in dogs and cats than people.

Pleural manometry was designed to monitor the pleural cavity for signs of non-recruitable lung, as evidenced by large decreases in intra-pleural pressures which may be subsequently associated with the development of pain or spontaneous pneumothorax. Spontaneous pneumothorax is of particular interest as in veterinary medicine; iatrogenic pneumothorax associated with thoracocentesis is most commonly though to be associated with inadvertent laceration of the lung. The concept of non-recruitable lung is compelling, as larger increases (eg. more negative) pleural pressures might be associated with spontaneous pneumothorax as well. Pleural manometry may easily be performed with an over-damped electronic manometer. A pilot evaluation of pleural manometry in our hospital, performed by Kendra LaFaunci, a veterinary student, showed findings as below. Interesting, in the CAT 2B, a spontaneous pneumothorax developed after thoracocentesis, potentially associated with trapped lung, and negative intra-thoracic pressure. Additionally, the use of pleural manometry is also able to answer the question as if the needle or catheter is still in the thoracic cavity following either re-positioning, patient movement, or apparent completion of the procedure.



Large volume thoracocentesis

In some large dogs, pleural effusions in excess of 2000 ml of fluid may develop. It is may be time consuming to the veterinary staff, and uncomfortable to the patient to remove the fluid using a small needle. Additionally, in chronic effusions, it is common for thickening of pleura covering the lungs (eg. restrictive

pleuritis) to develop, which increases the likelihood of iatrogenic pneumothorax developing with accidental pulmonary puncture with a needle.

One technique that may be useful is to drain the effusion with the use of a catheter (16-18 ga) and suction unit, such as a surgical unit. The advantages of this method include increased speed for the clinicians and staff, and less duration of restraint for the dog.

1. Determine the need for thoracocentesis; Ultrasound is ideal if available.
2. Clip, prep and block desired site. Sedation or brief anesthesia (propofol) may be used.
3. Place catheter into the chest, remove stylet, connect to suction

Summary

1) **Detection of pleural effusion should prompt a search for the underlying cause**
2) **Many cases of pleural effusion may be successfully managed but true cure is unlikely except with infection.**
3) **Iatrogenic air leak may accompany thoracocentesis**
4) **Cytology is warranted with every thoracocentesis (at least in-house)**
5) **Pleural ports may have a role in pleural effusion management.**