Pyothorax is the presence of a suppurative, septic effusion within the pleural space. It is typically easy to diagnose via cytologic analysis of fluid obtained by thoracentesis. The fluid obtained may be very turbid and can range in color from white to brown or red. Pyothorax is characterized as an exudate with protein above 3.5 g/dl, total nucleated cell count exceeding 7,000/µl of mostly degenerative neutrophils, pH below 6.9, and glucose concentration less than 10 mg/dl. Generally, extracellular and intracellular bacterial organisms are present on cytologic examination if the patient has not received antibiotic therapy before thoracentesis is performed. Because many cats with pyothorax present in respiratory distress, initial thoracentesis can be both a stabilizing, therapeutic measure as well as a definitive diagnostic test.

There are many potential causes of feline pyothorax, but the inciting cause remains undetermined in most cases. In cats, penetrating wounds to the thorax (e.g., bite wounds), extension of bacterial pneumonia, and hematogenous spread of bacteria into the thorax are most commonly suspected. Migrating foreign bodies, such as grass awns or parasites (Cuterebra), have been reported in cats. Pulmonary abscesses, neoplasia, perforation of the mediastinal contents (esophagus, trachea, bronchi), and iatrogenic causes (thoracentesis or thoracic surgery) have all been implicated in feline pyothorax.

The most recent studies have shown that cats with pyothorax have a good to fair prognosis if aggressive, early intervention is initiated; long-term, appropriate antimicrobial therapy is instituted; and regular reevaluations are performed. The recurrence rate is surprisingly low in cats that survive initial stabilization and receive appropriate medical therapy. To successfully manage a feline pyothorax patient, owners must be willing to medicate the cat for up to 6 weeks, return for multiple recheck visits at regular intervals, and make a substantial financial commitment.

**DIAGNOSTIC CRITERIA**

**Historical Information**

**Gender Predisposition:** No sex predisposition has been shown, but intact males are thought to be at greater risk because of their tendency toward territorial fighting.

**Age Predisposition:** Younger adult cats (about 3 years of age) are at greater risk.

**Breed Predisposition:** None.

**Owner Observations**

- Owners often observe nonspecific signs, such as decreased appetite, anorexia, lethargy, weakness, tachypnea, and weight loss.
- A cat with chronic effusive disease like pyothorax may suddenly decompensate and present in acute, severe respiratory distress.

**Other Historical Considerations/Predispositions**

- Indoor-outdoor status has not been found to be a significant risk factor in the development of pyothorax.
- Cats from multiple-cat households have been found to be more likely to develop pyothorax than cats from single-cat households.
- Late summer and fall months have the greatest incidence of cats presented for treatment of pyothorax. This may be related to an increase in mating behavior and fighting over the summer months, allowing time for pyothorax to develop secondary to bite wounds.
- No association has been shown between pyothorax and FeLV or FIV status.

**Physical Examination Findings**

- Tachypnea or dyspnea ranging from mild to severe is one of the most common physical examination findings. Increased respiratory distress in lateral recumbency may be observed while taking thoracic radiographs.
- Muffled heart sounds and decreased breath sounds are typically auscultated ventrally.
- Pyrexia and dehydration may be identified.
- Weight loss, dull haircoat, and poor body condition are common.
• Tachycardia with strong femoral pulses is usually found unless sepsis is present. Bradycardia is associated with severe sepsis and/or septic shock in cats and denotes a poorer prognosis for cats with pyothorax.
• Sepsis and systemic inflammatory response syndrome (SIRS) are sequelae of untreated pyothorax in cats.

**Laboratory Findings**

• Complete blood count consistently reveals a leukocytosis consisting of neutrophilia and a left shift. Presence of leukopenia (neutropenia with or without a degenerative left shift) is consistent with a higher mortality rate.
• Hyponatremia and hypochloremia are common secondary to fluid accumulation in the thorax, hypovolemia, and decreased nutritional intake.
• Hypoalbuminemia secondary to increased vascular permeability, protein loss into the pleural effusion, and decreased hepatic production may be found.
• Increased total bilirubin and aspartate aminotransferase have been observed; the cause is thought to be liver damage secondary to hypovolemia, hypoxia, and inflammation.
• Hematocrit may be elevated in dehydrated cats or decreased as a result of anemia associated with inflammatory disease.

**Other Diagnostic Findings**

• Thoracic radiography shows pleural effusion (pleural fissure lines and scalloping of the ventral lung borders) and helps determine whether the condition is bilateral or unilateral.
• Thoracic ultrasonography may identify consolidated lung lobes, lung or pleural abscesses, and lung or mediastinal masses. The best acoustic window and images may be obtained before drainage of the pleural effusion. Ultrasonography can be used to locate fluid pockets for effective thoracentesis.
• Laboratory analysis of fluid obtained via thoracentesis is consistent with septic exudate. Criteria for diagnosis of septic effusion (pyothorax) include the following:
  — Exudate with protein above 3.5 g/dl.
  — A total nucleated cell count above 7,000/µl with mostly degenerative neutrophils.
  — pH below 6.9.
  — Glucose below 10 mg/dl.
  — Most cell counts are much higher with pyothorax, occasionally greater than 100,000 cells/µl.

• Cytology often demonstrates both extracellular and intracellular bacterial organisms of mixed populations. Most cats have an anaerobic bacterial population with some gram-negative aerobes. Gram’s stain can be useful to further identify the bacterial population in the fluid for treatment considerations. Nonenteric bacterial isolates, primarily from the genus Pasteurella, are most often cultured from cats with pyothorax.
• Both aerobic and anaerobic cultures should be performed on the fluid and antimicrobial therapy adjusted as necessary based on culture results.
• Sulfur granules may be observed in the fluid, and filamentous fungal elements may be observed on cytologic examination. Actinomyces or Nocardia are often the culprits. Acid-fast staining can be performed to assist in the identification of these organisms, although not all Nocardia species will stain. These bacteria are slow growing and difficult to culture, making definitive diagnosis challenging. Antibiotic therapy may need to be based on clinical signs and cytologic findings in the absence of a positive culture.

**Summary of Diagnostic Criteria**

• Historically, weight loss, decreased activity (exercise intolerance), and lethargy are common. Dyspnea may or may not be noticed.
• Physical examination findings include muffled respiratory and heart sounds on auscultation.
• Pleural effusion is confirmed by thoracic radiography. Ultrasonography may be helpful.
• Fluid analysis is needed to determine the nature of the effusion. Thoracentesis can be both diagnostic and therapeutic.

**Diagnostic Differentials**

Other causes of pleural effusion that must be ruled out include:

• **Modified transudate** (heart failure, neoplasia, diaphragmatic hernia, or lymphatic leakage): Protein, 2.5 to 4 g/dl; total nucleated cell count, 1,000 to 7,000, consisting of mostly mesothelial cells, macrophages, eosinophils, and lymphocytes.
• **Chylothorax**: Effusion is usually opaque white to pink in color with variable protein; the total nucleated cell count is above 10,000 and consists of mostly lymphocytes and neutrophils; and triglycerides in the fluid exceed the serum triglyceride level.
• **FIP**: Effusion is usually straw to gold colored and hazy, with protein above 5.0 g/dl and a total nucleated cell count exceeding 10,000 and consisting of mostly nondegenerate neutrophils.
• **Hemothorax** secondary to trauma, pulmonary thromboembolism, lung lobe torsion, or coagulopathy.
CARE

Broad-spectrum, intravenous antimicrobial therapy should be administered to the patient. The remarkable cellularity and neutrophilia of pyothorax fluid in combination with the presence of intracellular bacteria is the most distinguishing criterion for diagnosis.

TREATMENT RECOMMENDATIONS

Initial Treatment

- Thoracentesis (see box above) should be performed immediately to stabilize the patient and obtain diagnostic samples.
- Unilateral chest tube placement (see box on right) and continuous or intermittent (every 2 to 4 hours) suction is recommended. Bilateral chest tube placement is indicated if the mediastinum is complete, there is pocketing of the effusion, or if effusion persists after drainage with the unilateral tube. A local anesthetic block with bupivacaine (1 mg/kg) may be performed at the time of tube placement.
- Radiography should be repeated to evaluate the completeness of thoracic drainage and the position of the chest tube.
- Broad-spectrum, intravenous antimicrobial therapy with anaerobic coverage should be instituted while culture results are pending: $$
  - Ampicillin with sulbactam (22 mg/kg slow IV q8h) is sufficient in most cases.
  - If infection with resistant gram-negative organisms is a concern, more aggressive therapy with a fluoroquinolone (ciprofloxacin, 10 mg/kg IV q24h) may be necessary. Some clinicians add clindamycin (11 mg/kg SQ or PO q12h).
- Antimicrobial therapy can be altered as needed once aerobic and anaerobic culture results are available.

Chest Tube Placement

- The patient should be well restrained and highly sedated or anesthetized with appropriate monitoring. A local anesthetic block (bupivacaine, 1 mg/kg [may be diluted with a small amount of sterile saline] injected locally) should be performed. Thoracostomy tube placement without general anesthesia should occur only in animals in critical condition.
- Prematurely measure the chest tube to the desired placement within the thoracic cavity.
- The lateral thorax should be generously clipped and surgically prepped. The free skin is pulled cranially to offset the skin and body wall incisions to prevent pneumothorax. Identify intercostal spaces 7 to 9. Using a blade, make a small skin incision in the dorsal two-thirds of the thorax between intercostal spaces 7 to 9.
- Using a hemostat, gently dissect to the thoracic wall without penetrating into the pleural space. The chest tube is advanced carefully through the thoracic wall into the pleural space using hemostats or a stylet and then guided ventrocranially as it is advanced into the thoracic cavity.
- Clamp the tube to room air immediately after placement, and suture it in place.
- Immediately apply suction to the tube to remove air that has gained entry during placement and any additional fluid remaining after thoracentesis. Aspiration pressure should not exceed 5–10 ml with a syringe or more than 15–20 cm H₂O using continuous suction.
- Radiographs should be taken to ensure correct placement of the chest tube and to evaluate the amount of pleural fluid remaining. The tube may need to be repositioned if there is radiographic evidence of pleural effusion after tube aspiration, or bilateral tubes may be needed to achieve complete fluid removal.
- The tube is then attached to a stopcock or adaptor to accommodate the type of suction that will be employed.
- Secure the tube connections with surgical steel wire, and double-check for leakage or loose connections.
- A light, loose bandage can be used to help secure the tube, and an Elizabethan collar should be placed on the patient. Be cautious not to cause chest compression and breath restriction with the bandage. Monitor the tube and bandage regularly.
- The highest standards of patient care should be implemented. This should include wearing gloves when handling the patient and chest tube, keeping all ports capped at all times, and wiping ports with alcohol before administering local anesthetics or lavage fluid.

Standards of Care: Emergency and Critical Care Medicine
The chest tube can be removed when:
— Pleural effusion has resolved radiographically.
— The amount of fluid aspirated from the tube decreases to 2 ml/kg/d.

and
— There is cytologic evidence of infection resolution (i.e., no organisms present on cytology, decreased numbers of neutrophils, an overall less degenerate appearance, and presence of macrophages). Resolution usually occurs within 5 to 7 days in most cases.

Cytologic examination of the recovered fluid should be performed daily for evidence of resolution.

Alternative/Optional Treatments/Therapy

Many experts recommend twice-daily lavage using sterile physiologic saline (0.9% NaCl, warmed to body temperature). A maximum saline volume of 10 ml/kg may be slowly infused through the chest tube and the patient gently rolled from side to side for several minutes. Less saline should be infused if the patient exhibits discomfort or dyspnea. Fluid recovery should approximate 75% of the total volume infused.

Owners should be aware of the possibility for intermittent thoracentesis in an effort to minimize costs associated with hospitalization and chest tube care. It has the potential to be as expensive (because of repeated visitations, sedation, etc.) as thoracostomy tube placement and has a poorer chance of success. The prognosis and survival rate are significantly worse and the chance of adhesions is great, making subsequent aggressive medical therapy (chest tube placement) less likely to be successful. Thus, this approach should be considered only when chest tube drainage is not an option.

Thoracotomy is a reasonable surgical option for pyothorax and should be considered under the following circumstances:
— Suspected foreign body.
— Evidence of a nidus of infection.
— Recurrence of pyothorax, indicative of either of the above.
— Persistent atelectasis or lobar pneumonia requiring lung lobectomy.
— Sufficient effusion drainage cannot be achieved via chest tubes (e.g., because of adhesions).
— A patient fails to respond after 5 to 7 days of aggressive medical management.

Some argue that thoracotomy is the preferred option. Performed early on, thoracotomy can clear inflammatory cells and mediators from the thoracic cavity, remove foreign material, and possibly result in a shorter hospital stay. In the referenced reports, thoracotomy patients had a longer stay, but that was using the criteria outlined above, and survival was better.

Supportive Treatment
Supportive care is based on the needs of the individual patient and may consist of:
— Oxygen therapy for dyspneic patients. Severely dyspneic patients should be treated gently as the stress from handling, restraint, or instrumentation (e.g., IV catheter placement, nasal oxygen tube placement, venipuncture, thoracentesis) could result in patient death.
— Fluid therapy to correct hypovolemia and electrolyte disturbances.
— Nutritional support, as indicated by the needs of the patient, may be as noninvasive as maximizing oral caloric intake or placing a nasoesophageal feeding tube. Percutaneous endoscopic gastrostomy tube placement or total parenteral nutrition may be considered if the patient is severely affected and recovery is expected to be prolonged.
— Analgesics for chest tube maintenance:
  — Hydromorphone (0.05–0.1 mg/kg IV q4–8h) or buprenorphine (0.005–0.01 mg/kg IV, IM, or SC q6–12h) may be given as needed for discomfort.
  — Bupivacaine (1 mg/kg q6h) diluted with 5 to 10 ml sterile saline may be administered through the chest tube for local analgesia.

Careful monitoring of the chest tube and drainage system is necessary to avoid potentially fatal complications such as pneumothorax and iatrogenic bacterial contamination.

Patient Monitoring
While patients are hospitalized, cytologic analysis of pleural fluid and radiography should be performed daily. Complete blood counts and chemistry panels should be repeated as indicated. Proper chest tube monitoring and maintenance is imperative for successful management of pyothorax. The tube should be checked regularly for leaks and, if the animal is to be left unattended, fully secured with an Elizabethan collar in place.
The chest tube bandage should be monitored to ensure proper fit. The tube must be secured and protected, but the bandage should apply minimal pressure to the chest wall to avoid decreasing chest compliance and increasing the work of breathing.

Oral antibiotics may be started before chest tube removal via a gastrostomy or esophagostomy tube if one was placed for nutritional support.

Once criteria have been met for chest tube removal and the patient is appetent, oral antibiotics may be started:

— Amoxicillin–clavulanic acid (15 mg/kg PO q8h) is sufficient in most cases.
— Marbofloxacin (2.75–5.5 mg/kg PO q24h for a maximum of 30 days) and clindamycin, if indicated or initiated previously (11 mg/kg PO q12h), may also be used based on culture and sensitivity results.
— Antibiotics should be continued for 6 weeks after chest tube removal unless Actinomyces or Nocardia were identified on cytology or culture, in which case antibiotic therapy is indicated for a total of 4 months.

Recheck visits, which should include thoracic radiography and complete blood count, are recommended 1 week after discharge, 1 week after antibiotics are discontinued, and again 1 month later. Radiographs should be scrutinized for evidence of effusion, indicating recurrence. It is ideal to identify a localized recurrence early to increase the likelihood of successful identification of a foreign body or other nidus of infection. Thoracotomy is indicated if pyothorax recurs, and owners should be warned that exploratory thoracotomy may be unrewarding in identifying the inciting cause of pyothorax.

Home Management

Owners should carefully monitor their cat for lethargy, inappetence, tachypnea, or dyspnea and seek veterinary care immediately if they suspect that their pet is not well.

Owner compliance regarding antibiotic administration is important for complete resolution.

Adherence to the recommended recheck schedule should be stressed to the owners.

Milestones/Recovery Time Frames

— Affected cats must stay in the hospital until the chest tube is removed. After 3 to 7 days, the lavage fluid should clear and cytology should no longer reveal bacteria and degenerate neutrophils.
— Most cases of feline pyothorax do not recur after the 6 weeks of antibiotics have been completed.
— Most deaths from feline pyothorax occur within the first 24 hours of hospitalization. An extended length of hospitalization is likely to increase the chance of survival in a cat with pyothorax.

Treatment Contraindications

— Patients should be stabilized as needed with thoracentesis and therapy for shock before thoracic radiography is attempted, especially in cats that are severely dyspneic.
— Caution should be used with aminoglycoside therapy in dehydrated or septic animals because of the potential for nephrotoxicity. Renal values and urinalysis should be monitored regularly for evidence of renal toxicity (tubular casts in the urine, elevated enzymes).
— Intravenous administration of enrofloxacin has been associated with acute blindness in cats. The use of both ciprofloxacin and marbofloxacin is off label in cats. It is unknown if these fluoroquinolones can cause the same ocular toxicity as enrofloxacin.
— Diuretics (furosemide) are not indicated.

PROGNOSIS

Favorable Criteria

— Early diagnosis and aggressive medical management greatly improve the prognosis.
— Survival beyond the first 24 hours of hospitalization.
— Resolution of effusion and removal of chest drain.
— Return of appetite.

Unfavorable Criteria

— Septic shock on presentation.
— Hypersalivation on presentation.
— Bradycardia on presentation.
— Recurrence of pyothorax.
— Evidence of pulmonary adhesions or coalesced lung lobes after removal of the septic effusion.


