Pleural Effusion: Diagnostic Approach in Adults

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Pleural effusion affects 1.5 million patients in the United States each year. New effusions require expedited investigation because treatments range from common medical therapies to invasive surgical procedures. The leading causes of pleural effusion in adults are heart failure, infection, malignancy, and pulmonary embolism. The patient's history and physical examination should guide evaluation. Small bilateral effusions in patients with decompensated heart failure, cirrhosis, or kidney failure are likely transudative and do not require diagnostic thoracentesis. In contrast, pleural effusion in the setting of pneumonia (parapneumonic effusion) may require additional testing. Multiple guidelines recommend early use of point-of-care ultrasound in addition to chest radiography to evaluate the pleural space. Chest radiography is helpful in determining laterality and detecting moderate to large pleural effusions, whereas ultrasonography can detect small effusions and features that could indicate complicated effusion (i.e., infection of the pleural space) and malignancy. Point-of-care ultrasound should also guide thoracentesis because it reduces complications. Computed tomography of the chest can exclude other causes of dyspnea and suggest complicated parapneumonic or malignant effusion. When diagnostic thoracentesis is indicated, Light's criteria can help differentiate exudates from transudates. Pleural aspirate should routinely be evaluated using Gram stain, cell count with differential, culture, cytology, protein, L-lactate dehydrogenase, and pH levels. Additional assessments should be individualized, such as tuberculosis testing in high-prevalence regions. Parapneumonic effusions are the most common cause of exudates. A pH level less than 7.2 is indicative of complicated parapneumonic effusion and warrants prompt consultation for catheter or chest tube drainage, possible tissue plasminogen activator/deoxyribonuclease therapy, or thoracoscopy. Malignant effusions are another common cause of exudative effusions, with recurrent effusions having a poor prognosis. (*Am Fam Physician*. 2023;108(5):464-475. Copyright © 2023 American Academy of Family Physicians.)

Pleural effusion is excess fluid accumulation in the pleural space caused by disease or physiologic dysregulation and requires careful investigation to identify the underlying cause. A normal amount of pleural fluid (5 to 10 mL) is physiologic and allows for apposition and sliding of the visceral and parietal pleura and normal lung expansion. Pleural effusion results when fluid production exceeds absorption. Leading causes of pleural effusion in adults are heart failure, infection, malignancy, and pulmonary embolism.[1,2] Transudative effusions are caused by disruptions in hydrostatic or oncotic pressures in heart failure, cirrhosis, or advanced kidney disease. Cirrhosis and portal hypertension may also cause ascitic fluid translocation across the diaphragm into the right hemithorax (hepatic hydrothorax). Inflammation of the pleural surface from pneumonia (parapneumonic effusion), malignancy, pulmonary embolism, medications,[3] or autoimmune disease results in exudative fluid accumulation *(Table 1[3-7])*.

Diagnostic evaluation focuses on differentiating exudates from transudates, ordering appropriate fluid analysis, and determining the need for thoracentesis or specialist consultation. Accurate and early diagnosis is critical because treatments range from medical management to invasive surgery, with delays potentially causing complications and increased mortality.[8]

CME This clinical content conforms to AAFP criteria for CME. See CME Quiz on page 447.

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Epidemiology

Pleural effusion is common, especially in hospitalized adults. Effusions are associated with higher costs, morbidity, and mortality.[9,10] Annually, 1.5 million patients in the United States have pleural effusions[7]; up to 1.3 million of these cases have nonmalignant causes.[2] Annually, approximately 173,000 patients (12%) undergo thoracentesis.[11] A prospective study in the United Kingdom found high one-year mortality rates for those with pleural effusions caused by heart failure (50%), malignancy (70%), and pneumonia (19%).[12] A large study in China

TABLE 1

Causes and Types of Pleural Effusions

Causes	Transudative	Exudative	
Common[5]	Cirrhosis	Bacterial pneumonia	Postcardiac bypass surgery
	Heart failure	Idiopathic	Pulmonary embolism
	Hepatic hydrothorax	Malignancy	Trauma
		Lung cancer	Tuberculosis
		Lymphoma	Viral disease
		Metastasis (e.g., breast, colon)	
Less common[4]	Cardiovascular	Cardiovascular	Pulmonary
	Superior vena cava obstruction	Pericardial disease	Benign asbestos effusion
	Genitourinary	Post myocardial infarction	Mesothelioma
	Nephrotic syndrome (high risk for pulmonary embolism)	Gastrointestinal	Other
	Peritoneal dialysis	Abdominal surgery	Chylothorax (e.g., idiopathic, lymphangioleiomyomatosis, neoplasm, trauma, tuberculosis)
	Urinothorax	Esophageal rupture	Medication induced*[3]
	Other	Intra-abdominal infection	Amiodarone
	Cerebrospinal fluid leak to pleura	Pancreatic disease	Clozapine (Clozaril)
	Myxedema	Genitourinary	Dantrolene (Dantrium)
		Catamenial hemothorax (thoracic endometriosis)	Ergot alkaloids
		Meigs syndrome (benign ovarian tumor with ascites and pleural effusion)	Methotrexate
		Ovarian hyperstimulation syndrome	Nitrofurantoin
		Postpartum effusion	Phenytoin
		Infectious	Tyrosine kinase inhibitors
		Fungal infection	Pseudochylothorax (e.g., rheumatoid arthritis, tuberculosis)
		Parasitic infection (lung fluke, amoebiasis, and echinococcus/ruptured hydatid cyst)[6]	Rheumatologic disorders
			Lupus
			Rheumatoid arthritis
			Yellow nail syndrome

*–See https://www.pneumotox.com.

Adapted with permission from Saguil A, et al. Diagnostic approach to pleural effusion. Am Fam Physician. *2014;90(2):100, with additional information from references 3 and 5-7.*

of patients with COVID-19 found low rates of pleural effusion (7% to 10%); however, effusion was associated with prolonged hospitalization and a sixfold increase in mortality.[13]

Clinical Features

The clinical features of pleural effusion can be insidious and challenging to recognize. The condition is typically diagnosed when imaging is ordered for a different reason. Symptoms include chronic dyspnea, cough, and pleuritic chest pain.[4,8] Patients may be asymptomatic or progressively symptomatic based on the rate of fluid accumulation. Dyspnea is attributed to restricted diaphragmatic excursion.

On examination, there is dullness to percussion and decreased breath sounds over the area of effusion. Hypoxia is frequently absent or late in onset with large volume accumulation.[2] In older patients, empyema can present as fatigue, weight loss, and failure to thrive.[2] The complete list of pleural effusion causes is extensive, but considering the patient's medical history and physical examination can narrow down the possible causes and guide workup *(Table 2)*.[4]

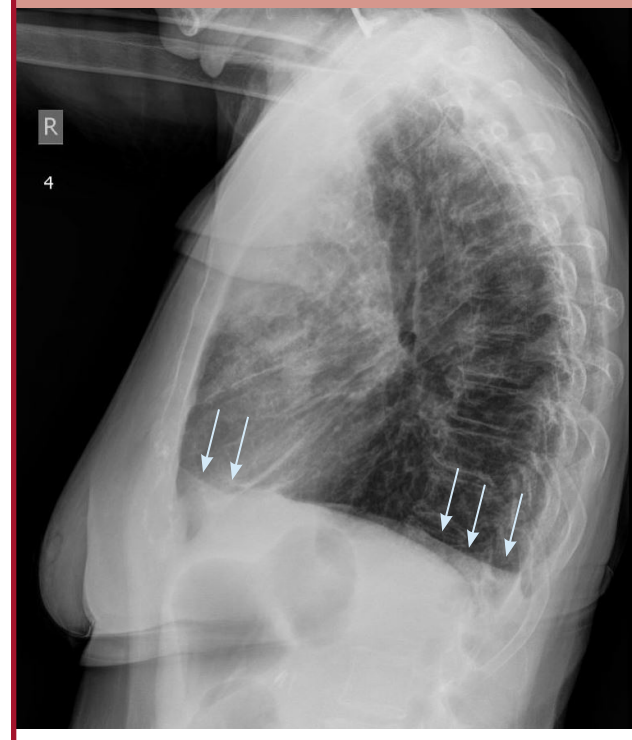
TABLE 2

Signs and Symptoms Suggesting Pleural Effusion Etiology

Signs and symptoms	Suggested etiology
Ascites	Cirrhosis
Distended neck veins	Heart failure, pericarditis
Dyspnea on exertion	Heart failure
Fever	Abdominal abscess, empyema, malignancy, pneumonia, tuberculosis
Hemoptysis	Malignancy, pulmonary embolism, tuberculosis
Hepatosplenomegaly	Malignancy
Lymphadenopathy	Malignancy
Orthopnea	Heart failure, pericarditis
Peripheral edema	Heart failure
S_3 gallop	Heart failure
Unilateral lower extremity swelling	Pulmonary embolism
Weight loss	Malignancy, tuberculosis

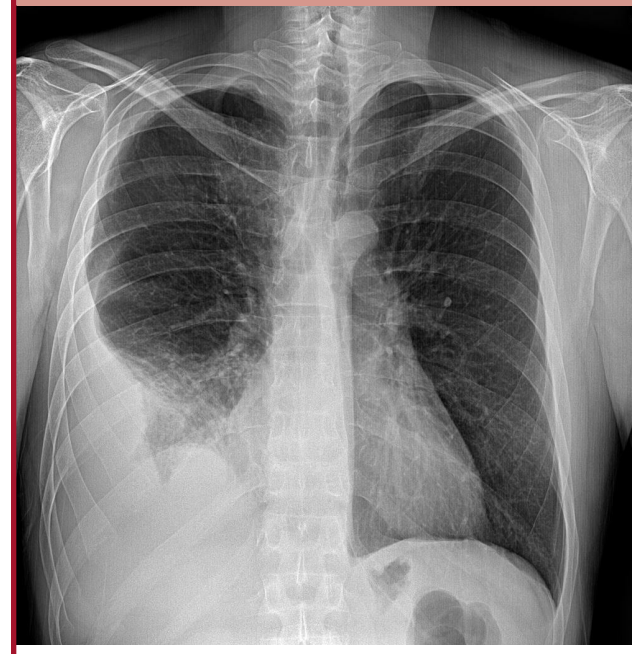
Adapted with permission from Saguil A, et al. Diagnostic approach to pleural effusion. Am Fam Physician. *2014;90(2):101.*

FIGURE 1



Lateral upright radiograph with small pleural effusion (with only blunting of angles).

FIGURE 2



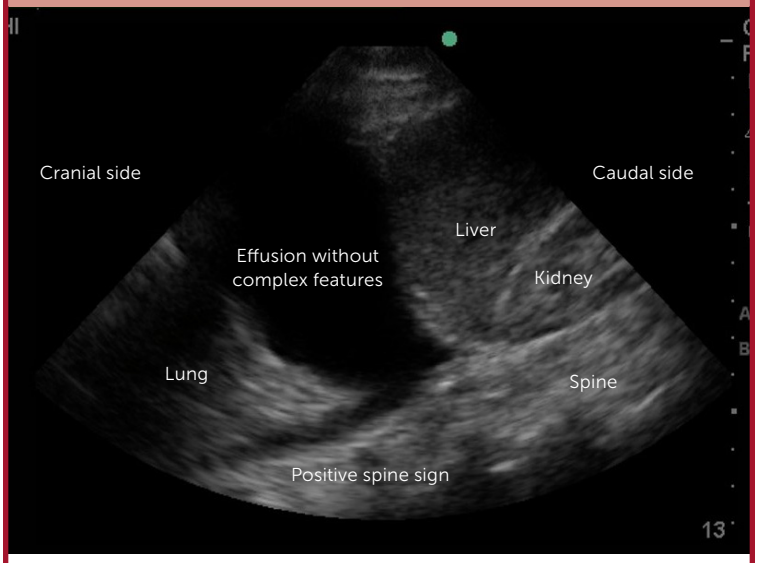
Posteroanterior chest radiograph with moderate pleural effusion on the right side (hemidiaphragm).

Chest Imaging

RADIOGRAPHY

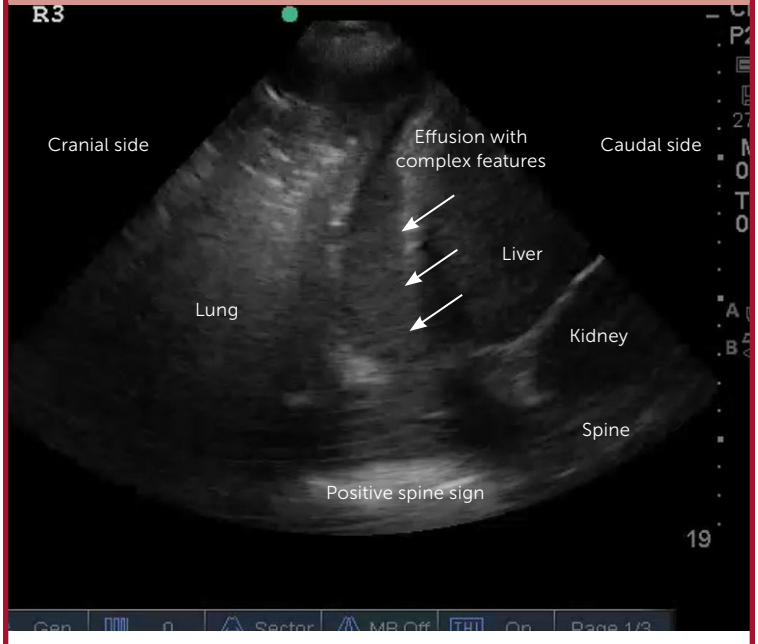
Chest radiography is the most common initial imaging modality used to diagnose pleural effusion. It reliably rules out large effusions and is helpful in determining whether an effusion is unilateral or bilateral. Sensitivity varies widely depending on the view. An effusion is undetectable on a posteroanterior film until it is at least 200 mL, whereas a lateral upright film detects effusions as small as 50 mL.[5] The lateral decubitus film is the most sensitive, detecting minimal effusions as small as 10 to 25 mL, and it also indicates whether fluid is free-flowing or loculated.[1,4] A supine anteroposterior film can hide large amounts of effusion, making it a poor diagnostic choice. Raising the head of the patient's bed to the semi-upright position improves the anteroposterior film sensitivity.[5] Lower lobe consolidation makes diagnosis more difficult, and chest radiography cannot differentiate between transudates and exudates.[14,15] Signs of pleural effusion on radiography first appear as thickening of the pleural fissures and blunting of the costophrenic angle *(Figure 1)*. With moderate effusions, the diaphragm appears hazy and obscured, progressing to the presence of an air-fluid meniscus in large effusions *(Figure 2)*. In massive effusions, there is dense opacification of the hemithorax and mediastinal shift.[14]

FIGURE 3



Pleural effusion with black anechoic fluid without internal echoes, on point-of-care ultrasound with a positive spine sign.

FIGURE 4



Echogenic pleural effusion *(arrows)* on point-of-care ultrasound with heavy sediments; purulence was found on thoracentesis that required chest tube drainage.

ULTRASONOGRAPHY

Point-of-care ultrasound (POCUS) and thoracic ultrasonography are sensitive to small amounts of pleural effusion (those as small as 20 mL),[16] characterize effusions, and provide guidance during pleural procedures. For these reasons, the British Thoracic Society recommends early usage of bedside ultrasound in the evaluation and management of pleural effusion.[2,16,17] The American Association for Thoracic Surgery recommends using thoracic ultrasonography in addition to chest radiography in the evaluation of pleural effusion in the setting of infection.[18] POCUS outperforms chest radiography in differentiating the presence of effusion *(Figure 3)* from consolidation[15,19] and detects septations with greater sensitivity than computed tomography (CT).[5] POCUS can identify complex parapneumonic effusions with findings such as echogenic fluid *(Figure 4)*, septations, and loculations *(Figure 5)*. It can also identify signs of malignancy, such as pleural thickening and nodularity. Treatment of complicated parapneumonic effusions (i.e., infection of the pleural space) and empyema is time sensitive. Early detection warrants escalation of care and specialty consultation.[8,16,19,20] Current barriers to routine use of thoracic ultrasonography in evaluating pleural disease include inconsistent availability and lack of operator training and experience.[21,22]

COMPUTED TOMOGRAPHY

Chest CT is helpful in determining the size and location of an effusion and can exclude other causes of dyspnea (e.g., pulmonary embolism, mediastinal disease, esophageal rupture). If malignancy is suspected, further evaluation with CT is indicated. However, a negative CT result does not exclude malignancy.[17] In patients with known malignancy, extending CT to the abdomen and pelvis can help identify a primary source and metastasis.[5,22] The American College of Radiology grades chest CT with or without contrast as usually appropriate in the evaluation of suspected pleural disease.[23] If malignancy is suspected, CT with contrast may detect pleural thickening and nodularity but has poor sensitivity (36% to 68%) and better specificity (78% to 94%).[5,22] CT-guided or video-directed pleural biopsy can make the diagnosis definitive. Pleural fluid attenuation on CT cannot distinguish exudate from transudate.

CT findings of lenticular effusion, loculation, and pleural thickening are associated with complicated parapneumonic effusions[18] *(Figure 6)*.

Thoracentesis

INDICATIONS AND CONTRAINDICATIONS

Diagnostic thoracentesis can help determine the cause of pleural effusion, and therapeutic drainage provides symptomatic relief. Thoracentesis is warranted for cases where the suspected cause is not heart disease, kidney failure, or liver failure (e.g., those presenting with fever and pleuritic chest pain or those with unilateral or disparate effusion sizes), or cases that do not improve after diuresis, dialysis, or treatment of the underlying disease.[5] Heart failure is estimated to cause 36% of all effusions,[24] and patients with small bilateral, right-greater-than-left effusions and high pretest probability for effusion due to heart failure do not need diagnostic thoracentesis *(Figure 7*[1,5,12,18,25,26]*)*. Minimal parapneumonic effusions can be treated conservatively with antibiotics and close monitoring.[25]

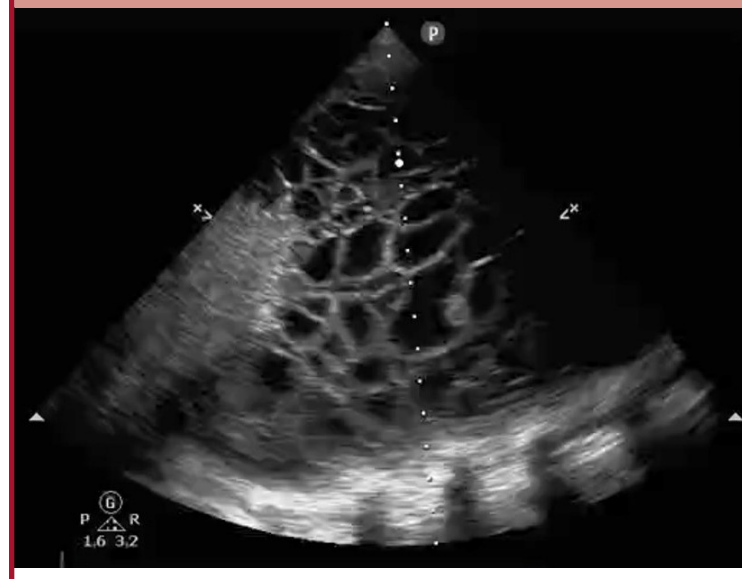
Traditional teaching recommends diagnostic thoracentesis for new-onset unilateral effusions greater than 1 cm on lateral decubitus radiography or those greater than 2 cm on ultrasonography and CT.[1,8,18] Relative contraindications to thoracentesis include skin infection at the insertion site and uncorrected severe bleeding diathesis.[27-29] Effusions that are too small (less than 1 cm) or loculated on POCUS or CT may require an interventional radiology or thoracoscopy approach. Bleeding risk may be reduced with ultrasound guidance by using direct visualization to decrease solid organ injury and avoid intercostal vessels.[27,28] Decisions about the reversal of coagulopathies should be individualized based on urgency.[29,30]

PROCEDURAL BASICS

The physician should obtain consent and inform patients about the potential complications of an unsuccessful procedure, which include pain, pneumothorax, hemorrhage, or solid organ injury. Bilateral thoracentesis is not recommended.

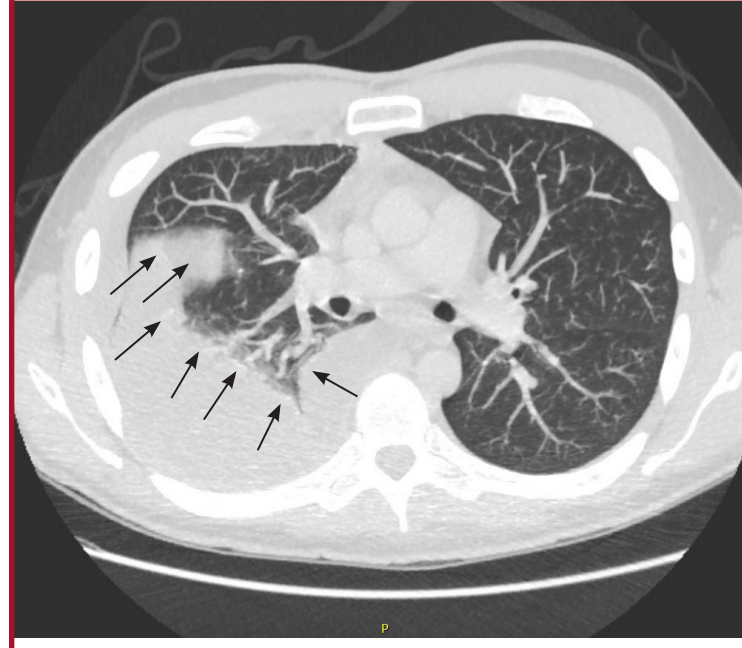
The patient may be positioned supine or seated upright. A low-frequency ultrasound probe is used to identify the diaphragm inferiorly and the edge of the lung cranially, noting the height of the effusion *(Figure 8)*. The insertion site is

FIGURE 5



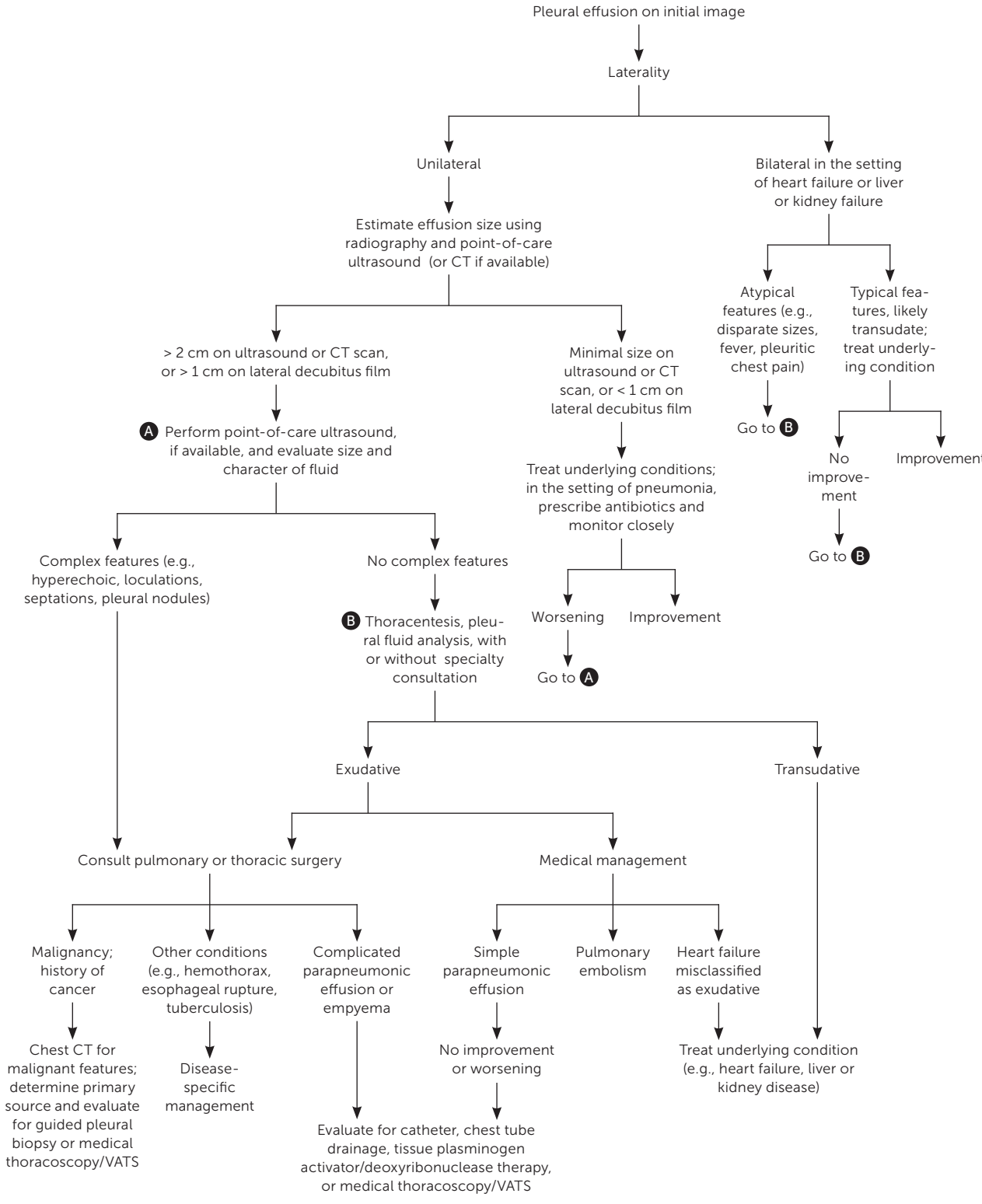
Complex effusion with septations and loculations, needing chest tube or thoracoscopy.

FIGURE 6



Loculated, right-sided, moderate pleural effusion *(arrows)* on computed tomography scan.

FIGURE 7

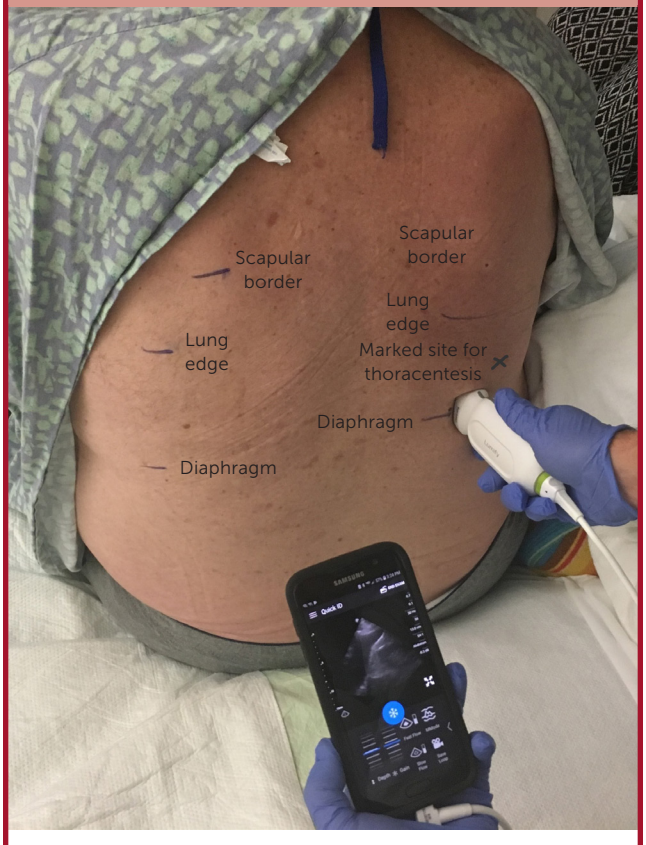


CT = computed tomography; VATS = video-assisted thoracoscopic surgery.

Evaluation and initial management of pleural effusion.

Information from references 1, 5, 12, 18, 25, and 26.

FIGURE 8



Marking the insertion site for ultrasound-guided thoracentesis.

marked no closer than 5 to 10 cm from the spine and one to two intercostal spaces above the diaphragm.[31] The needle should not be inserted below the ninth rib, which avoids the diaphragm.[32] After site marking, local anesthesia is administered superior to the rib, avoiding the inferior surface and the neurovascular bundle. A diagnostic sample can be aspirated with a fine-bore needle and a 50-mL syringe.[5] For therapeutic drainage, a large-bore, over-the-needle catheter is inserted perpendicular to the chest wall. The catheter is guided over the needle, and the needle is removed before aspiration begins.[31,32] In therapeutic thoracentesis, up to 1.5 L can be drained. Aspiration volumes greater than 1.5 L may be associated with an increased risk for reexpansion pulmonary edema.[33] After the procedure, the patient should be monitored for post-procedural pneumothorax, bleeding, and reaccumulation. Routine chest radiography is not required unless the patient is symptomatic, air is aspirated, or multiple thoracentesis attempts were performed.[2,28,31,34] Videos demonstrating the procedure are available at https://www.youtube.com/watch?v=ivTyH09BcHg and https://www.youtube.com/watch?v=lUAn_1R7V3E.

ULTRASOUND GUIDANCE

The Society of Hospital Medicine,[11] American Thoracic Society,[26] and the British Thoracic Society[5,17] recommend that all pleural procedures be ultrasound guided based on evidence demonstrating safety, increased success, and relative absence of harm. Compared with percussion to identify effusion borders, ultrasound guidance is associated with fewer complications, including solid organ puncture, pneumothorax, and unsuccessful procedure.[5,11,17,18,26,28,33,35] Outcomes with static guidance, where patients are marked using ultrasonography at the bedside before thoracentesis, are similar to those with live guidance, in which needle entry is actively visualized.[11,34] Live guidance requires additional sterile preparation and additional operator experience but is selectively useful for smaller or loculated effusions.

TABLE 3

Appearance of Pleural Aspirate and Potential Etiology

Pleural fluid appearance	Potential etiology
Anchovy brown fluid	Ruptured amoebic abscess
Bile stained	Chylothorax (e.g., biliary fistula)
Black	*Aspergillus* infection
Bloody	Benign asbestos, malignancy, post–cardiac injury syndrome, pulmonary embolism, trauma
Containing food particles	Esophageal perforation
Milky	Chylothorax or pseudochylothorax
Serous	Nonspecific, heart failure, liver disease
Turbid with foul odor	Anaerobic empyema
Urine; may have ammonia odor	Urinothorax

Adapted with permission from Hooper C, et al.; BTS Pleural Guideline Group. Investigation of a unilateral pleural effusion in adults: British Thoracic Society pleural disease guideline 2010. Thorax. 2010;65(suppl 2):ii7, with additional information from reference 4.

Fluid Analysis

Fluid analysis begins with evaluation of aspirate appearance and odor *(Table 3*[4,5]*)*. Light's criteria can help differentiate exudates from transudates[36-38] *(Table 4*[2,5,17,36,39,40]*)*. It is nearly 100% sensitive for exudates but is less

TABLE 4

Routine Pleural Fluid Analysis

Test	Criteria	Comments
Protein	1. Pleural/serum protein ratio > 0.5	Light's criteria* is positive for exudative fluid when 1 of 3 criteria is met[2,5,36]
LDH	2. Pleural/serum LDH ratio > 0.6 3. Pleural LDH > two-thirds of upper limit of normal serum LDH range	
Cell count with differential	Neutrophil predominant	Indicates acute parapneumonic effusion, pulmonary embolism, and benign asbestos[5]
	Lymphocyte predominant	Indicates long-standing effusions caused by malignancy, heart failure, long-standing tuberculosis, lymphoma, rheumatoid pleurisy, sarcoidosis, or late post coronary artery bypass grafting[5]
Culture and Gram stain	Positive	Culture has low sensitivity (56%),[39] but a positive culture result is diagnostic for bacterial parapneumonic effusion; inoculating blood culture bottles (anaerobic and aerobic) at the bedside increases positivity rate[5]
Cytology	Presence of atypical cells	Send as much aspirate volume as available, with a goal of 50 to 60 mL; most common causes of secondary pleural malignancies are lung and breast cancer, and other common primary cancers are lymphoma, gastrointestinal, and ovarian; mesothelioma is a common cause with low cytology sensitivity; overall, cytology has a poor sensitivity of 60%[17,40]; pleural biopsy is diagnostic
pH	Level < 7.2†	When arterial blood gas kit is available, test for aspirates with concern for infection that are not obviously purulent; pH < 7.2 is consistent with complicated effusion; if purulence is present, do not test for pH—the diagnosis is empyema[5]

LDH = L-lactate dehydrogenase.

*—Light's criteria can be calculated at https://www.mdcalc.com/calc/797/lights-criteria-exudative-effusions.
†—A pH level < 7.2 can help diagnose complicated parapneumonic effusion early, before the culture returns positive. Local lidocaine infiltration can falsely lower the pH, and the sample should be analyzed within one hour.[5]

Information from references 2, 5, 17, 36, 39, and 40.

specific because 20% of patients with heart failure after receiving diuretics have fluid ratios consistent with exudate. Elevated serum N-terminal pro-brain natriuretic peptide indicates heart failure as the cause of pleural effusion.[38,40,41] Pleural aspirate should routinely be tested using Gram stain, cell count with differential, culture, cytology, and protein, L-lactate dehydrogenase, and pH levels. Serum protein and L-lactate dehydrogenase should be assayed at the same time. In the setting of infection in the absence of purulence, testing for a glucose level less than 40 mg per dL (2.22 mmol per L) and pH less than 7.2 is helpful for diagnosing complicated parapneumonic effusion because cultures are slow to return and have low sensitivity.[18] In high prevalence areas, initial testing may include tuberculosis testing (i.e., acid-fast bacillus, *Mycobacterium* culture, and adenosine deaminase) because it requires special cultures[5,6,24] *(Table 5[1,5,17,18,40,41])*. Additional testing should be based on clinical suspicion.[1,5,31]

Empyema and Parapneumonic Effusions

Parapneumonic effusion (pleural effusion associated with pneumonia or lung abscess) and empyema (aspiration with purulence *[Figure 9]*) are the most common causes of exudates and are rising in incidence in the United States.[2] Parapneumonic effusions are found in 20% to 40% of hospitalized patients with pneumonia and up to 62% of patients with pneumonia in the intensive care unit.[42] Complicated effusions can be associated with small volumes; therefore, size alone cannot rule out the need for thoracentesis. Early POCUS of the pleura can detect complex effusions by demonstrating echogenic fluid, septations, and loculations. However, anechoic fluid that appears to be a simple effusion does not rule out culture-positive effusions.[20] Given the potential for an effusion to become complicated within days if treatment is delayed, it is important for primary care physicians to recognize and treat effusions appropriately and promptly[8] *(Table 6[8,17,18,25,42-44])*.

To address parapneumonic effusions, the underlying pneumonia must be treated. This generally includes antibiotics chosen based on prevalent community- or hospital-acquired causes. Anaerobic coverage with metronidazole (Flagyl) is warranted for treatment of complicated effusions[39] *(Table 7[39,43])*. Antibiotics should not be delayed for pleural analysis unless the patient is clinically stable with an indolent infection. Simple parapneumonic

TABLE 5

Additional Pleural Fluid Analysis Orders Based on Concern

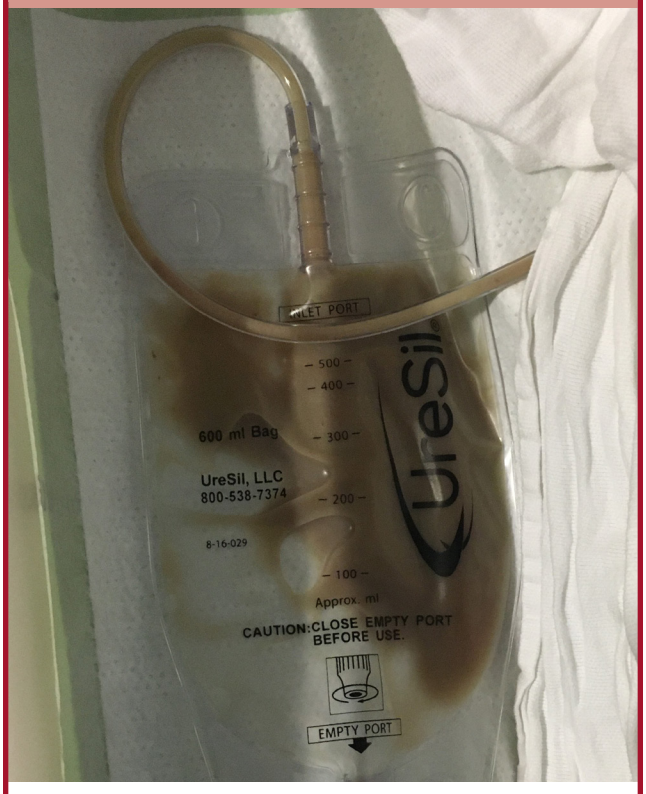
Concern/indication	Further testing	Comments
Bloodstained fluid	Pleural red blood cell count > 100,000 per mm^3	Fluid hematocrit > 1% is diagnostic for malignancy, trauma (including recent cardiac surgery), pneumonia, and pulmonary embolism[1]
Bloody aspirate, trauma	Pleural hematocrit > 50% of the peripheral hematocrit	Indicates hemothorax[1]
Clinical infection, concurrent pneumonia, empyema, tuberculosis	Pleural glucose level < 40 mg per dL (2.22 mmol per L)	Useful when pH test is not reliable, or not available; may warrant earlier and more invasive methods of drainage[18]; low glucose can also indicate advanced malignancy, rheumatoid effusions, and esophageal rupture[5]
Esophageal rupture or acute pancreatitis/ pancreatic pseudocyst	Pleural fluid amylase level	Food particles can be found with esophageal rupture and are a surgical emergency; amylase is also elevated in tuberculosis and malignancy, especially adenocarcinoma and ruptured ectopic pregnancy[5]; serum lipase is sensitive for pancreatitis
Heart failure (when misclassified as exudates by Light's criteria)	Serum NT-proBNP thresholds for acute heart failure, which are adjusted for age Pleural NT-proBNP level > 1,500 pg per mL *or* Serum-pleural albumin gradient > 1.2 g per dL (12 g per L) *or* Serum-pleural protein gradient > 3.1 g per dL (31 g per L)	NT-proBNP is more sensitive for heart failure than protein or albumin gradient[41]; serum NT-proBNP values are comparable with pleural assay values in predicting heart failure and are less costly[40]
Malignancy	Cytology Serum/pleural mesothelin and other tumor markers (e.g., CEA, CA 125, CA 15-3)	Cytology is positive in 60% of malignant pleural effusions[1] Consider serum/pleural mesothelin in concerning cytology, but not for screening; tumor markers have low sensitivity and are not recommended for routine testing; imaging-guided pleural biopsy is recommended[5]; thoracoscopy is diagnostic in 90% of patients with negative cytology[1]
Milky appearance of fluid	Pleural fluid triglyceride and cholesterol levels	Chylothoraxes (triglycerides > 110 mg per dL [1.24 mmol per L] with low cholesterol on fluid assay) in thoracic duct injury Pseudochylothorax (cholesterol > 250 mg per dL [6.47 mmol per L] on fluid assay) in chronic rheumatoid effusion and tuberculosis[5]
Systemic lupus erythematosus (lupus pleuritis) and small bilateral effusion	Pleural ANA[17]	High pleural-serum ANA ratio is sensitive for lupus pleuritis[17]; however, it may be elevated due to malignancy and infection[5]
Tuberculosis (lymphocyte predominant) in high-prevalence populations	Pleural ADA, pleural IGRA, pleural *Mycobacterium* cultures, pleural AFB	Pleural ADA testing is 91% sensitive and 88% specific (false positives in the setting of empyema, rheumatoid pleurisy); IGRA is 95% sensitive and 96% specific[17]; AFB sensitivity < 5%, *Mycobacterium* cultures are 10% to 20% sensitive; pleural biopsy is definitive when tuberculosis is cultured or PCR positive; cell count is lymphocytic in tuberculosis[5]

ADA = adenosine deaminase; AFB = acid-fast bacillus; ANA = antinuclear antibodies CA = cancer antigen; CEA = carcinoembryonic antigen; IGRA = interferon-gamma release assay; NT-proBNP = N-terminal pro-brain natriuretic peptide; PCR = polymerase chain reaction.

Information from references 1, 5, 17, 18, 40, and 41.

effusions will often resolve with antibiotics alone. Complicated parapneumonic effusions and empyema require more invasive methods of drainage with catheter or chest tube. Experts estimate 30% of patients may require further surgical intervention with medical thoracoscopy or video-assisted thoracoscopic surgery.[18,43] Patients who are good surgical candidates may benefit from earlier video-assisted thoracoscopic surgery. Patients with a high risk of mortality may benefit from combined tissue plasminogen activator/deoxyribonuclease administered via chest tube.[44] A five or greater RAPID (renal, age, purulence, infection source, and dietary factors) score predicts a high three-month

FIGURE 9



Purulent chest tube drainage diagnostic for empyema.

mortality risk[45] (https://www.mdcalc.com/calc/4014/rapid-score-pleural-infection).

Malignant Pleural Effusion

Malignant pleural effusion is another common cause of exudates in the United States. Recurrent malignant pleural effusions have an overall poor prognosis, with an average survival of four to seven months.[26] The American Thoracic Society has an evidence-based guideline on treating malignant effusions and recommends individualized treatment with an indwelling pleural catheter or talc pleurodesis in symptomatic patients.[26]

Referral

Specialist consultation is recommended if assistance with the initial thoracentesis is needed, for a suspected exudative effusion, or for a complicated effusion with loculations on imaging. Referral is also warranted if pleural effusion attributed to a transudative process does not resolve after treatment or if the diagnosis is still unknown after the initial aspirate analysis. Complicated parapneumonic effusion, empyema, and malignant effusion warrant consultation for catheter or chest tube drainage, evaluation for pleurodesis, indwelling pleural catheter placement, or thoracoscopy. Repeat imaging should be performed several days after

TABLE 6

Characterization of Parapneumonic Effusions

Parapneumonic effusion	Imaging characteristics	Aspirate characteristics	Therapy overview
Minimal	Lateral anterior chest radiography with costophrenic angle blunting, minimal size on POCUS or CT (estimated < 100 mL, < 10 mm fluid in height on lateral decubitus film)	Unknown	Thoracentesis usually *not* indicated; antibiotic therapy with close monitoring
Simple	Effusion without complex features on POCUS or CT (free-flowing and without septations or loculations); often a small, unilateral effusion (estimated size 100 mL, > 20 mm in height on CT or POCUS, > 10 mm on lateral decubitus film)	Gram negative, culture negative, pH > 7.2, and glucose > 60 mg per dL (3.33 mmol per L)	Thoracentesis *is* indicated; medical management with antibiotics; monitoring for exacerbations, increasing effusion size, and new complex features on repeat imaging
Complicated	Variable in size—any large (more than one-half of the hemithorax on chest radiography) effusion is suspect; septations and loculations on POCUS; loculation and thickened parietal pleura on contrast CT; absence of these findings on imaging does not rule out a complicated parapneumonic effusion	Gram positive, culture positive, or pH < 7.2; glucose < 40 mg per dL (2.22 mmol per L), or purulence on initial aspirate (empyema)	Thoracentesis plus catheter or chest tube drainage; tissue plasminogen activator/deoxyribonuclease therapy; medical thoracoscopy and video-assisted thoracoscopic surgery for decortication; expanded antibiotic coverage and duration

CT = computed tomography; POCUS = point-of-care ultrasound.

Information from references 8, 17, 18, 25, and 42-44.

TABLE 7

Empiric Broad-Spectrum Antibiotic Coverage for Complicated Parapneumonic Effusions

	Community-acquired infection	Hospital-acquired infection
Target species	Anaerobes, *Streptococcus pneumoniae*, and *Viridans streptococci*	Anaerobes and methicillin-resistant *Staphylococcus aureus*, *Pseudomonas*, *Enterobacter*
Antibiotics	Metronidazole (Flagyl) plus ceftriaxone *or* Ampicillin-sulbactam *or* Metronidazole plus fluoroquinolone *or* Carbapenem	Metronidazole, vancomycin, and cefepime *or* Piperacillin/tazobactam (Zosyn) and vancomycin *or* Metronidazole, vancomycin, and ciprofloxacin *or* Carbapenem and vancomycin

Note: Antibiotic choice should follow local bacterial resistance patterns until culture and sensitivities have returned. Macrolides are not used because atypical bacteria (e.g., legionella, chlamydia) are rarely found in pleural effusion. Aminoglycosides should be avoided because they have poor pleural penetration.

Information from references 39 and 43.

treatment to check for improvement. Repeated evaluations are recommended for patients with reaccumulating fluid or clinical decline.[4]

This article updates previous articles on this topic by Saguil, et al.[4] and Porcel and Light.[1]

Data Sources: PubMed searches were completed using the key terms pleural effusion, pleural fluid analysis, pleural tap, and thoracentesis. The searches included systematic reviews, meta-analyses, randomized controlled trials, review articles, and practice guidelines. The Cochrane database and Essential Evidence Plus were also searched. Search dates: January 2022 to July 2022.

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SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	Evidence rating	Comments
If available, point-of-care ultrasound with chest radiography should be used in the initial evaluation of the pleural space to determine the size and character of the effusion.[2,5,8,17,18]	C	Expert opinion and consensus guideline with disease-oriented evidence
If malignancy is suspected, further evaluation with computed tomography is indicated. However, a negative computed tomography result does not exclude malignancy.[17]	C	Expert opinion, consensus guidelines
Diagnostic thoracentesis is typically indicated for pleural effusions that are new onset, unilateral, and larger than minimal, in the absence of clinically evident heart failure, cirrhosis, or kidney failure appropriately responsive to therapy. Therapeutic thoracentesis should be performed to relieve symptoms.[2,5,17,18]	C	Expert opinion, consensus guidelines, and usual practice
Routine chest radiography after pleural aspiration is not required unless the patient is symptomatic, air is aspirated, or after multiple thoracentesis attempts.[2,28,31,34]	B	Expert consensus based on multiple medium-size prospective cohort studies; systematic review
Ultrasound-guided thoracentesis should be used because it decreases complications from pneumothorax and solid organ puncture.[5,11,17,18,26,28,33,35]	B	Expert consensus and guideline based on multiple small observational studies

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to https://www.aafp.org/afpsort.

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