



V. N. Karazin Kharkiv National University  
School of Medicine

Propaedeutics of Internal Medicine and Physical Rehabilitation  
Department

**Student's Scientific Community**  
**21 October 2021**



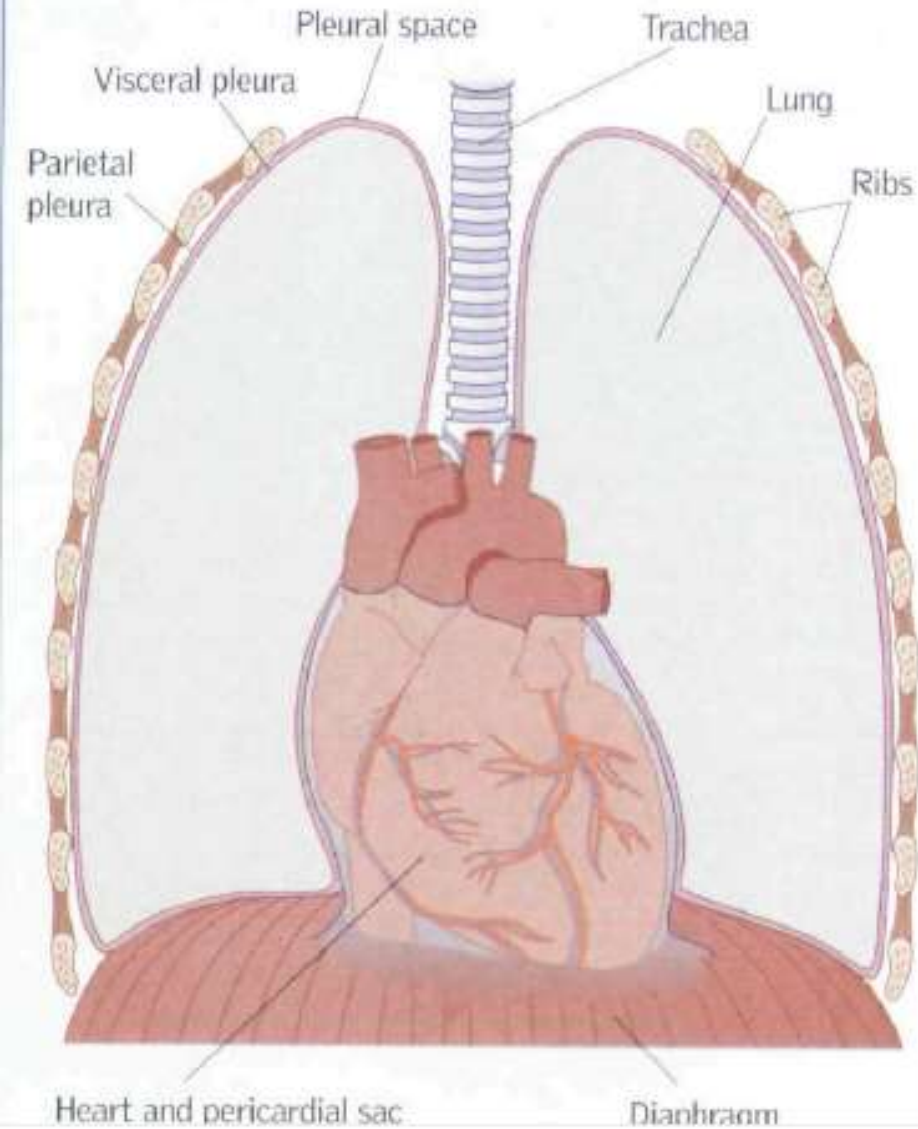
## **Scientific Discussion**

# **“THE MODERN APPROACH TO THE DIFFERENTIAL DIAGNOSIS OF PLEURAL EFFUSION IN ADULTS”**

**Nataliia Yu. Bogun,**  
Assistant of Department of the Propaedeutics  
of Internal Medicine and Physical  
Rehabilitation

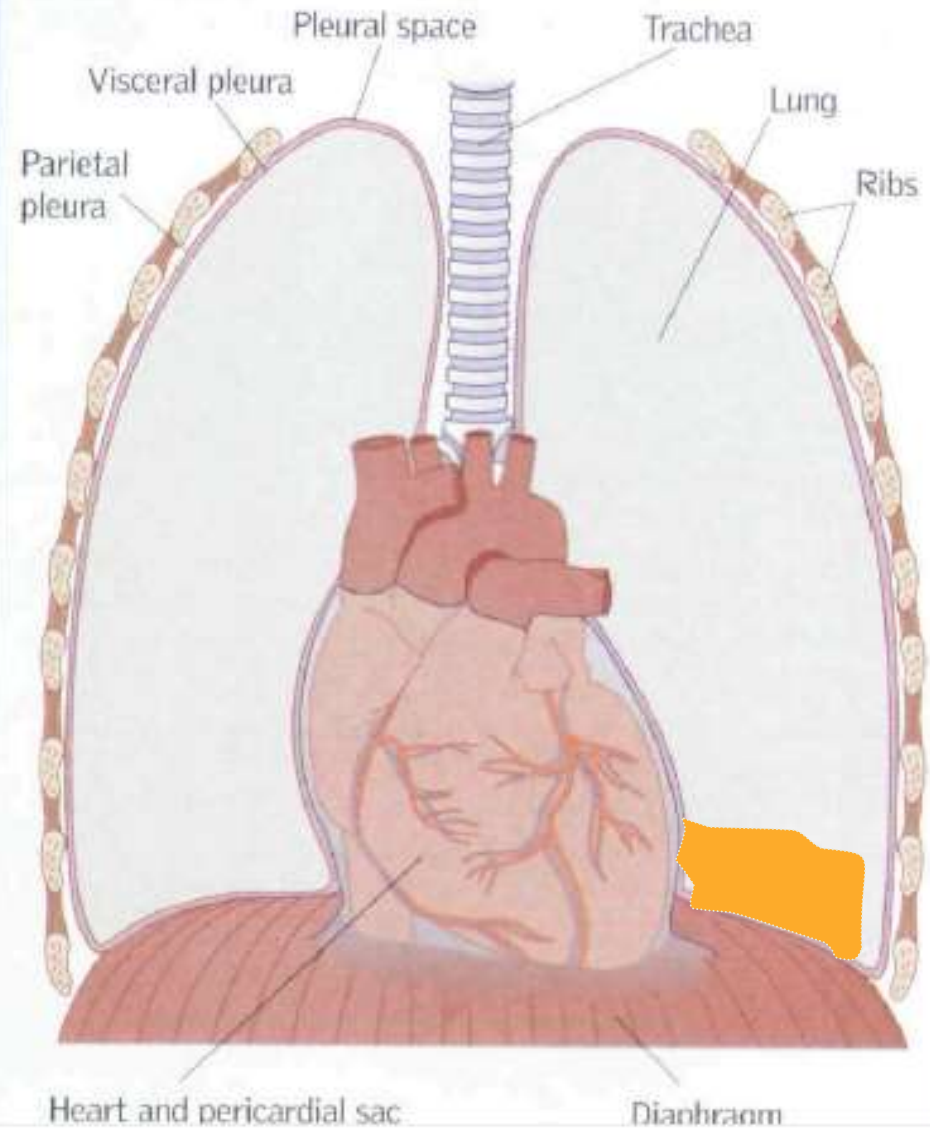
# Normal lung

The thorax, lungs and pleura



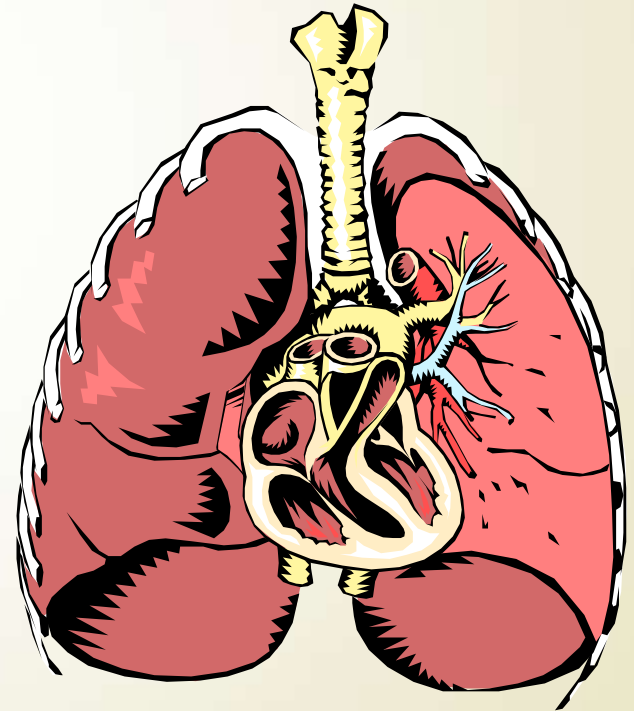
# Pleural effusion

The thorax, lungs and pleura



# Physiology of the normal lung

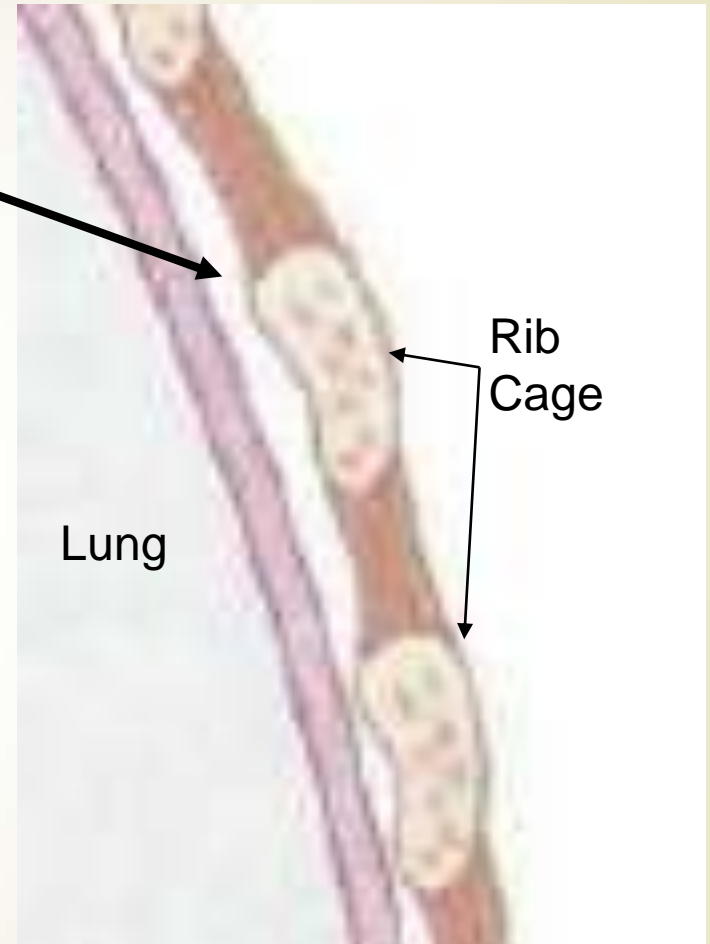
- The lungs are soft, spongy, cone-shaped organs located in the chest cavity.
- They are separated by the mediastinum and the heart.
- There are 3 lobes on the right lung and 2 lobes on the left lung.



# Layers of the lung

## Parietal Pleura

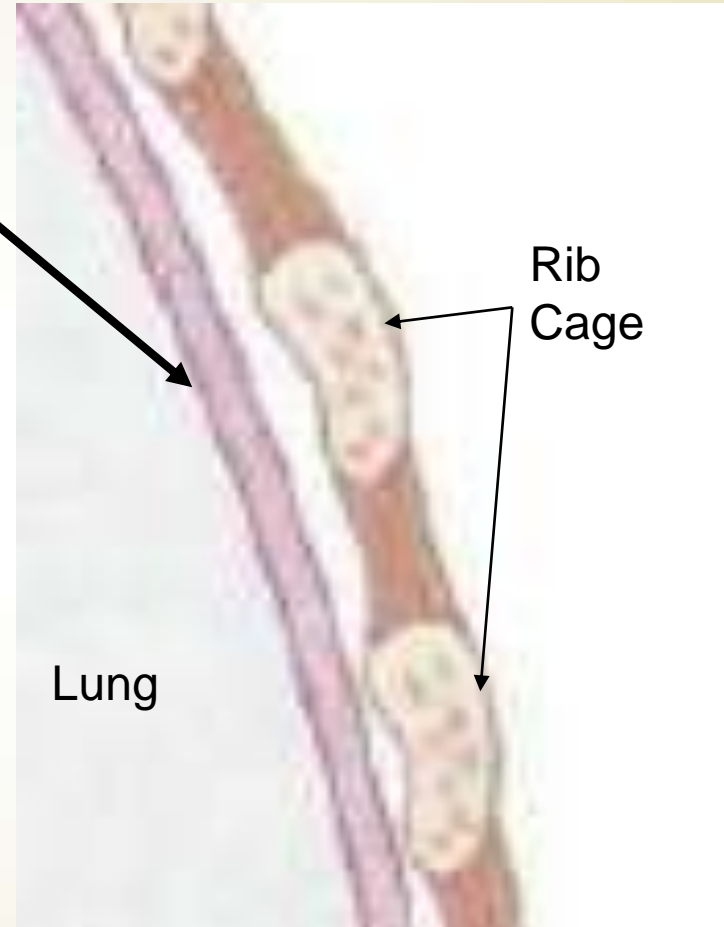
- ▶ Lines the thoracic cavity, including the thoracic cage, mediastinum, and diaphragm
- ▶ Contains sensory nerve endings that can detect pain



# Layers of the lung

## Visceral Pleura

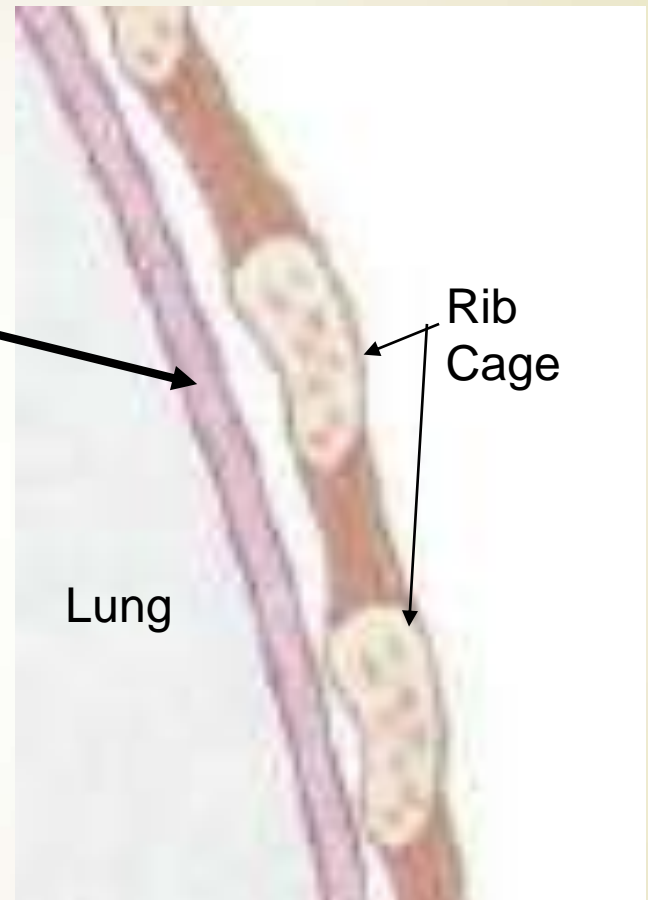
- ▶ Lines the entire surface of the lung
- ▶ Contains NO sensory nerve endings that detect pain



# Layers of the lung

## Pleural Space

- thin, transparent, serous membrane which lines the thoracic cavity
- a potential space between the parietal pleura and visceral pleura





# Pleural fluid


- serous fluid that allows for the parietal pleura and visceral pleura to glide over each other without separation
- contains about 5-15ml of fluid at one time
- Pleural fluid is produced by the parietal pleura and absorbed by the visceral pleura as a continuous process.
- about 100-200ml of fluid circulates though the pleural space within a 24-hour period
- has an alkaline pH of about 7.64





# Review question:

Pleuritic chest pain indicates inflammation or irritation of the parietal pleura or visceral pleura?





# Think again!



The **visceral pleura** contains no nerve endings for detecting pain.

# Correct!



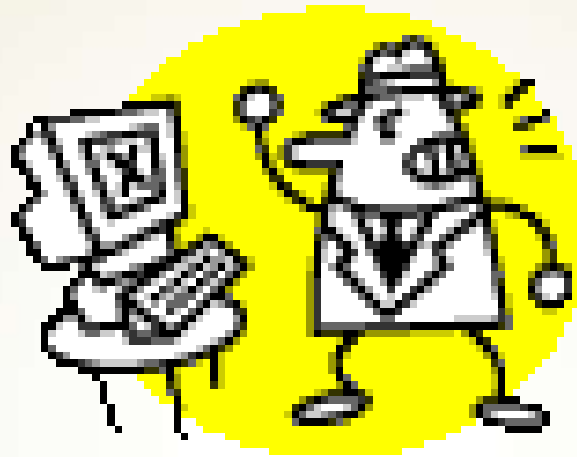
The **parietal pleura** contains sensory nerve endings that can detect pain.

# Review question:

The pleural space typically contains how much fluid?

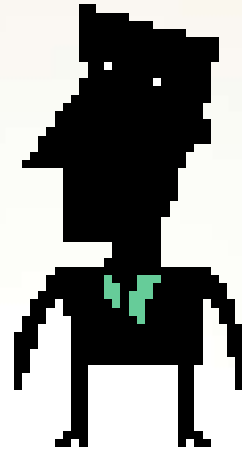
- 5-15ml
- 50-100ml
- 100-200ml

# Think again!



About 100-200ml of fluid circulates  
through the pleural space within a 24-hour  
period

# Correct!



- 5-15ml of fluid are present at one time
- The pleural space is a potential space between the parietal pleura and visceral pleura, allowing them to glide over each other without separation

# Let's review

Fluid is absorbed by the:

- ➡ Parietal Pleura
- ➡ Pleural Space
- ➡ Visceral Pleura



# Think Again - - -



- Pleural fluid is produced by the parietal pleura
- The pleural space is a potential space between the parietal pleura and visceral pleura
- Negative pressure is created in the pleural space

# Correct!!!



- Pleural fluid is produced by the parietal pleura and absorbed by the visceral pleura as a continuous process.
- The visceral pleura absorbs fluid, which then drains into the lymphatic system and returns to the blood

# Pleural effusion



Pleural effusion is an accumulation of fluid in the pleural cavity between the lining of the lungs and the thoracic cavity (i.e., the visceral and parietal pleurae).

# TRANSUDATE

- ▶ The pleural fluid is called a transudate if it permeates (transudes) into the pleural cavity through the walls of intact pulmonary vessels.
- ▶ The accumulation of transudate is typically due to increased hydrostatic pressure (e.g., in congestive heart failure) and/or decreased oncotic pressure (e.g., in cirrhosis or nephrotic syndrome).
- ▶ Since transudate is a filtrate, it is typically a clear fluid with a low protein and cell content.
- ▶ **Common causes:** congestive heart failure; hepatic cirrhosis; nephrotic syndrome; protein-losing enteropathy; chronic kidney disease

# Exudate

- It is called an exudate if it escapes (exudes) into the pleural cavity through lesions in blood and lymph vessels, e.g., as caused by inflammation and tumors.
- By contrast, the lesions responsible for the outflow of exudate allow larger molecules and even solid matter to pass into the pleural cavity.
- For this reason, exudate is a cloudy fluid with a high protein and cell content.
- Common causes: **INFECTION** (pneumonia; tuberculosis; pleural empyema); **MALIGNANCIES** (e.g., lung cancer, metastatic breast cancer, lymphoma, mesothelioma); **PULMONARY EMBOLISM** (In ~ 80% of pleural effusions associated with pulmonary embolisms, the fluid is an exudate (suggesting a pulmonary infarction). In ~ 20% of cases, the fluid is a transudate.); **AUTOIMMUNE DISEASE** ( vasculitis; SLE; rheumatoid arthritis; sarcoidosis); **PANCREATITIS**; **HEMOTHORAX**; **CHYLOTHORAX**; **PSEUDOCYLOTHORAX**



# Empyema

- Accumulation of pus in the pleural cavity.
- Most common: pneumonia → extension of bacterial infection into the pleural space
- Less common: infected hemothorax, ruptured lung abscess, esophageal tear, thoracic trauma



# Chyle



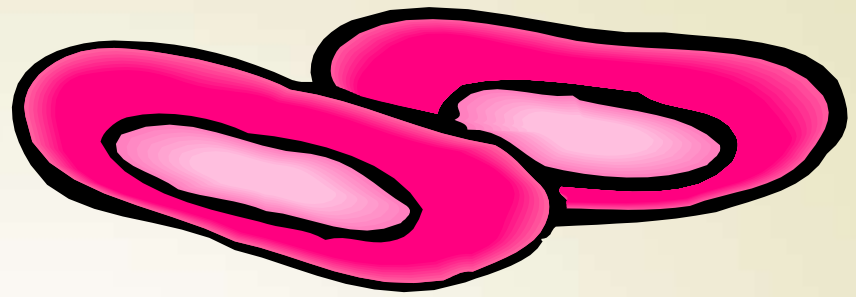
- Lymphatic fluid from the thoracic duct (chyle) accumulates in the pleural cavity
- Etiology: Trauma (including iatrogenic); Malignancy (e.g., lymphoma, bronchogenic carcinoma); Congenital lymphatic anomalies (e.g., lymphangiectasis)
- Cloudy, milky fluid with high concentrations of lipids (triglycerides, cholesterol, chylomicrons, and fat-soluble vitamins)

# Pseudochylothorax



- Accumulation of cholesterol-rich fluid in the pleural cavity due to chronic inflammation
- Etiology: chronic pleural inflammation (e.G., Due to rheumatoid arthritis, pulmonary tuberculosis)
- Cloudy, milky appearance
- In contrast to chylothorax, a pseudochylothorax is characterized by **high cholesterol and low triglyceride levels in the pleural fluid**. The **presence of cholesterol crystals** may also help differentiate a pseudochylothorax from a chylothorax.

# Hemothorax



## Red Blood Cell

- Accumulation of blood in the pleural cavity
- Most commonly due to penetrating or blunt trauma
- A hemothorax, however small, must always be drained because blood in the pleural cavity will clot if not evacuated, resulting in a trapped lung or an empyema.

# Let's review

- Which is NOT a type of fluid that may cause a pleural effusion?
  - empyema
  - chylothorax
  - pneumothorax
  - hemothorax

# This is a fluid that may cause a Pleural Effusion



Empyema (pus),  
Chylothorax (chyle), and  
hemothorax (blood) are all  
fluids that may result in a  
pleural effusion.

# Correct, this is not a fluid!

Pneumothorax is a collection of air in the pleural cavity.





# Signs and symptoms

➤ Patients with a small pleural effusion (< 300 mL) are often asymptomatic. (*Symptoms typically only develop with large (> 300 mL) effusions.*)

## Characteristic symptoms

- Dyspnea
- Pleuritic chest pain
- Dry, nonproductive cough
- Symptoms of the underlying disease (e.g., fever in empyema, cachexia in cases of malignancy, symptoms of left-sided heart failure)



# Physical exam findings

## **Inspection and palpation:**

- Asymmetric expansion and unilateral lagging on the affected side
- Reduced tactile fremitus due to fluid in the pleural space

## **Auscultation**

- Faint or absent breath sounds over the area of effusion
- Pleural friction rub
- **Percussion:** dullness over the area of effusion



# Diagnosis

Imaging can confirm a pleural effusion, but analysis of the pleural fluid (via thoracentesis) is usually required to establish the underlying etiology.



## ➤ **Chest radiograph (x-ray)**

-Very small pleural effusions (< 300 mL) may not be visible on a chest x-ray

## ➤ **Chest ultrasound**

-Very sensitive: can detect fluid amounts as low as 20 mL

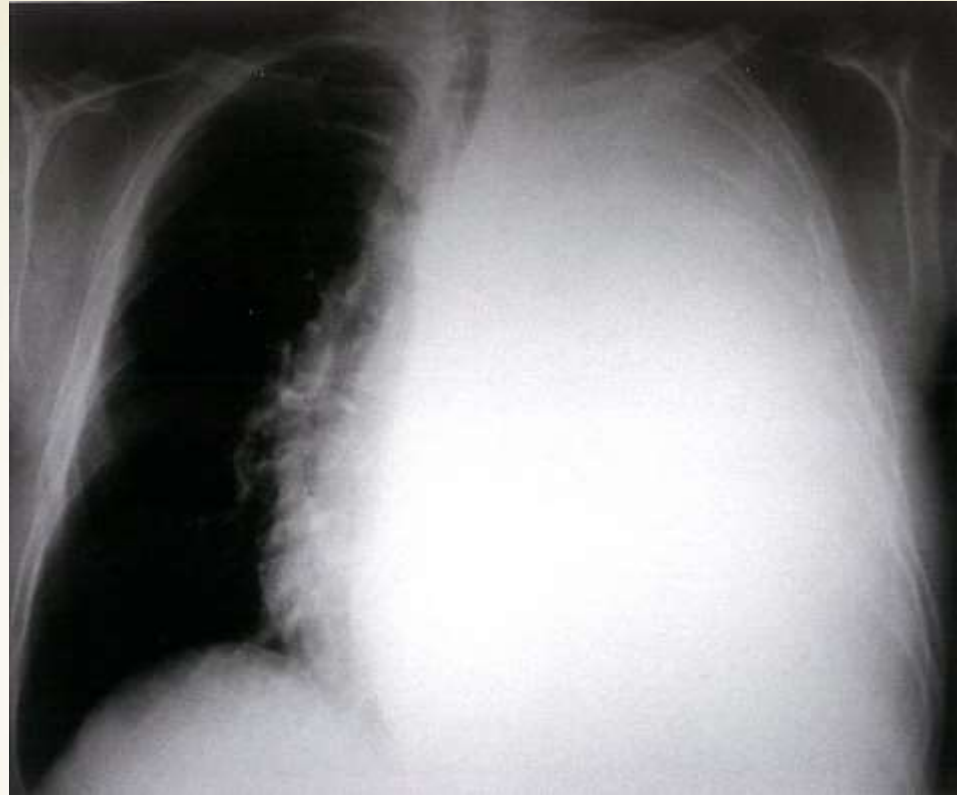
-able to give precise position of accumulation - commonly used for planning thoracentesis

## ➤ **Computed Tomography (CT) scan**

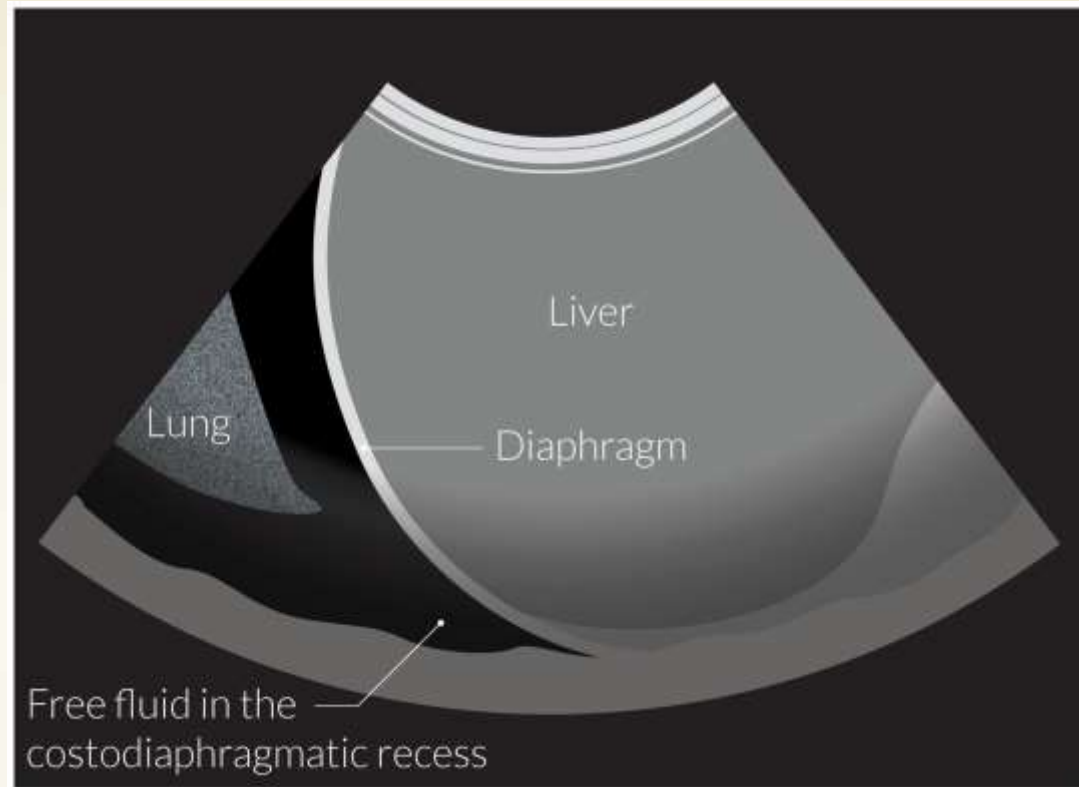
-more sensitive than CXR and ultrasound in identifying small pleural effusions but not required for diagnosis

- measurement of fluid density on CT scan may provide a clue to the underlying etiology (e.g., hyperattenuation of blood in hemothorax).

- consider IV contrast if there is a concern for underlying malignancy

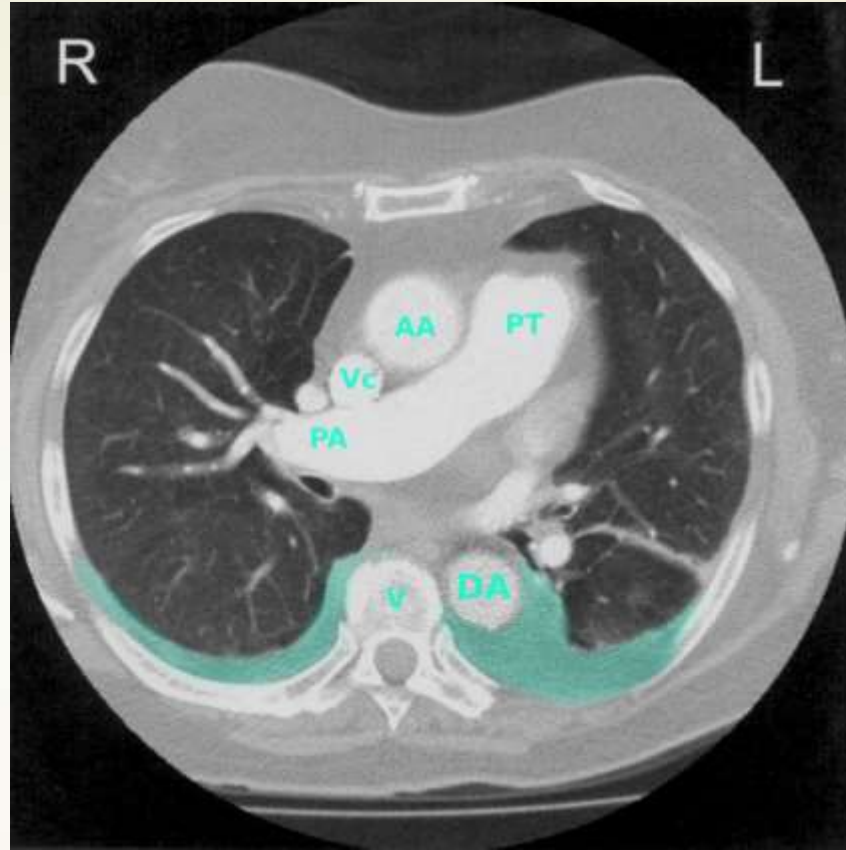


Malignant pleural effusion in lung  
cancer



Fluid in the right costodiaphragmatic  
recess





Bilateral pleural effusion

# Thoracentesis

Aspiration of fluid from the pleural space for diagnostic (e.g., transudate vs. exudate) and/or therapeutic purposes

## Indications:

- ▶ Any new unilateral effusion  $> 1$  cm on x-ray in an undiagnosed patient (*Except in patients with obvious signs of typical heart failure or very small effusions in patients with an established diagnosis*)
- ▶ History of malignant tumor with effusion  $> 1$  cm on x-ray
- ▶ Large effusion with dyspnea and/or cardiac decompensation

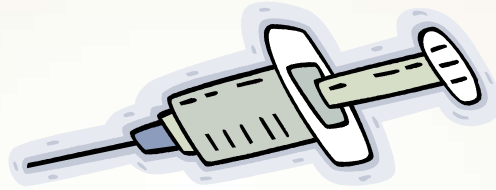


# Thoracentesis

- A needle is inserted into the chest wall to remove the collection of fluid
- 50-100ml of fluid is sent for analysis
- Determines the type of fluid (transudate or exudate)



# Thoracentesis



- Not a permanent solution, fluid may reaccumulate after a few days
- Will temporarily relieve symptoms
- Potential complications include bleeding, infection, and pneumothorax



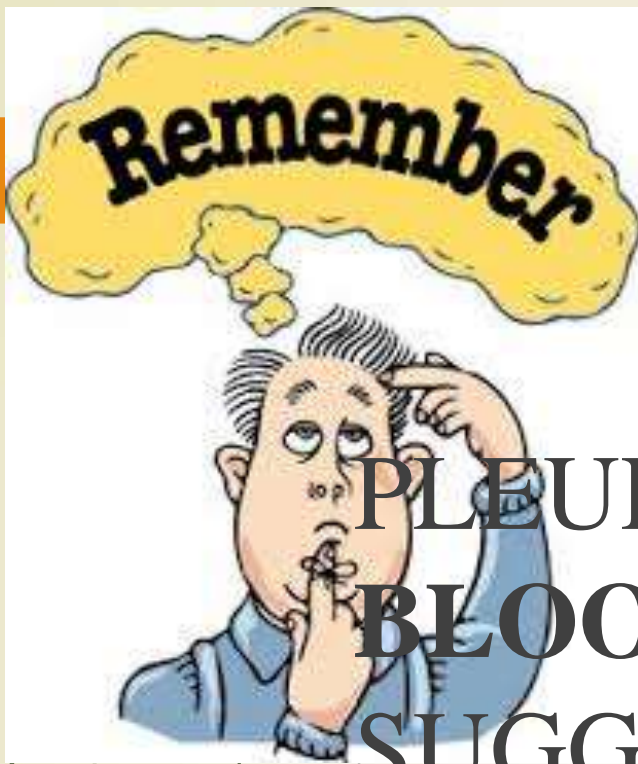
**Transudate** is usually clear, has a decreased cell count, and has low levels of protein, albumin, and LDH. **Exudate** typically appears cloudy, has an increased cell count, and has high levels of protein, albumin, and LDH.



Think **MEAT** to memorize causes of pulmonary effusion with decreased glucose content: **M** = Malignancy, **E** = Empyema, **A** = Arthritis (rheumatoid pleurisy), **T** = Tuberculosis!







**PLEURAL FLUID WITH A  
BLOODY APPEARANCE  
SUGGESTS A MALIGNANT  
ETIOLOGY OR  
HEMOTHORAX!**



# Reporter: 4-year student Amal Krishna

## CASE

- A 67-year-old man presents to the emergency department with a 5-day history of fever and cough that produces green sputum. He has a history of tobacco use and ischemic cardiomyopathy with a left ventricular ejection fraction of 25%. He is admitted with a pre sumptive diagnosis of pneumonia and is started on antibiotics. A chest radiograph is obtained and shows a left-sided infiltrate and moderate size effusion.



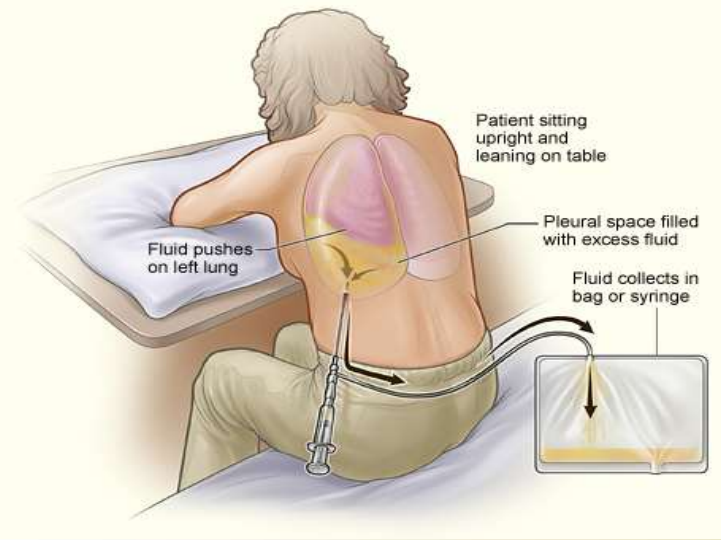
# QUESTIONS



# 1. Why should a diagnostic thoracentesis be performed on this patient?


- (A) This patient's effusion is likely related to his congestive heart failure (CHF)**
- (B) The effusion is a new finding and its etiology is unknown**
- (C) Thoracentesis should be performed on all pleural effusions**
- (D) This patient's effusion is malignant given his smoking history**

# ANSWER



**(B) The effusion is a new finding and its etiology is unknown.**

Diagnostic thoracentesis is indicated when pleural effusion is a new finding and the etiology is unknown. Observation without thoracentesis may be warranted in pleural effusions due to uncomplicated CHF, ascites, and other volume overload states. This patient's pneumonia may be the cause of the effusion; therefore, it cannot be determined if the effusion is caused by CHF alone. It is not possible to determine the etiology of a pleural effusion based on chest radiograph alone, and therefore malignancy cannot be determined at this point.




**2. Which of the following studies can be used to determine if the patient's effusion is due to his CHF (a transudate) or is a parapneumonic effusion (an exudate)?**

- (A)Pleural fluid pH**
- (B)Pleural fluid glucose**
- (C)Pleural fluid cell count**
- (D)Lactate dehydrogenase (LDH)**

# ANSWER

**(D) LDH.** Traditionally, Light's criteria have been used to differentiate transudative from exudative effusions. These criteria include: (1) pleural fluid protein to serum protein ratio greater than 0.5, (2) pleural fluid LDH to serum LDH ratio greater than 0.6, and (3) pleural fluid LDH ratio greater than two thirds the upper limit of normal for the serum LDH. Exudative effusions meet at least 1 of Light's criteria, and transudates meet none. Recently, several other tests have been proposed as well. A pleural fluid cholesterol concentration greater than 60 mg/dL and a pleural fluid to serum albumin gradient of less than 1.2 may also suggest an exudative effusion. Pleural fluid glucose, pH, and cell count levels are helpful in characterizing pleural effusions but do not differentiate between transudates and exudates.



**3. The fluid from thoracentesis has a pH of 7.3, which can be consistent with either CHF or a parapneumonic effusion. Which of the following types of pleural effusions have a pleural fluid pH greater than 7.2?**

- (A) Empyema**
- (B) Rheumatoid pleuritis**
- (C) Hepatic hydrothorax**
- (D) Urinothorax**

# ANSWER

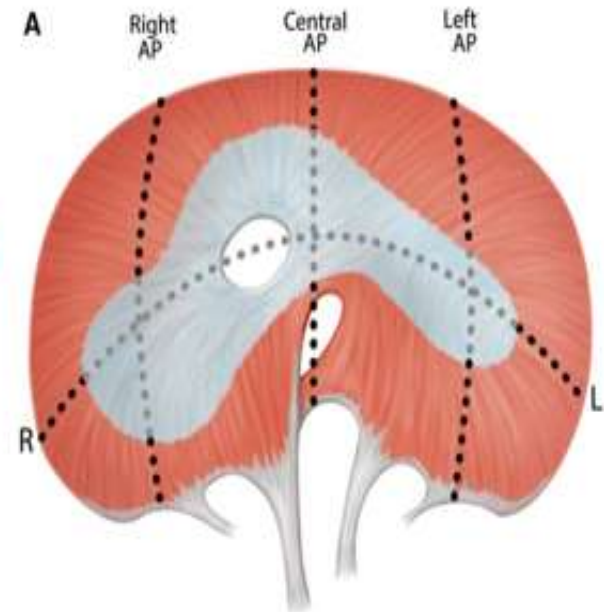


➤ (C) **Hepatic hydrothorax.** Hepatic hydrothorax is a transudative effusion. With transudative pleural effusions, the pleural fluid pH is usually similar to or slightly higher than the simultaneous blood pH. Therefore, pleural fluid pH levels will be greater than 7.3. Urinothorax is a notable exception; it is an acidic transudate and has a pleural fluid pH less than 7.2. Measurement of the pleural pH is useful in the differential diagnosis and prognosis of exudative effusions. The following conditions will have pleural fluid pH less than 7.2: empyema, complicated parapneumonic effusion, esophageal rupture, rheumatoid pleuritis, tuberculous pleuritis, malignant pleural disease, hemothorax, systemic acidosis, paragonimiasis, and lupus pleuritis.




# Hepatic hydrothorax

- Presents as right sided in 85% of cases
- Fluid studies:
  - Pleural fluid/serum total protein ratio  $< 0.5$  💡
  - Pleural fluid/serum LDH ratio  $< 0.6$  💡
  - Serum-to-pleural fluid albumin gradient  $> 1.1$  g/dL ★
  - Protein  $< 2.5$  g/dL ★
  - pH  $> 7.4$
- Spontaneous bacterial pleural empyema may develop
- Management: Diuresis → Thoracentesis → ?TIPS, Liver transplant



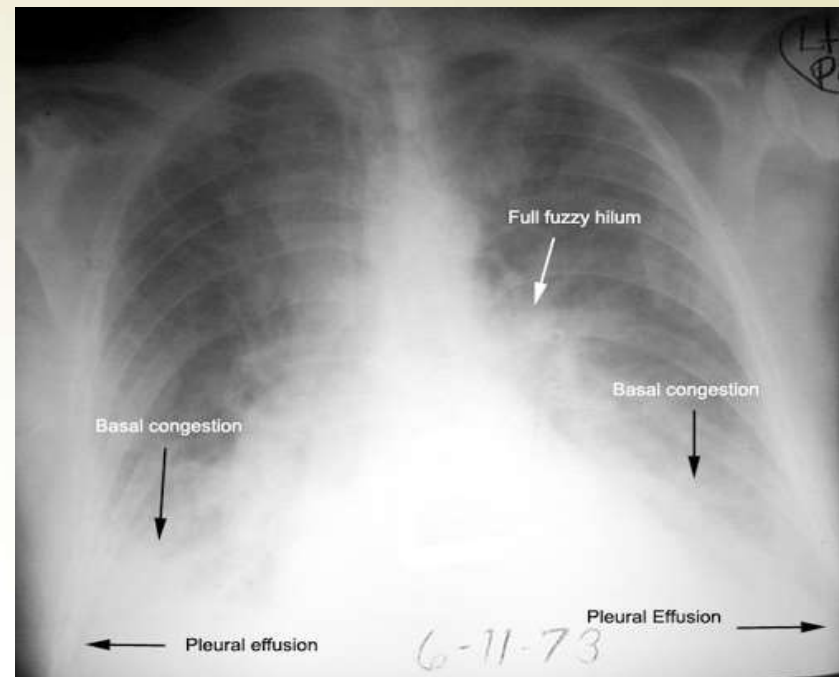





**4. Results of the patient's pleural fluid and serum glucose measurements are 56 mg/dL and 90 mg/dL, respectively. Which of the following types of effusions typically have a pleural fluid glucose concentration similar to that of blood glucose?**

- (A) Malignant effusion**
- (B) Lupus pleuritis**
- (C) Esophageal rupture**
- (D) Effusion due to CHF**

# ANSWER



- (D) **Effusion due to CHF.** Most pleural effusions have a pleural fluid glucose concentration similar to that of blood glucose, including effusions due to CHF and nearly all transudates. The following exudates may have a low ( $< 60$  mg/dL) pleural fluid glucose concentration: rheumatoid pleurisy, parapneumonic effusion or empyema, malignant effusion, tuberculous pleurisy, lupus pleuritis, and esophageal rupture.



5. Results of additional pleural fluid studies reveal an LDH of 670 U/L and a protein level of 3.4 g/dL. Gram stain and culture are negative. Based on these data, what is the most likely cause of this patient's pleural effusion?

- (A) Typical parapneumonic effusion**
- (B) Complicated parapneumonic effusion**
- (C) Empyema**
- (D) CHF**

# ANSWER



➤ **(A) Typical parapneumonic effusion.** Based on the patient's history of infectious respiratory symptoms and results of pleural fluid studies revealing a low pleural fluid glucose concentration and borderline low pH, the case patient has class 2 or typical parapneumonic effusion. Typical parapneumonic effusions can usually be treated with antibiotics and do not require further intervention after the initial diagnostic thoracentesis. Both complicated parapneumonic effusions and empyema would have a pleural fluid pH less than 7.2. An empyema would also have a positive Gram stain or culture. A pleural effusion due to CHF would be a transudate, with pleural fluid pH and glucose similar to serum values (this was an exudate).

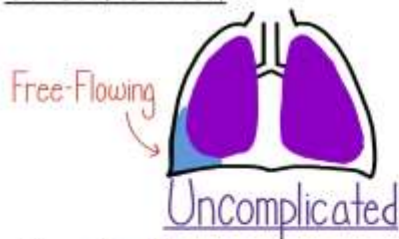


# Parapneumonic Effusion

## Epidemiology

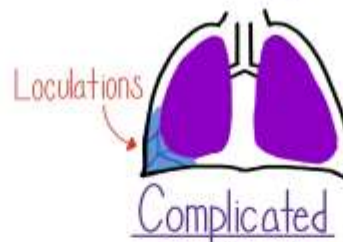
- 2-3% Of All Pneumonias
- 20-40% Of All Inpatient PNAs
- 5-10% Progress to Empyema

## Classification



- Dx:
- Exudative
  - Free-Flowing
  - Sterile

- Tx:
- Antibiotics
  - No Drainage Needed

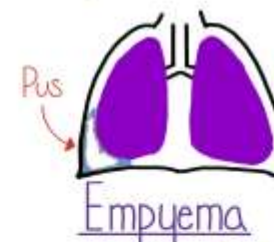


- Exudative + 1 Of The Following:
- $\text{pH} < 7.2$
  - Glucose  $< 40$
  - $\oplus$  Gram Stain or Cx

- Antibiotics
- Drainage w/ Chest Tube

## Microbiology:

- S Pnevmo
- Oral Anaerobes
- S Aureus
- Mycobacteria (in the Right Host)



- Exudative + 1 Of The Following:
- $\text{pH} < 7.2$
  - Glucose  $< 40$
  - $\oplus$  Gram Stain or Cx

- Antibiotics
- Drainage w/ Chest Tube

# Congratulations!



You have successfully completed  
this topic!