



Pleural effusion

● Objectives:

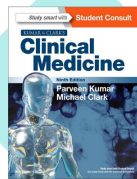
- Describe the pathophysiology of a pleural effusion
- Describe the main causes of a pleural effusion
- Differentiate among the manifestations of fluid collections
- Describe the signs and symptoms of a pleural effusion
- Explain diagnostic methods
- Describe the various treatment options

[Color index : **Important** | **Notes** | Extra]

● Resources:

- 435 slides, team 434, step-up, master the board, Davidson's.

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"Medicine is an art, nobody can deny it."

● **Definition:**

○ **Pleura:**

- Serous fluid [5-15 ml] that allows for the parietal pleura (outer lining) and visceral pleura (inner lining) to glide over each other without separation.
- **Produced** by the parietal Pleura, **absorbed** and **drained** by visceral Pleura
- **100-200ml** of fluid circulates through the pleural space within a 24-hour period
- **Pleural fluid helps in lubrication and prevents atelectasis**
- **≥ 300 ml of pleural fluid is abnormal**

● **Pleural Effusion:**

Pleural effusion is an excessive accumulation of **serous fluid** within the **pleural space**, which can be detected on PA X-ray when ≥ 300 ml of fluid is present and clinically when ≥ 500 ml is present.

○ **The accumulation of:**

- **frank pus** is termed **empyema**,
- **blood** is **haemothorax**,
- chyle is a chylothorax¹.

○ **This accumulation can be caused by one of the following mechanisms:**

- Increased production of fluid by cells in the pleural space,
- Increased drainage of fluid into pleural space,
- Decreased drainage fluid from the pleural space.

● **Pleural Effusion types:**

	Transudative pleural effusion²	Exudative pleural effusion³
Pathophysiology	<ul style="list-style-type: none"> → Due to elevated capillary hydrostatic pressure in visceral or parietal pleura (e.g., CHF) → Due to decreased plasma oncotic pressure (e.g., hypoalbuminemia) → Due to increased intrapleural pressure (eg. atelectasis). 	<ul style="list-style-type: none"> → ↓ lymphatic flow from pleural surface due to a damage to pleural membranes or vasculature. → ↑ capillary permeability (eg. Pneumonia) → ↑ pleural membrane permeability (eg. malignancy) → Thoracic Duct rupture (eg. Chylothorax) → Lymphatic Obstruction (eg. malignancy)

¹ It results from lymph formed in the digestive system called chyle accumulating in the pleural cavity due to either disruption or obstruction of the thoracic duct.

²The protein content is less than 30 g/L and the lactic dehydrogenase is less than 200 IU/L and/or the fluid to serum ratio is <0.6.

³The protein content of exudates is > 30 g/L and the lactic dehydrogenase is > 200 IU/L. (e.g., Bacterial pneumonia, tuberculosis (TB), Malignancy, metastatic disease, Viral infection)

Main causes and types of fluid⁴	The causes of the majority of pleural effusions are identified by a thorough history, examination and relevant investigations.	
	<p style="text-align: center;">*(Think Big Organs) MEMORIZE THESE 4 CAUSES *</p> <ol style="list-style-type: none"> 1. Cardiac failure: Serous fluid, straw-coloured 2. Liver: Cirrhosis: Movement of ascitic fluid from the peritoneal cavity into the pleural space through diaphragmatic defects. 3. Renal: Nephrotic syndrome. 4. Thyroid: Hypothyroidism. <p>Others: ovarian tumours producing right-sided pleural effusion - Meigs' syndrome.</p>	<ol style="list-style-type: none"> 1. Bacterial Infections: <ol style="list-style-type: none"> a. Tuberculosis (chronic): <ul style="list-style-type: none"> - Fluid is serous, usually amber-coloured, - Fluid contains predominantly Lymphocytes b. Pneumonia (acute): Parapneumonic effusion⁵ may lead to empyema 2. Malignancy: <ul style="list-style-type: none"> - Serous, often blood stained, - Serosal cells and lymphocytes, - Often clumps of malignant cells. 3. Inflammatory Diseases: Collagen Vascular Disease (also called connective tissue disease) <ul style="list-style-type: none"> - Rheumatoid Disease, - SLE. 4. Pulmonary infarction: <ul style="list-style-type: none"> - Serous, or blood stained, - Fluid contains: Red blood cells and Eosinophils 5. Viral infection. Others: idiopathic pleural effusion, drugs (hydralazine).

★ **Light's criteria for distinguishing pleural transudate from exudate: (Important).**

98% sensitive and 83% specific for **exudative** effusion using **Light's criteria**.

Exudative effusions have at least one of the following (*transudates have none of these*):

- Protein (pleural)/protein (serum) >0.5
- LDH (pleural)/LDH (serum) >0.6
- LDH > two-thirds the upper limit of normal serum LDH (same concept in point 2)

Exudate Exceeds 0.5 & 0.6 (الدكتور قال اللبيب بالإشارة يفهم)



[Pleural Effusion - causes, symptoms, diagnosis, treatment, pathology](#) 9:08 minutes

○ **The most common causes are:**

1. **CHF** is **most common cause**.
2. **Pneumonia** (bacterial)
3. **Malignancies:** lung (36%), breast (25%), lymphoma (10%)
4. **Pulmonary embolism** (PE)
5. Viral diseases
6. Cirrhosis with ascites

⁴ you don't need to know the details of the pathology

⁵ pleural effusion in the presence of pneumonia

- Differentiate among the manifestations of fluid collections

THE 5 C's: (very important)

1. **Cytology**: to tell you if there's **malignancy** or not e.g. cells of **metastatic** adenoma from the breast.

2. **Culture**: for diagnosis of **Parapneumonic** effusion, **Empyema**, **TB**

3. **Cell count**: look for the **DDx** depending on the **predominant** cells:

Lymphocytes (chronic)

Malignancy, TB, Connective tissue disease (e.g. sarcoidosis, **SLE**)
Predominant (>60%) lymphocytes = red color

Neutrophils (acute)

Parapneumonic (Acute infection), Empyema, Rheumatoid or Pulmonary infarction

Eosinophils

Lymphatic obstruction, Fungal Infection, Allergy, Drugs (e.g. hydralazine).
Others: Trauma, pneumothorax, CA, Asbestos, parasites, Pneumonia
Predominant eosinophils = green color

RBC > 100,000/mm

Malignancy, Trauma, Pulmonary infarction

4. **Color/Character**: pleural fluid is normally colorless (transparent)

Red (Important)

Exudative effusions that are primarily lymphocytic:

Blood (Hemorrhagic effusion/trauma), Malignancy, TB (chronic infection), Connective tissue disease. (الدكتور قال اللبيب بالإشارة يفهم) How to know if this blood is hemothorax or iatrogenic? We divide the hematocrit level in the pleura by the hematocrit level in the blood, if it is $\geq 50\%$ = hemothorax (blunt)

Green

Fungal infection

White/Milky

Lymphatic obstruction as in Lymphoma, **Thoracic duct injury, Chylothorax** (lymph in the pleural space)

Yellow & serous

Any of the mentioned causes above can cause yellow **"it's the most common color"**.

Turbid

زي الطباشير

Acute infection = Pneumonia (**Parapneumonic effusion**)
Acute infection will give you turbid while chronic infection (TB) will give you red

Black

Aspergillus niger and Rhizopus oryzae, metastatic melanoma, ... [Read more](#)

Brown/Roasted

→ Pus → **Empyema**.

5. **Chemistry**: To minimize your DDX. Extra info on slides 16,17,18 (FYI)

PH (< 7.2), Glucose, Protein & LDH(for light's criteria)

In general, pleural fluids with a **low glucose** level also have **low pH** and **high LDH** levels (**Exudate**), as in **infections** (parapneumonic effusion or empyema), connective tissue disease, TB and malignancies.

Amylase

Elevated pleural fluid **amylase**: esophageal rupture, pancreatitis, malignancy.

Pleural fluid pearls	
Condition	Suggests
Elevated pleural fluid amylase	Esophageal rupture, pancreatitis, malignancy.
Milky, opalescent fluid	Chylothorax (lymph in the pleural space)
Frankly purulent fluid	Empyema (pus in the pleural space)
Bloody Effusion	Malignancy
Exudative effusions that are primarily lymphocytic	TB
pH < 7.2	Parapneumonic effusion ⁶ or empyema

- **Empyema:** (pus within the pleural space).

Exudative pleural effusions **-if left untreated-** can lead to empyema, which means the pleural effusion is **infected**.

- The Pus may be as thin as **serous fluid** or so **thick** that it is impossible to aspirate
- **Most cases** occur as **a complication of bacterial pneumonia⁷ (parapneumonic effusion)**.
- empyema may involve the whole pleural space or only part of it ('loculated' or 'encysted' empyema)

- ◆ **Clinical features:** The clinical features are those of the underlying disease (most commonly pneumonia).
- ◆ **Diagnosis:** CXR⁸ and CT scan of the chest are the recommended tests.
- ◆ **Treatment:** aggressive drainage of the pleura (via thoracentesis) and antibiotic therapy.
 - if the condition is not adequately treated, pus may rupture into a bronchus, causing a bronchopleural fistula and pyopneumothorax

19.17 Clinical features of empyema	
Systemic features	
<ul style="list-style-type: none"> • Pyrexia, usually high and remittent • Rigors, sweating, malaise and weight loss • Polymorphonuclear leucocytosis, high CRP 	
Local features	
<ul style="list-style-type: none"> • Pleural pain; breathlessness; cough and sputum, usually because of underlying lung disease; copious purulent sputum if empyema ruptures into a bronchus (bronchopleural fistula) • Clinical signs of pleural effusion 	

⁶ A parapneumonic effusion is a non infected pleural effusion secondary to bacterial pneumonia.

⁷ Over 40% of patients with community- acquired pneumonia develop an associated pleural effusion ('parapneumonic' effusion)

⁸ Chest X-ray appearances may be indistinguishable from those of pleural effusion.

Objective 4: Describe the signs and symptoms of a pleural effusion

● **Clinical Features: (important)**

○ **History / Symptoms:** (Often asymptomatic)

1. Symptoms of pleural effusion:

- Pleuritic chest pain (on inspiration and coughing) (defined as pain in the lung)
- Cough
- Dyspnea (classified by MRC scale)⁹

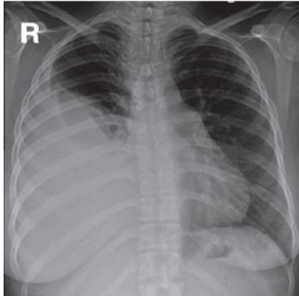
2. Symptoms of the underlying cause, e.g. in CHF: Peripheral edema, orthopnea, paroxysmal nocturnal dyspnea. Or Sx related to malignancy.

○ **Physical examination / Signs:**

(Findings usually present for effusions > 300 mL)

- **Stony dullness to Percussion**¹⁰.
- **Reduced** tactile fremitus¹¹
- Asymmetrical chest wall expansion → reduced in affected side. **When you do the chest Expansion examination, the distance between your thumbs should be > 5cm**
- **Decreased vesicular breath sounds** over the effusion. (in pleural effusion or mass consolidation)
- Egophony¹² above the effusion.
- **Trachea will shift away from the affected side.**
- **Palpation of apex beat** → if the effusion was on the left side apex beat will be displaced, or if it was on the right side but there was cardiomegaly.
- Mediastinum shifted away.

Large right pleural effusion



Inspection
Tachypnoea
Palpation
↓Expansion on R
Trachea and apex may be moved to L
Percussion
Stony dull
R mid- and lower zones
Auscultation
Absent breath sounds and vocal resonance R base
Bronchial breathing or crackles above effusion

Symptoms and signs of pleurisy often precede the development of an effusion, especially in patients with underlying pneumonia, pulmonary infarction or connective tissue disease. However, the onset may be insidious.



[Physiological & pathological breath sounds](#) 6 :03 minutes

⁹ Medical Research Council dyspnoea scale [Picture](#)

¹⁰ Characteristic for pleural effusion, في محاضرة الدكتور, investigations

¹¹ tactile fremitus is a vibration that you can feel with the palm of your hands when someone says "blue moon" or "99" "أربع" "وآربعين". increased fremitus is a sign of consolidation. Decreased fremitus is a sign of pneumothorax or pleural effusion.

¹² is an increased resonance of voice sounds heard when auscultating the lungs, often caused by lung consolidation and fibrosis. This finding is referred to in clinical contexts as the "E to A transition."

Objective 5: Explain diagnostic methods

● Diagnosis: How to diagnose pleural effusion?

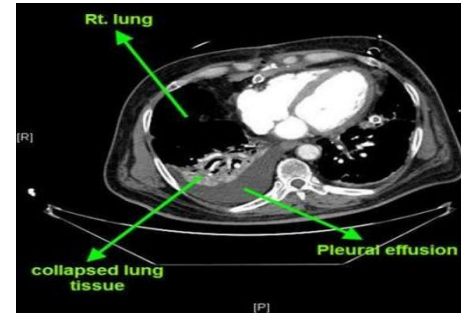
1- History & 2- Physical examination → give **85%** of diagnosis.

3- Chest x-ray: Initial diagnostic test for pleural effusion.

- **Postero-anterior:** Around 250-500 mL of pleural fluid must accumulate before an effusion can be detected. Look for: **blunting of costophrenic angle**¹³
- **Lateral decubitus films** (patient lying on one side): very sensitive, can detect effusions as small as 50 mL, can also determine whether fluid is free flowing or loculated. (it is old, not used anymore)

4- CT scan: What's the indication for CT in pleural effusion?

- CT scanning is indicated where **malignant disease** is suspected.
- Better characterization of underlying lung parenchyma and certain processes that may be obscured on radiographs by large pleural effusions. E.g. consolidation or masses. More reliable than CXR for detecting effusions.
- **To detect the underlying cause, ovary masses could cause pleural effusion (meigs syndrome)**¹⁴



5- Ultrasound: What are the advantages of ultrasound?

- **More sensitive and specific**¹⁵ and it can detect minimal fluid.
- It will help you to rule out others like pneumothorax and fluid collection.
- Cheap and available at bedside
- Can help identify free vs. loculated effusions. A **clear hypoechoic** space is consistent with a transudate and the presence of moving floating densities suggests an exudate. The presence of septation suggests an evolving empyema or resolving haemothorax.

6- Thoracentesis: It's aspiration of fluid facilitated by ultrasound guidance

- Thoracentesis is not immediately indicated if there is an obvious explanation for pleural effusion without atypical features. E.g. a patient with CKD and on hemodialysis, we don't need to do thoracentesis as we already know the cause.
- Indications for thoracentesis:
 - **NEW** Pleural effusion of **unknown** etiology, with >10mm depth on lateral decubitus CXR or Ultrasound
 - **Therapeutically for symptomatic relief**
 - Concern for empyema
 - Air fluid level in pleural space¹⁶
- Pneumothorax is a complication seen in 10% to 15% of thoracenteses. - After you get the fluid send it for analysis.

¹³ need to be larger than 500 mL to cause much more than blunting of the costophrenic angle. On an erect film they produce a characteristic shadow with a curved upper edge rising into the axilla. If very large, the whole of one side of the thorax may be opaque, with shift of the mediastinum to the opposite side.

¹⁴ **Meigs syndrome** is defined as the triad of benign ovarian tumor with ascites and pleural effusion

¹⁵ more accurate than plain chest X-ray for determining the presence of fluid.

¹⁶ The pleural effusion behaves according to basic fluid dynamics, conforming to the shape of pleural space, which is determined by the lung and chest wall. If the pleural space contains both air and fluid, then an air-fluid level that is horizontal will be present, instead of conforming to the lung space.

Objective 6: Describe the various treatment options

● Treatment:

Thoracentesis – then treat underlying disease

- **Uncomplicated pneumonia:** antibiotics.
- **Hemithorax involved/empyema:** tube thoracostomy¹⁷ +/- VATS¹⁸
- **Malignant effusion:** chest tube +/- pleurodesis (sclerosants)¹⁹ / VATS

1- Transudative effusion:

- Diuretics and sodium restriction.
- Therapeutic thoracentesis (in massive effusion).

2- Exudative effusion underlying cause.

3- Parapneumonic effusions:

- Uncomplicated: antibiotics alone.
- Complicated or empyema:
 - Chest tube drainage and antibiotics.
 - Intrapleural injection of thrombolytic agents (streptokinase or urokinase); may accelerate the drainage.

Surgical lysis of adhesions may be required.

A patient came to the ER with SOB weight loss and CXR showed massive pleural effusion, what's the next step?

- ➔ Ultrasound ?
- ➔ Thoracentesis ?
- ➔ CT ?

The right step is to perform **Thoracentesis**, since the patient came to ER your aim should be to relieve his symptoms and approach to diagnose him, and that will be done through aspirating the fluid (Relieve) and sending it to Pathology (Diagnose)

Summary:

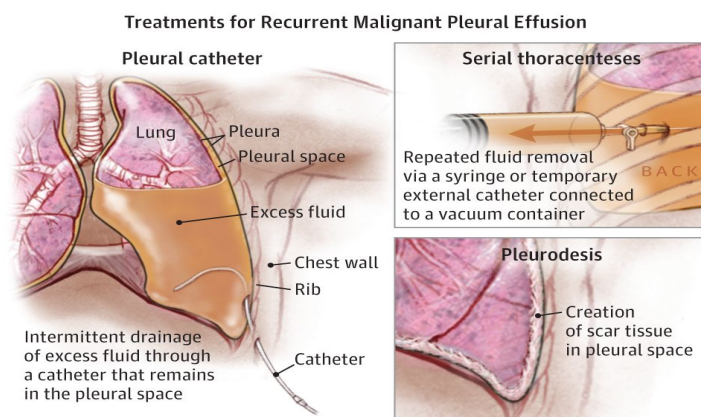
19.15 Pleural effusion: main causes and features				
Cause	Appearance of fluid	Type of fluid	Predominant cells in fluid	Other diagnostic features
Tuberculosis	Serous, usually amber-coloured	Exudate	Lymphocytes (occasionally polymorphs)	Positive tuberculin test Isolation of <i>M. tuberculosis</i> from pleural fluid (20%) Positive pleural biopsy (80%) Raised adenosine deaminase
Malignant disease	Serous, often blood-stained	Exudate	Serosal cells and lymphocytes Often clumps of malignant cells	Positive pleural biopsy (40%) Evidence of malignancy elsewhere
Cardiac failure	Serous, straw-coloured	Transudate	Few serosal cells	Other signs of cardiac failure Response to diuretics
Pulmonary infarction	Serous or blood-stained	Exudate (rarely transudate)	Red blood cells Eosinophils	Evidence of pulmonary infarction Obvious source of embolism Factors predisposing to venous thrombosis
Rheumatoid disease	Serous Turbid if chronic	Exudate	Lymphocytes (occasionally polymorphs)	Rheumatoid arthritis: rheumatoid factor and anti-CCP antibodies Cholesterol in chronic effusion; very low glucose in pleural fluid
SLE	Serous	Exudate	Lymphocytes and serosal cells	Other signs of SLE Antinuclear factor or anti-DNA positive
Acute pancreatitis	Serous or blood-stained	Exudate	No cells predominate	Higher amylase in pleural fluid than in serum
Obstruction of thoracic duct	Milky	Chyle	None	Chylomicrons

(anti-CCP = anti-cyclic citrullinated peptide; SLE = systemic lupus erythematosus)

¹⁷ Tube thoracostomy is the insertion of a tube (chest tube) into the pleural cavity to drain air, blood, bile, pus, or other fluids. [How is it different from thoracentesis?](#)

¹⁸ Video-assisted thoracoscopic surgery (VATS) is a type of thoracic surgery performed using a small video camera that is introduced into the patient's chest via small incisions.

¹⁹ Pleurodesis is a medical procedure in which the pleural space is artificially obliterated. It involves the adhesion of the two pleurae.



Cases

★ A 65 year old male, smoker presented to ER with SOB that started 3 months ago and pleuritic chest pain that started 3 days ago CXR showed pleural effusion. Aspiration by thoracentesis was done and showed bloody effusion, cell count showed lymphocyte count 80%. What are the most likely causes?

- 1) Congestive heart failure.
- 2) Nephrotic syndrome.
- 3) Chronic liver disease.
- 4) **Lung cancer.**

★ A 26 year old girl get upper respiratory tract infection. Her doctor gave her azithromycin for 3 days. After 5 days, she came to emergency complaining of pleuritic chest pain and SOB. CXR showed pleural effusion. Aspiration by thoracentesis was done and showed Pus and cell count showed Neutrophil 100%. WHAT IS THE NEXT STEP FOR THE TREATMENT?

- 1) CT for the chest
- 2) IV antibiotic
- 3) Surgical intervention
- 4) **Chest tube** Ddx : Empyema (treatment : drainage of abscess in the pleura by the chest tube, Antibiotics should be given afterwards. > remember what we said in investigations lecture :) ? we said that indications for chest tube are pus, infection and blood.)

1) A 54-year-old woman is seen in clinic with a history of weight loss, loss of appetite and shortness of breath. Her respiratory rate is 19 and oxygen saturations (on room air) range between 93 and 95 per cent. On examination, there is reduced air entry and dullness to percussion on the lower to mid zones of the right lung. There is also reduced chest expansion on the right. From the list below, select the most likely diagnosis:

- A. Right middle lobe pneumonia
- B. Pulmonary embolism
- C. Right-sided pleural effusion
- D. Right-sided bronchial carcinoma
- E. Right lower lobe pneumonia

2) A 56-year-old woman who has recently been discharged from your ward, with oral antibiotics for right basal community-acquired pneumonia, is re-admitted with transient pyrexia and shortness of breath. She is found to have a right-sided pleural effusion which is drained and some pleural aspirate sent for analysis. The results reveal an empyema. Which of the following, from the pleural aspirate analysis, would typically be found in a patient with an empyema?

- A. pH >7.2, ↑ LDH, ↑ glucose
- B. pH <7.2, ↑ LDH, ↑ glucose
- C. pH >7.2, ↓ LDH, ↓ glucose
- D. pH <7.2, ↑ LDH, ↓ glucose
- E. pH <7.2, ↔ LDH, ↔ glucose

3) A 45-year-old woman with unexpected weight loss, loss of appetite and shortness of breath presents to you in clinic. On examination, there is reduced air entry and dullness to percussion in the right lung. A pleural tap is performed and the aspirate samples sent for analysis. You are told that the results reveal a protein content of >30 g/L. From the list below, select the most likely diagnosis:

- A. Bronchogenic carcinoma
- B. Congestive cardiac failure
- C. Liver cirrhosis
- D. Nephrotic syndrome
- E. Meig's syndrome

Answers

1) **C.** The fact that there is reduced air entry, dullness to percussion in the lower and mid-zones of the right lung and reduced chest expansion, indicates that there is most likely to be a pleural effusion (C) from the list of answers above. 'Stony dullness' is usually used to describe the presence of a pleural effusion but, in clinical practice, distinguishing between dullness and stony dullness can be quite challenging for even the most experienced clinicians. Pulmonary embolism (B) does not usually present with any chest signs. Pneumonia (A and E) and bronchial carcinoma (D) can lead to a secondary pleural effusion, but during the initial stages will present with bronchial breathing over the affected area of the lung.

2) **D.** Empyema can be defined as pus in the pleural space which can occur in patients with resolving pneumonia. Associated symptoms include transient fever, shortness of breath and pleural effusion on the side of the resolving pneumonia. Management includes ultrasound-guided chest drain insertion coupled with antibiotic therapy. The pleural aspirate obtained during the chest drain insertion may appear turbid and (yellow) straw in colour. Empyema falls into the category of exudates, hence protein content is $>30\text{g/L}$.

The pH of pleural fluid is used to ascertain pleural infection. The normal pH of pleural fluid is approximately 7.6. A pleural pH of <7.2 with a normal blood pH is usually found in:

- pleural infections
- empyema
- TB
- malignancy
- oesophageal rupture.

Light's criteria states that pleural fluid can be categorized as an exudate if one or more of the following exist: (1) The pleural fluid protein divided by serum protein >0.5 ; (2) Pleural fluid LDH divided by serum LDH >0.6 and (3) Pleural fluid LDH is more than two-thirds the upper limits of normal serum LDH.

A low glucose level ($<3.3\text{mmol/L}$) is usually seen in the following conditions:

- empyema;
- rheumatoid arthritis;
- SLE;
- TB;
- malignancy
- oesophageal rupture.

Therefore, from the answers above, D is the most appropriate.

3) **A.** Pleural effusions can be categorized into transudates and exudates according to their protein content. Transudates (protein content $<30\text{g/L}$) occur as a result of increased venous pressure (cardiac failure (B), restrictive pericarditis, fluid overload), hypoproteinaemia (cirrhosis (C), nephrotic syndrome (D), malabsorption) hypothyroidism and Meig's syndrome (E) (right pleural effusion coupled with ovarian fibroma). Exudates occur as a result of increased capillary permeability secondary to infection (pneumonia, tuberculosis), inflammation (pulmonary infarction, rheumatoid arthritis, SLE) or malignancy (bronchogenic carcinoma, secondary metastases, lymphoma, mesothelioma, lymphangitis carcinomatosa). From the history, the most likely answer is bronchogenic carcinoma (A).