Cartoon : Javad Tarighi Akbarpor FARS NEWS AGENCY

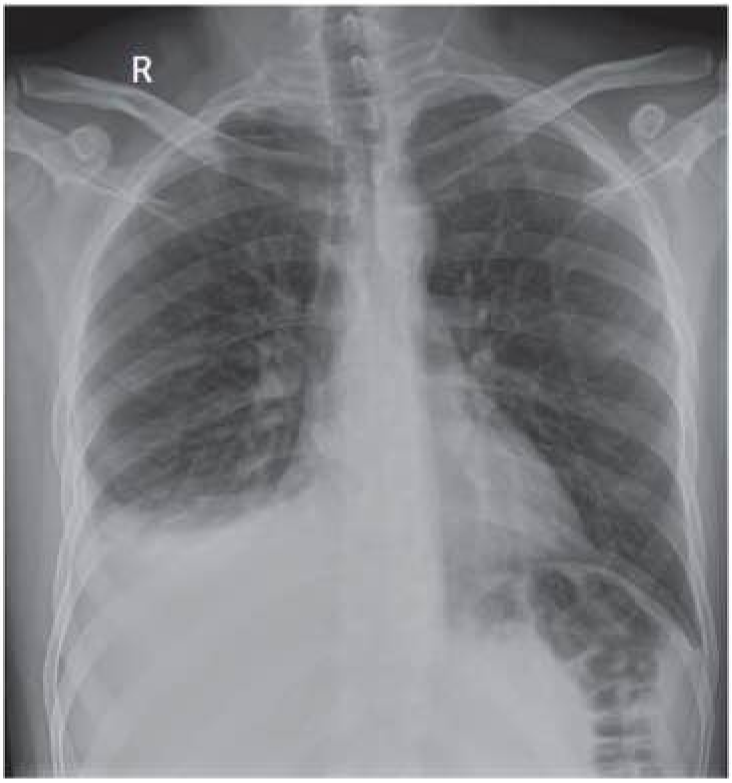
Case one

- A 33-year-old male presented to our hospital with a history of sudden-onset, pleuritic, right-sided chest pain of 2 days' duration.
- It was not associated with fever, cough, dyspnoea, wheeze or haemoptysis.
- There was no history of swelling in the lower extremities, weight loss or anorexia. There was no history of any significant comorbidities.
- He was a smoker (8 pack- years). He had no history of drug abuse.

- On examination, his temperature was 37.2°C, pulse was 77 beats·min−1 , respiratory rate was 22 breaths·min−1 , blood pressure was 112/66 mmHg and oxygen saturation by pulse oximetry was 98% on room air.
- There was no pallor, clubbing, pedal oedema, icterus or lymphadenopathy.
- The breath sounds were absent in the infrascapular and infra-axillary areas on the right side.
- No adventitious sounds were heard on either side of the chest.
- The remaining systemic examination was unremarkable.

- Investigations revealed a haemoglobin level of 16.4 g·dL−1 , and total leukocyte count of 8870 cells·mm−3 with a differential count of 62% neutrophils, 28% lymphocytes, 7% monocytes, 2% eosinophils and 1% basophils.
- The platelet count was 160 000 cells·mm−3 .
- Creatinine, electrolytes and liver function tests were normal.
- The ECG was unremarkable and cardiac enzymes were within normal limits.

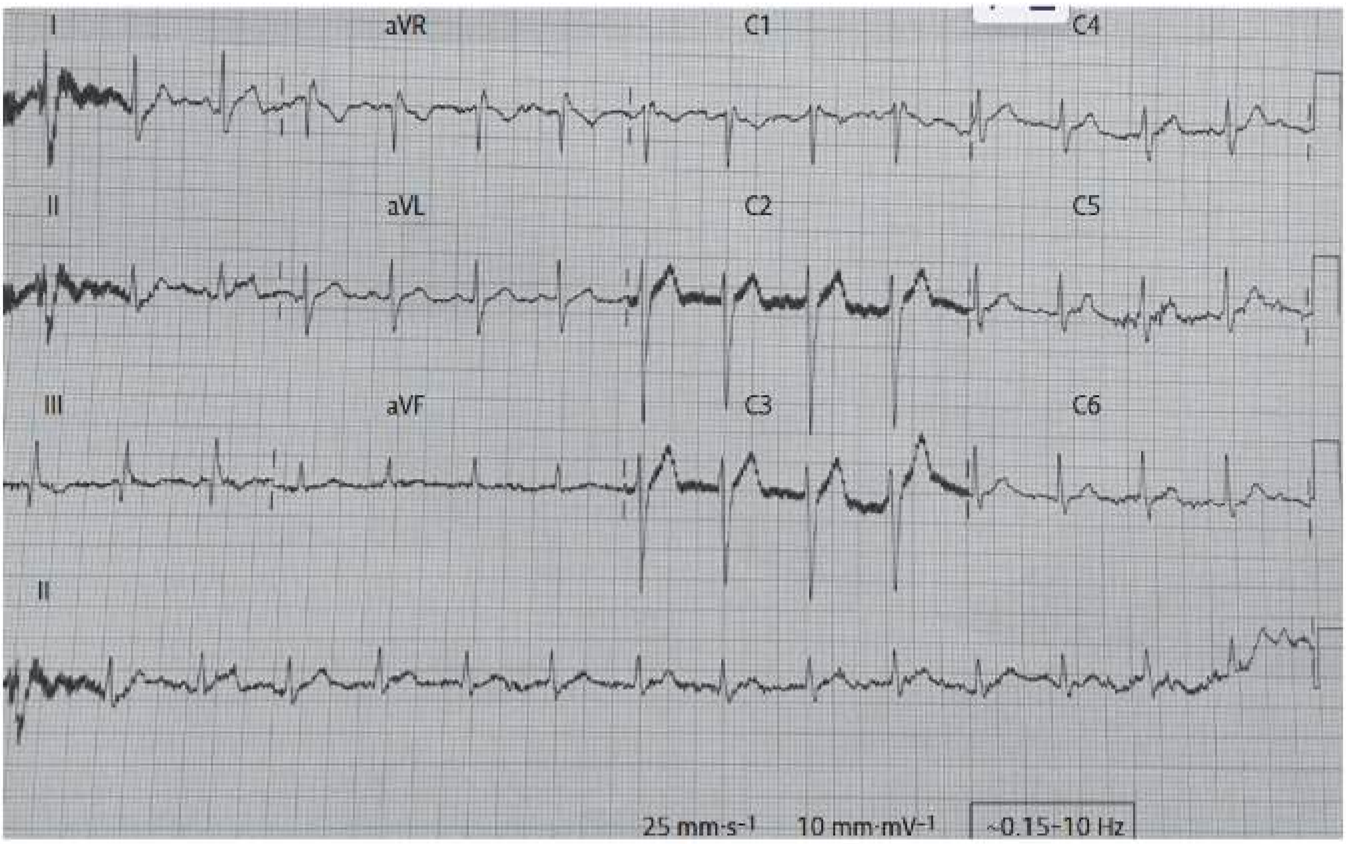
Chest radiograph showed a mild, right-sided pleural effusion, blunting of the left costophrenic angle, no shift of mediastinal position and no lung parenchymal opacities.



What is the next step in management?

- Bilateral effusions that are of unequal size, unresponsive to therapy and associated with pleuritic chest pain or fever should be subjected to diagnostic thoracentesis
- Protein 6.5 g·L−1 (corresponding serum proteins were 7.3 g·L−1),
- Lactate dehydrogenase (LDH) concentration was 820 U·L−1 (corresponding serum LDH was 563 U·L−1)
- Glucose was 7 mmol·L−1 .
- The erythrocyte count was 2 700 000 cells·μL−1 ,
- Leukocytes count was 3400 cells·μL−1 with 53% neutrophils , 42% lymphocytes and 5% monocytes.

- The Gram stain and cultures were sterile.
- There were no acid-fast bacilli seen in smears and real-time PCR for Mycobacterium tuberculosis was negative.
- The cytological examination showed no malignant cells.
- He was treated with antibiotics and analgesics.
- 48 h after admission, the patient complained of severe, left-sided chest pain in the night. It was nonradiating and not associated with sweating, nausea or vomiting.
- There was no haemodynamic compromise and the patient was normoxaemic.
- There were reduced breath sounds in both infrascapular and infra-axillary areas.
- An ECG was performed.

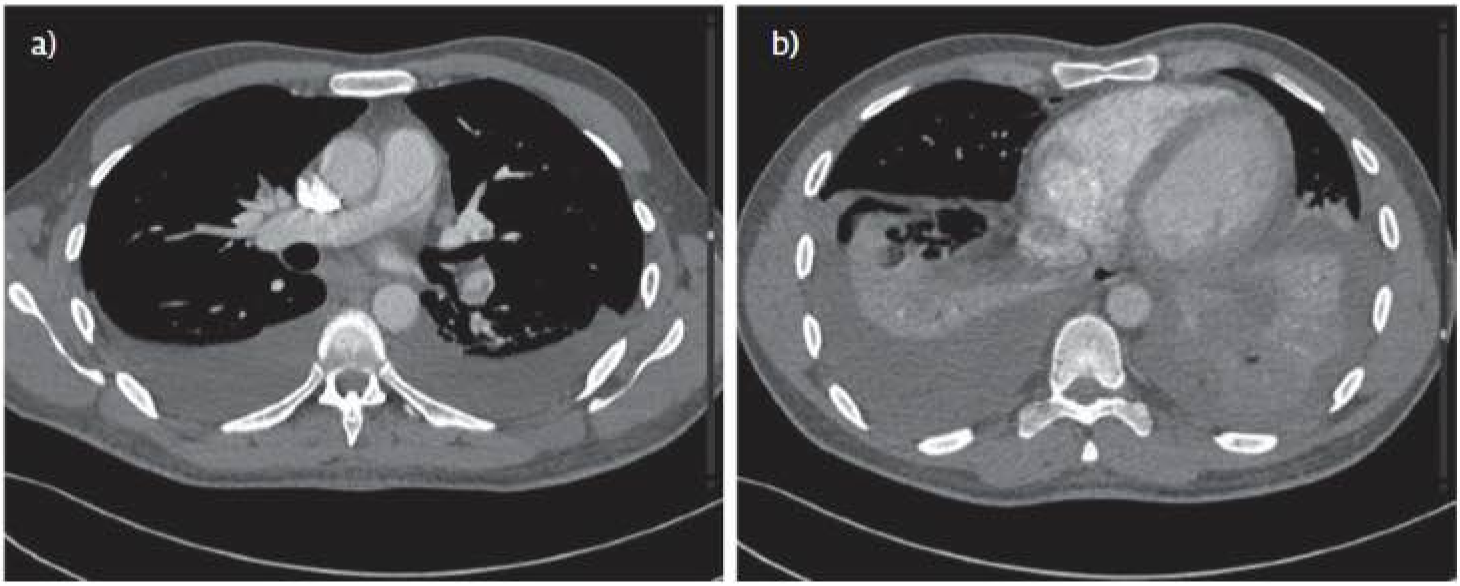


Describe the ECG findings.
What is the differential diagnosis for these findings?

- The ECG showed a normal sinus rhythm with an S-wave in lead I, and a Q-wave and an inverted T-wave in lead III. This pattern is the S1Q3T3 pattern. There was an inverted T-wave in V1.
- The S1Q3T3 pattern is a sign of acute cor pulmonale.
- The differential diagnosis for this condition includes acute pulmonary embolism (PE), pneumothorax, acute bronchospasm and left posterior fascicular block.
- Severe pneumonia may also show this pattern in almost 10% of cases.
- It is seen in 12–50% of cases of acute PE.
- This pattern has 54% sensitivity, 62% specificity, 80% positive predictive value and 33% negative predictive value for the diagnosis of acute PE.

- Serial cardiac enzymes were normal.
- Chest radiography was also repeated

- The patient had a bout of cough associated with mild haemoptysis and fever of up to 38°C.
- The possibility of PE was entertained.
- The revised Geneva score for the assessment of the clinical probability of PE was 5, suggesting that there was an intermediate probability of an embolism.
- D-dimer test level was found to be 3.6 mg·L−1 (normal range 0.09–0.33 mg·L−1).
- In line with the diagnostic algorithm for patients with suspected, not high-risk PE proposed by the European Society of Cardiology , the patient was subjected to (CTPA)

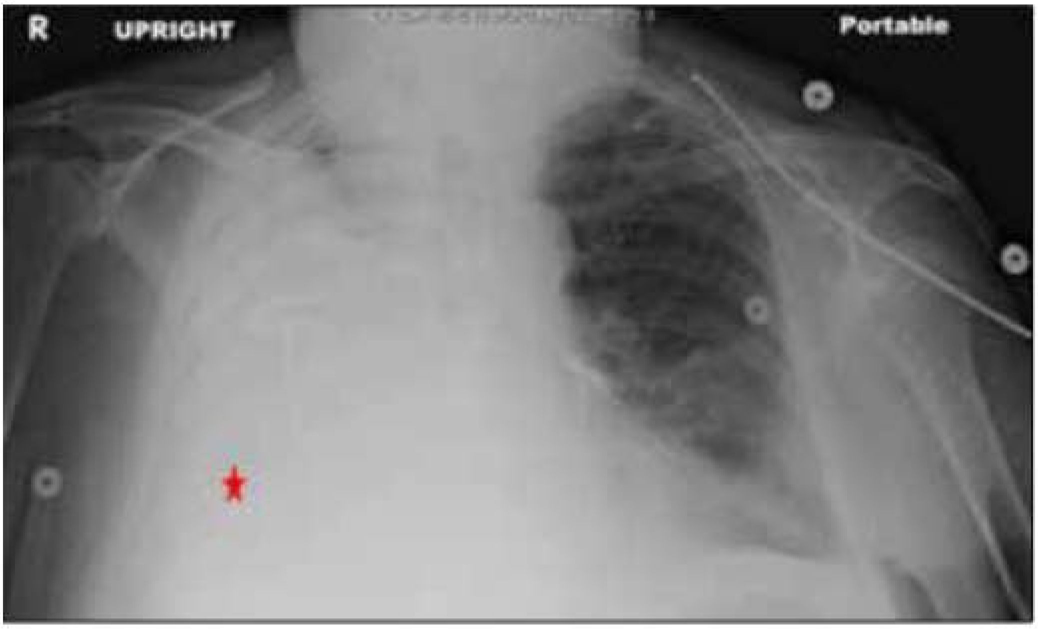


CTPA showing filling defects in both the upper and left lower lobar pulmonary arteries suggestive of bilateral pulmonary embolism. Bilateral, mild pleural effusion is also seen. b) CTPA showing no enlargement of the right ventricle with a normal position of the interventricular septum suggesting no evidence of right ventricle dysfunction

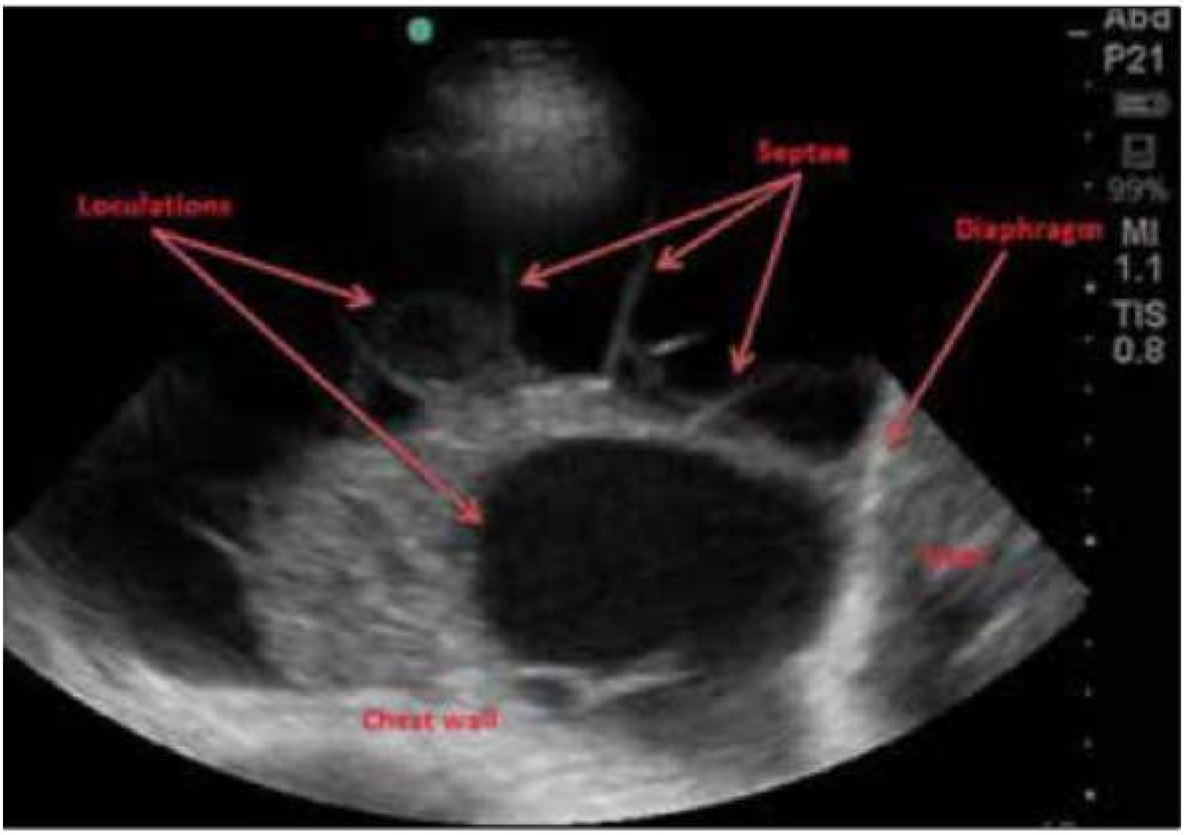
Case 2

- 55-year-old female presented with dyspnea, cough and yellowish sputum for 3 days.
- She is known to have Crohn's disease and was started on prednisone and azathioprine one month prior.
- Her heart rate was 136 bpm, blood pressure 150/103, respiratory rate 37 bpm, O2 saturation 88% and temperature 36.2°C.
- She had a markedly diminished air sounds over the right lung.
- Her white cell count was 21,000/mcL, hemoglobin 8.9 g/dL, pH 7.11, pCO2 81 mmHg and HCO3 25 mmol/L.

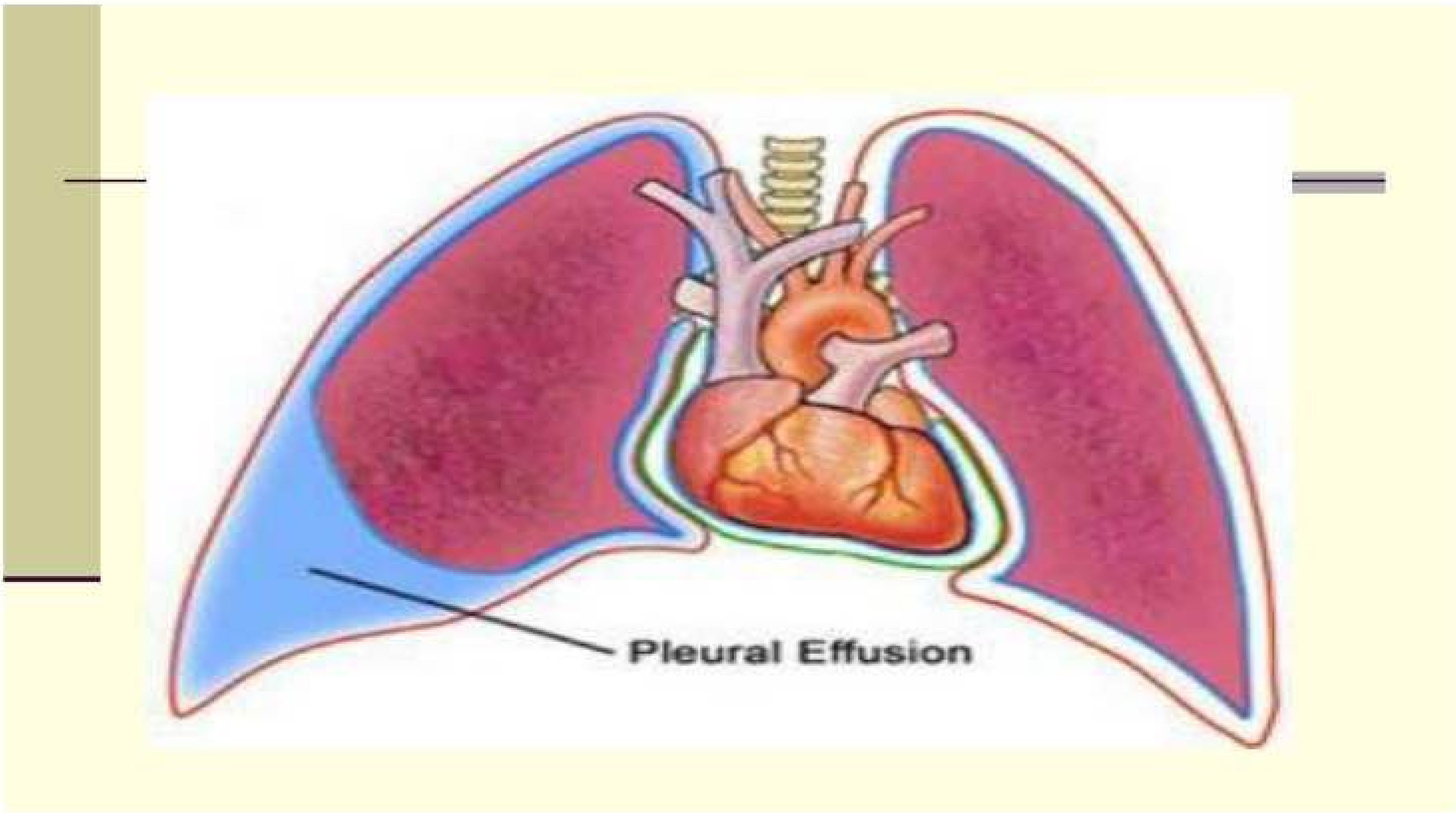
Chest x-ray showed complete opacification of right hemithorax



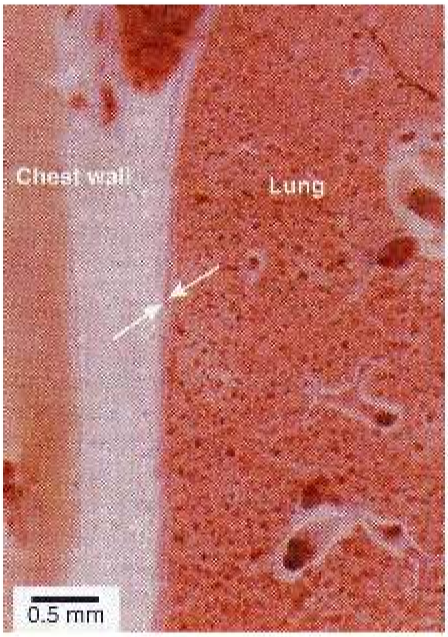
- She was put on BiPAP initially, but then required intubation.
- A bedside chest tube insertion was unsuccessful.
- CT scan of the chest showed a large pleural effusion occupying the right hemithorax with collapse of the right lung in a bizarre fashion.
- Another attempt for drainage by chest tube yielded only 100 ml.
- Suspicion of loculations at this point was confirmed by a bedside ultrasound which showed a multiloculated pleural effusion that was not clearly evident on CT scan.

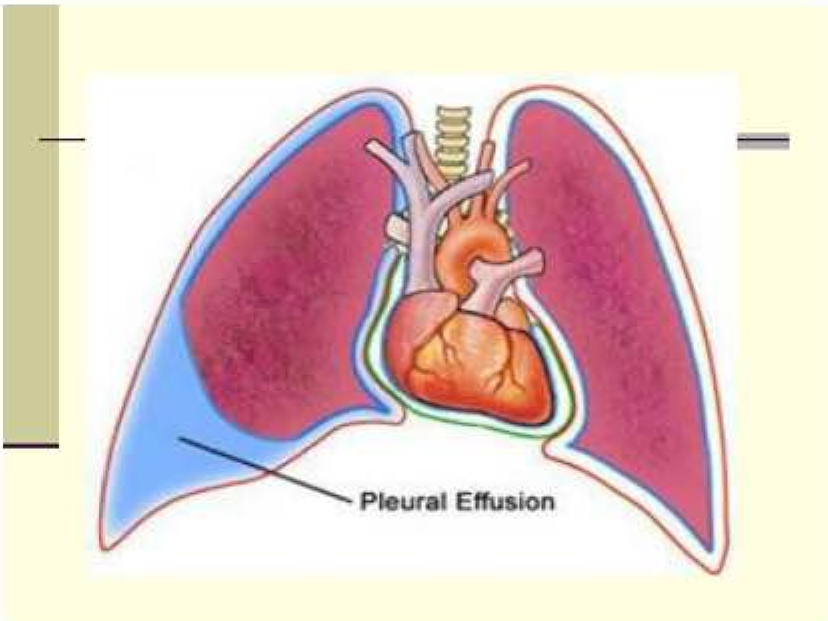


- She subsequently underwent thoracotomy which showed multiple, fluid-filled loculations mostly around the right lower lobe with significant adhesions to the diaphragm and along the major and minor fissures.
- The loculations were dissected along with decortications of thick a pleural rind.
- Two chest tubes were inserted.
- Blood and pleural fluid cultures grew Streptococcus pneumoniae and the patient was treated successfully with Penicillin G



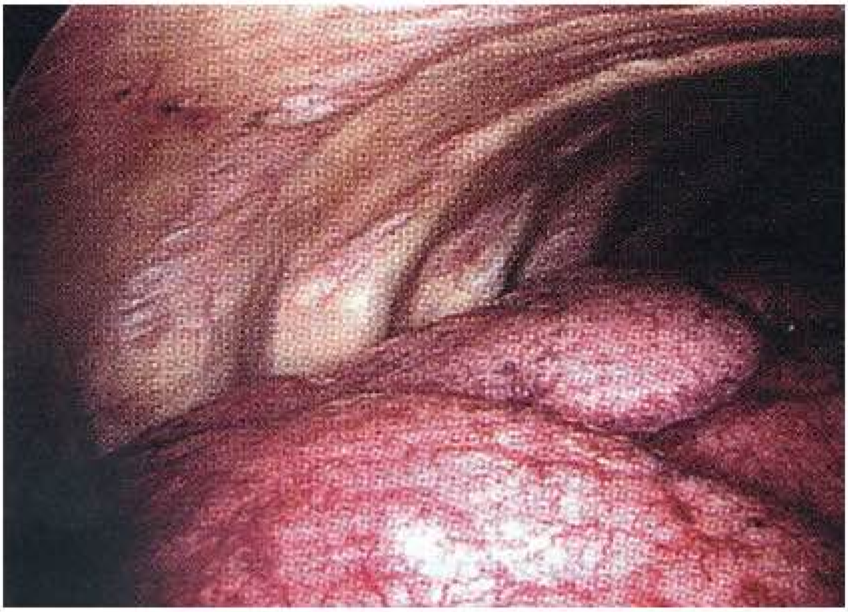
Anatomy & Physiology





- The normal pleura is a thin translucent membrane consisting of 1-mesothelium, 2-thin layer of subendothelial connective tissue rich in lymphatics, arteries veins and nerves.

- Functions:
  - Space for movement &
  - protective in volume overload



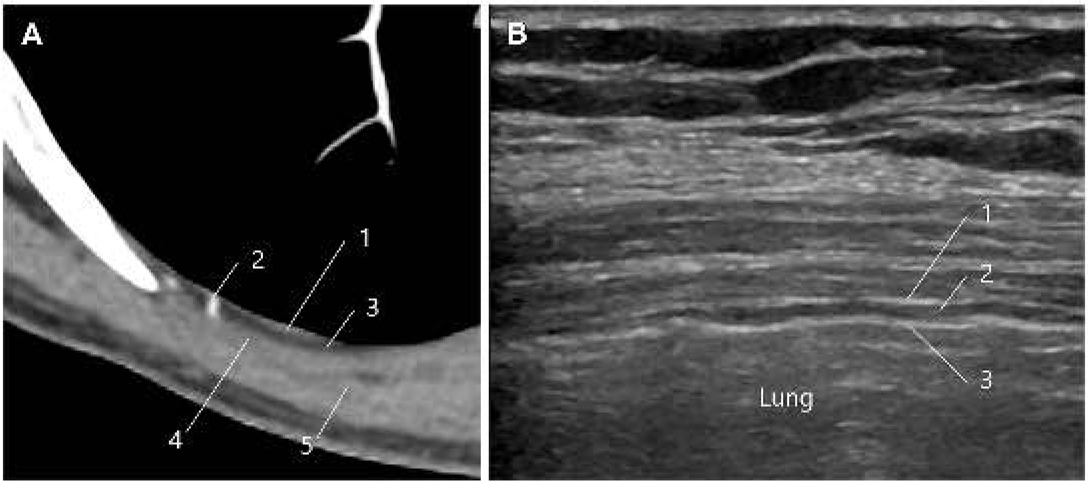


Figure 1. Normal anatomy of the pleura. **(A)** Contrast-enhanced CT image shows the pleura and chest wall. The visceral and parietal pleurae, extrapleural fat layer, endothoracic fascia, and innermost intercostal muscles are represented by a thin line *(1)*. Contrast-enhanced CT also demonstrates the costal artery *(2)*, intercostal fat *(3)*, internal intercostal muscle *(4)*, and external intercostal muscle *(5)*. **(B)** US image shows the border between the parietal pleura *(1)* and visceral pleura *(2)* as a hyperechoic linear shadow. A small amount of pleural effusion can be recognized as an anechoic region *(3)*.

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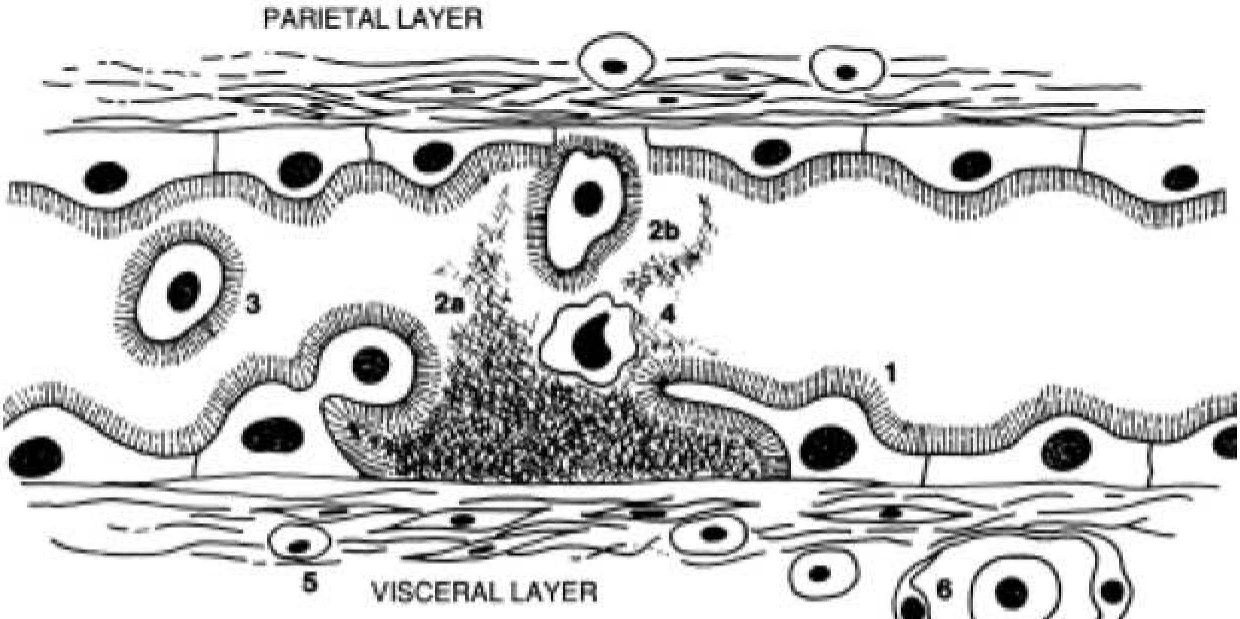
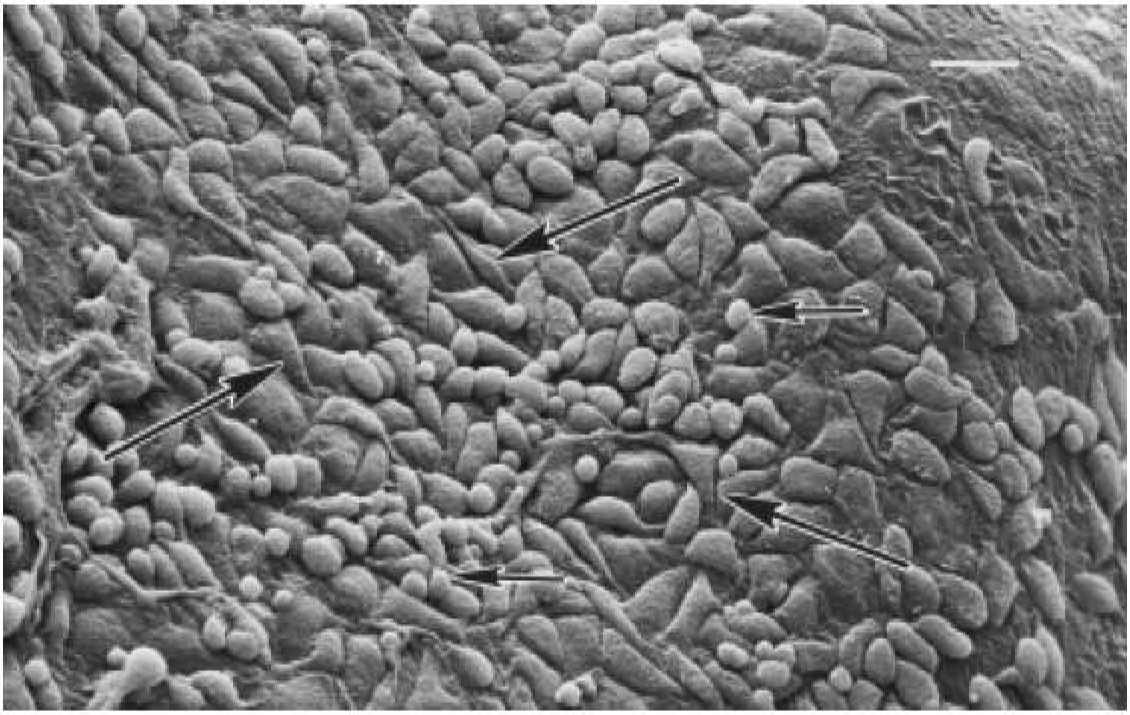
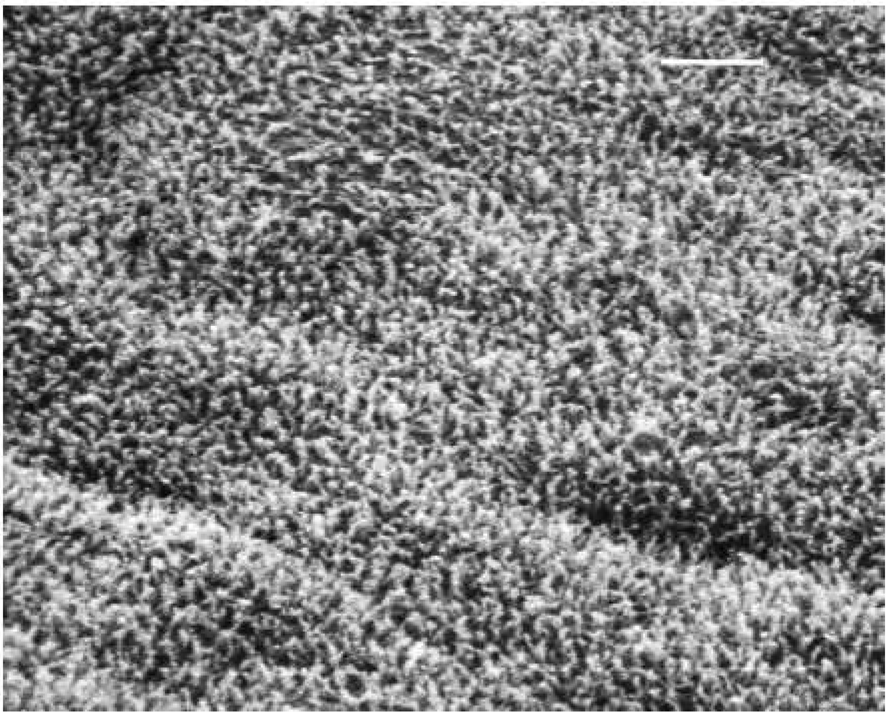
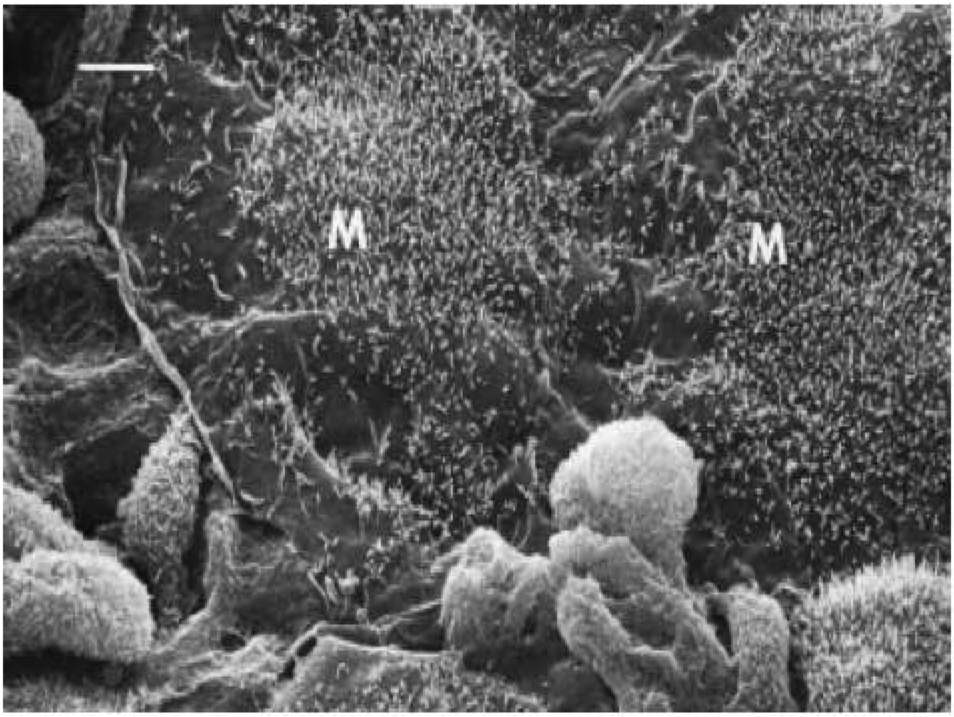
RadioGraphics





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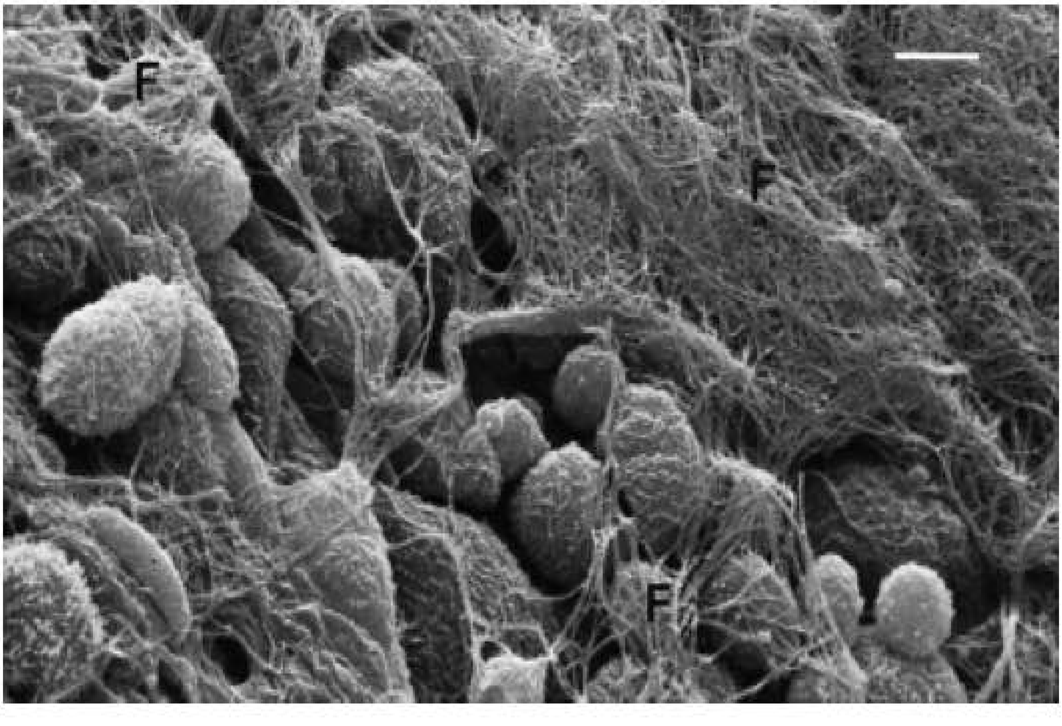
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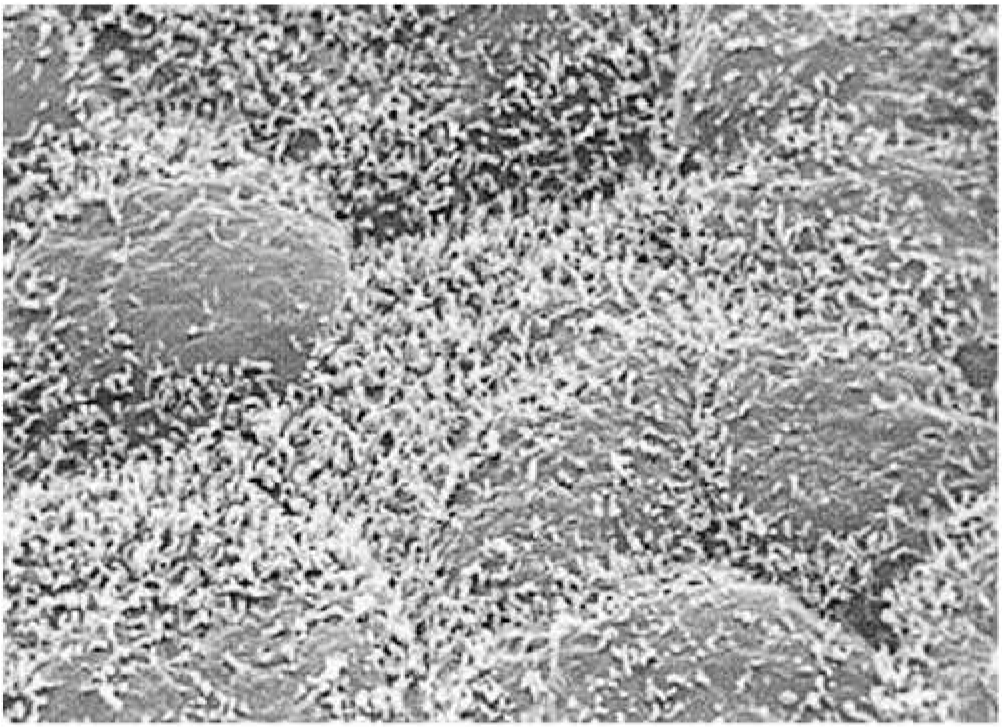


Fig. 2 Scanning electron micrograph showing pari

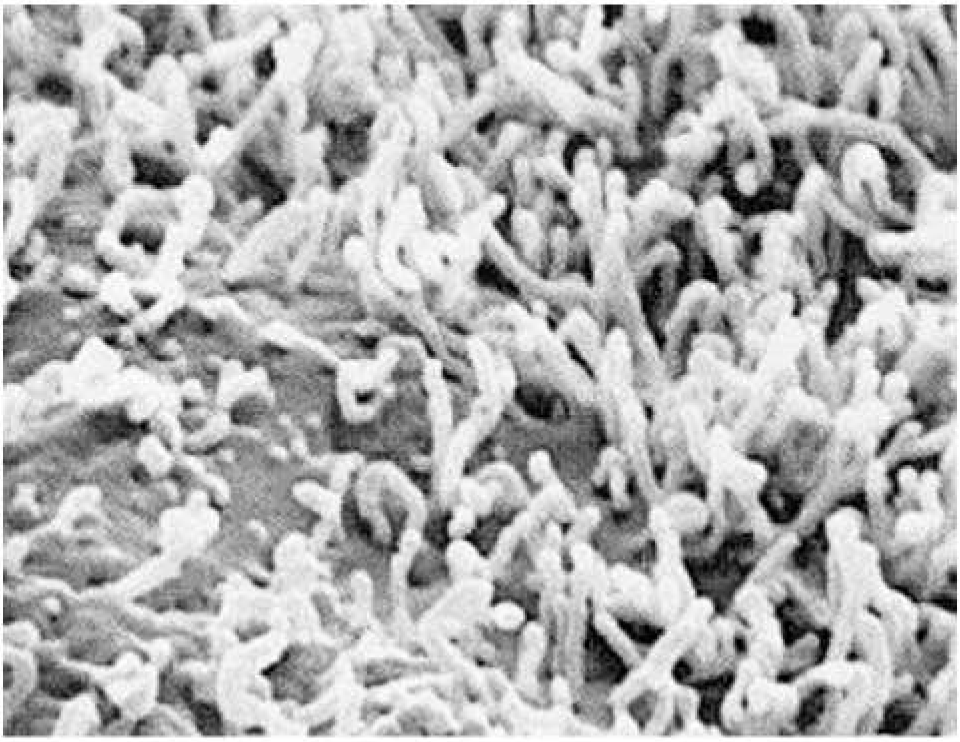


Fig. 3 A close-up view of surface microvilli of a meso

Fig. 4 Scanning electron micrograph of a group of

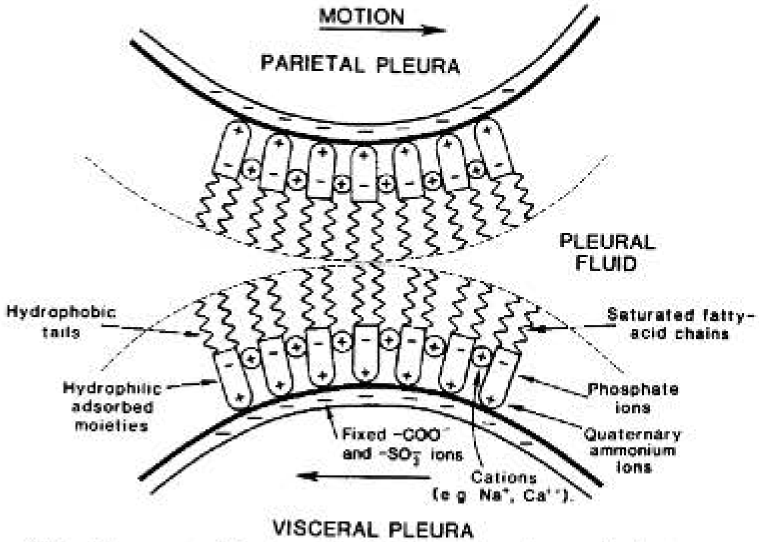


Fig 4 *The concept of the pleural interface*[33,49] *envisaged as two adsorbed monolayers of surfactant with their molecules orientated with the fatty acid chains close packed with their neighbours to provide what is effectively a polyethylene lining. This packing is enhanced by cations interspersed between the negative phosphate groups of the zwitterions to impart the cohesion that is so desirable for low wear and for good lubrication at points of high load.*

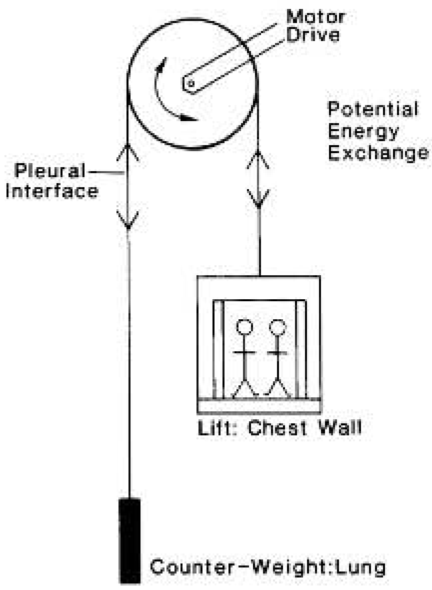
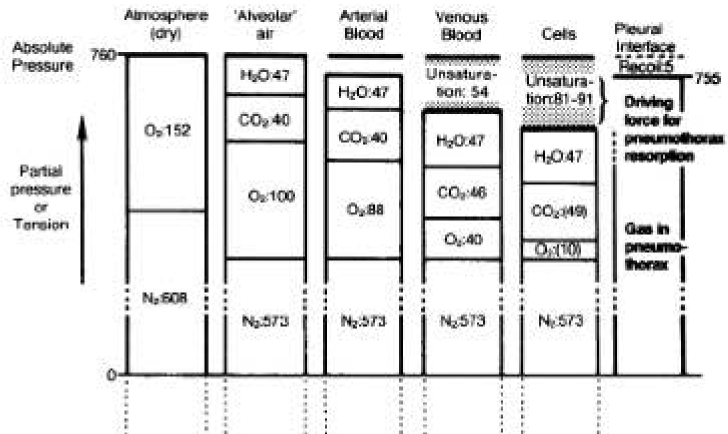


Fig 3 A cartoon depicting the pleural interface as the cable holding a lift simulating the chest wall and a counterweight simulating the lungs to demonstrate the exchange of potential energy with respiration. Note that the least work is required when the weights of the lift and counterweight are equal, just as the lung needs an adequate capability to match the chest wall in storing potential energy.



Conversion: Partial pressures in the diagram in kPa

Unsaturation	-	-	?	7.2	10.8-12.1
H_2O	-	6.3	6.3	6.3	6.3
CO_2	-	5.3	5.3	6.1	(6.5)
O_2	20.3	13.3	11.7	5.3	(1.3)
N_2	81.1	76.4	76.4	76.4	76.4

Fig 1 *The gas gradients for resorption of a pneumothorax in which the gas is in the gaseous phase and the sum of the partial pressures must equal the absolute pressure (Dalton's law—which does not apply to the tensions of gases dissolved in liquid or tissue).*

Starling equation: PFM =K[(CAPhp - PLEhp) - (CAPop - PLEop)]

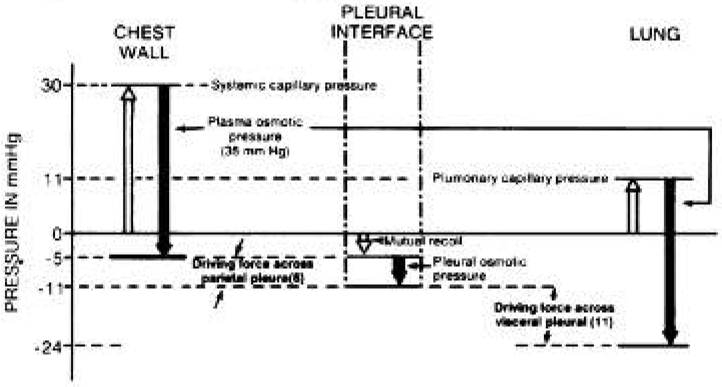
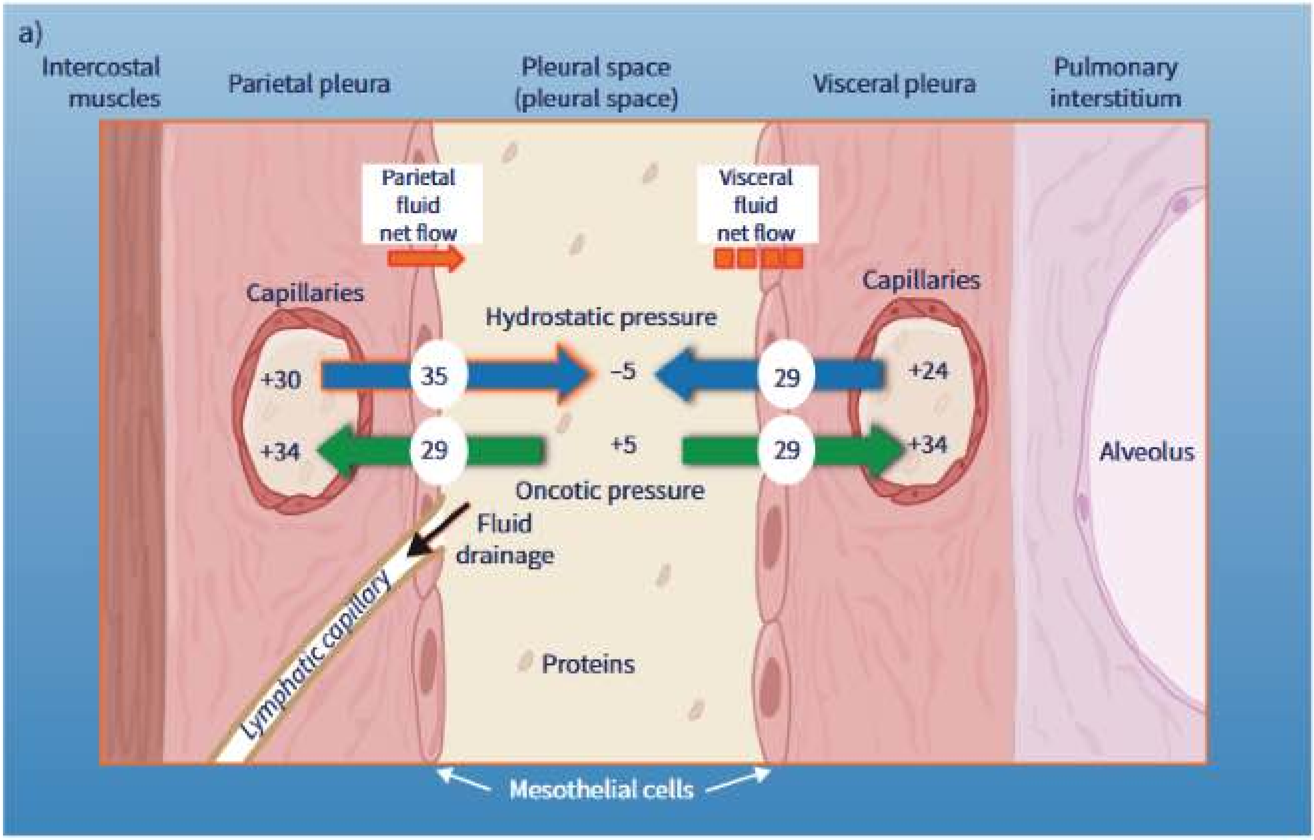
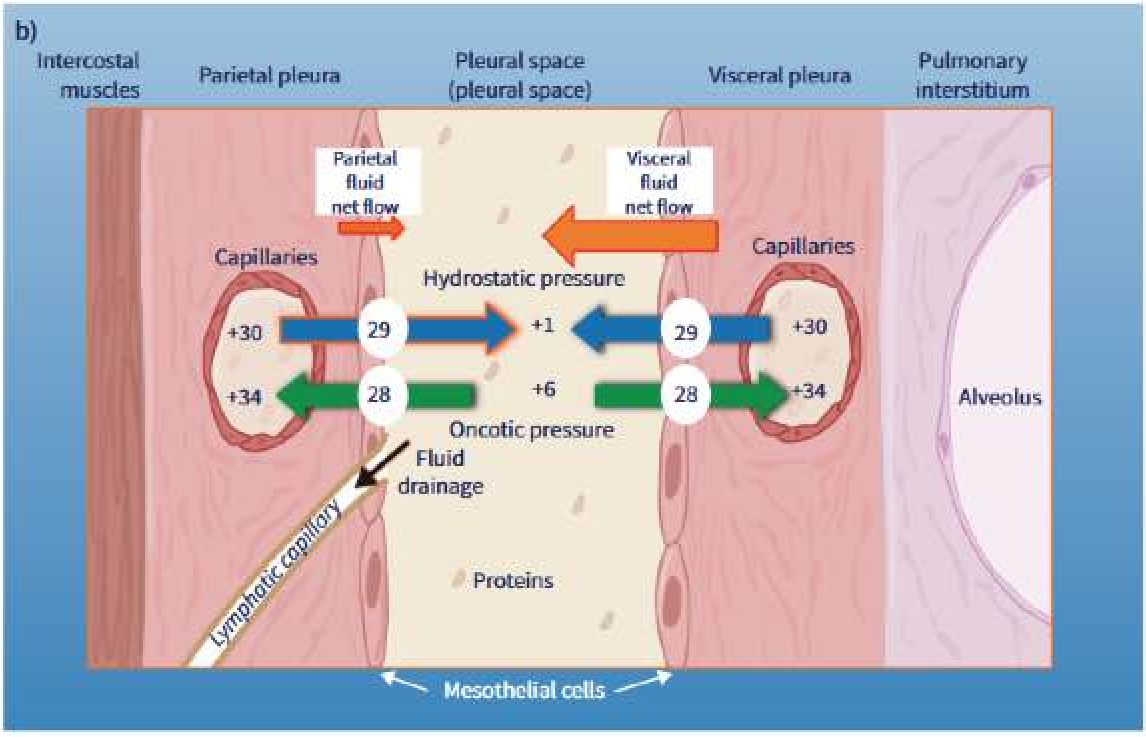


Fig 2 *The hydrostatic and osmotic pressures providing the driving forces for the filtration of fluid across the parietal pleura into the interface and the resorption of that fluid by the lung. Note that the resorptive capacity of the visceral pleura will be even greater than is indicated by the comparison of driving forces owing to its greater permeability to fluid.*



Congestive heart failure



Trapped lung

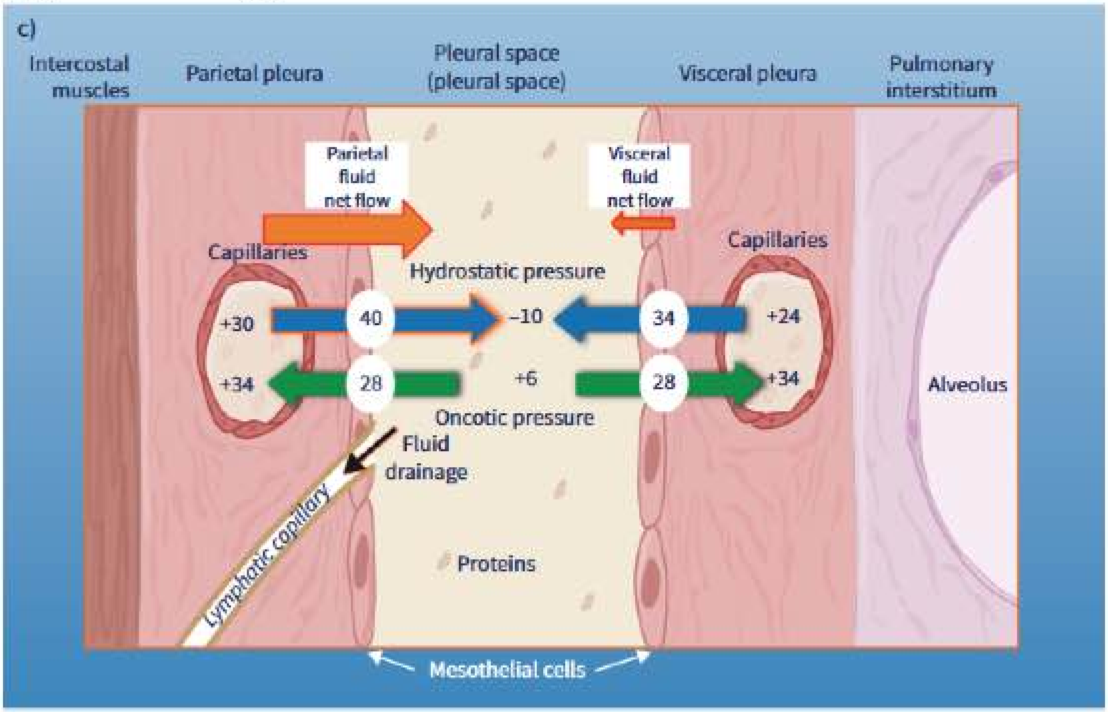


TABLE 1 Mechanisms of production of a pleural effusion

Mechanism	Type of pleural effusion
Increased hydrostatic pressure in the capillaries of the visceral pleura	Transudate
Decrease in oncotic pressure in pleural capillaries	Transudate
Decrease in hydrostatic pressure in the pleural space	Transudate
Increased permeability of pleural capillaries	Exudate
Impaired lymphatic drainage of the pleural space	Exudate
Movement of fluid from the peritoneal space	Transudate/exudate Sometimes chylothorax
Thoracic duct injury	Chylothorax
Vascular rupture	Haemothorax

Types of Pleural Pathology

- Pneumothorax
- Effusion
- Haemothorax
- Pyothorax
- Chylothorax, pseudochylothorax
- Hydro-pneumo
- Malignancies:Mesothelioma & metastasis
- Others

Approach

- **Detailed history and physical examination.**
- **imaging: CXR; Ultrasound Chest CT.**
- **Pleural fluid/tissue analysis.**

Symptoms

- Chest pain
- Cough
- Dyspnea
- +-Systemic features
- No symptom in early stage of transudative effusion

Signs

- LN
- Clubbing
- Tachypnea /Tachycardia
- cyanosis

Signs:Respiratory

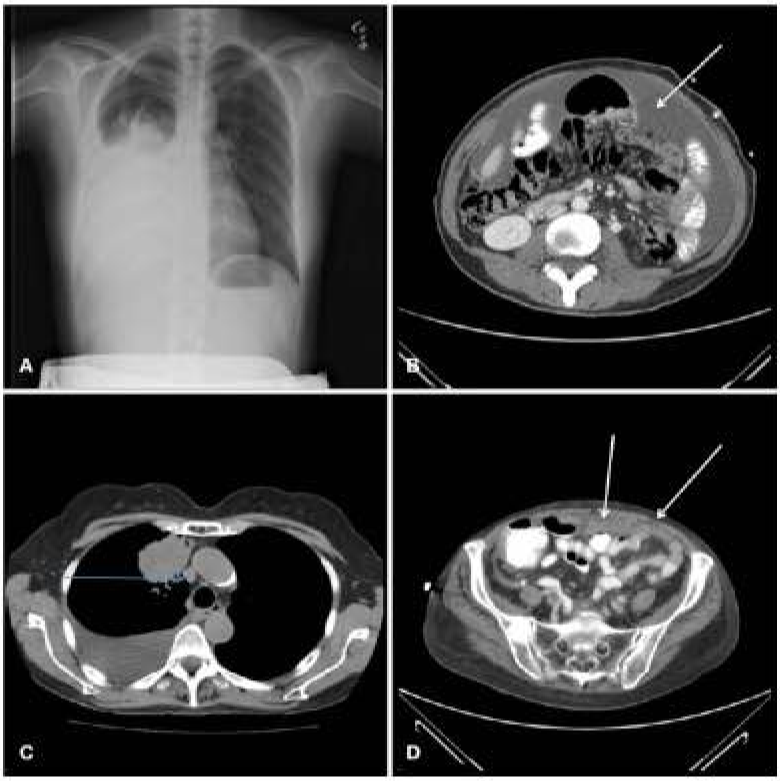
- Inspection
- Palpation
- Persussion: **Stony dull**
- Auscultation: Rub
    - Dec Breath sounds

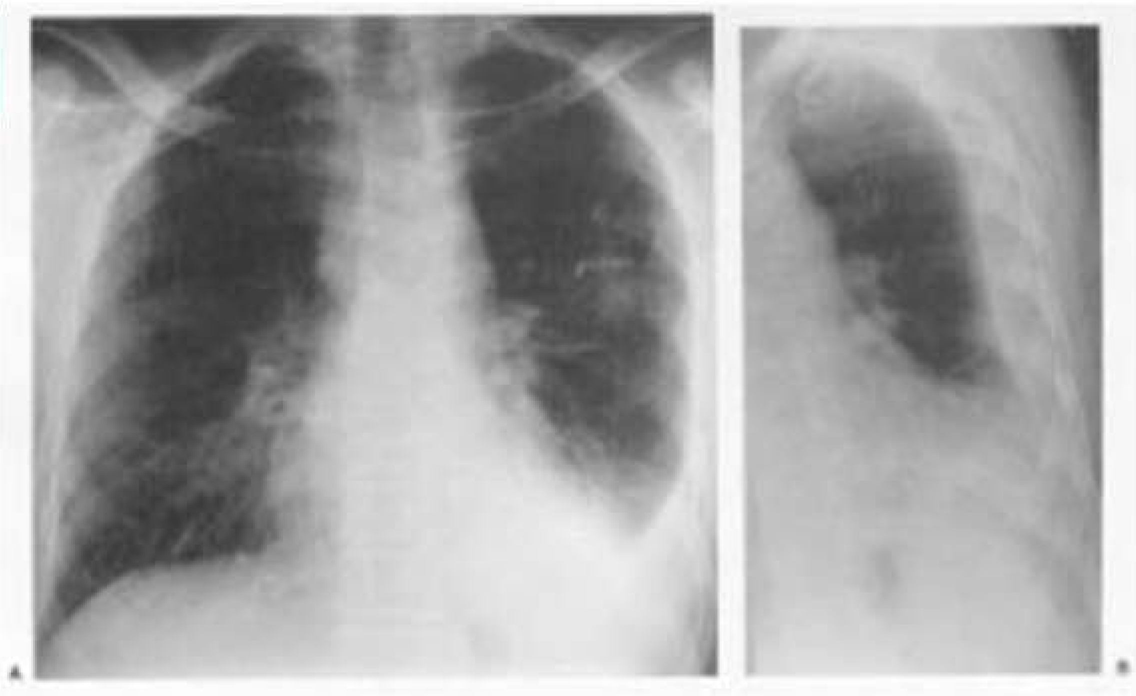
Radiology

- PA view>200
- Lateral 75 ml
- USG 10 ml
- Ct sensitive

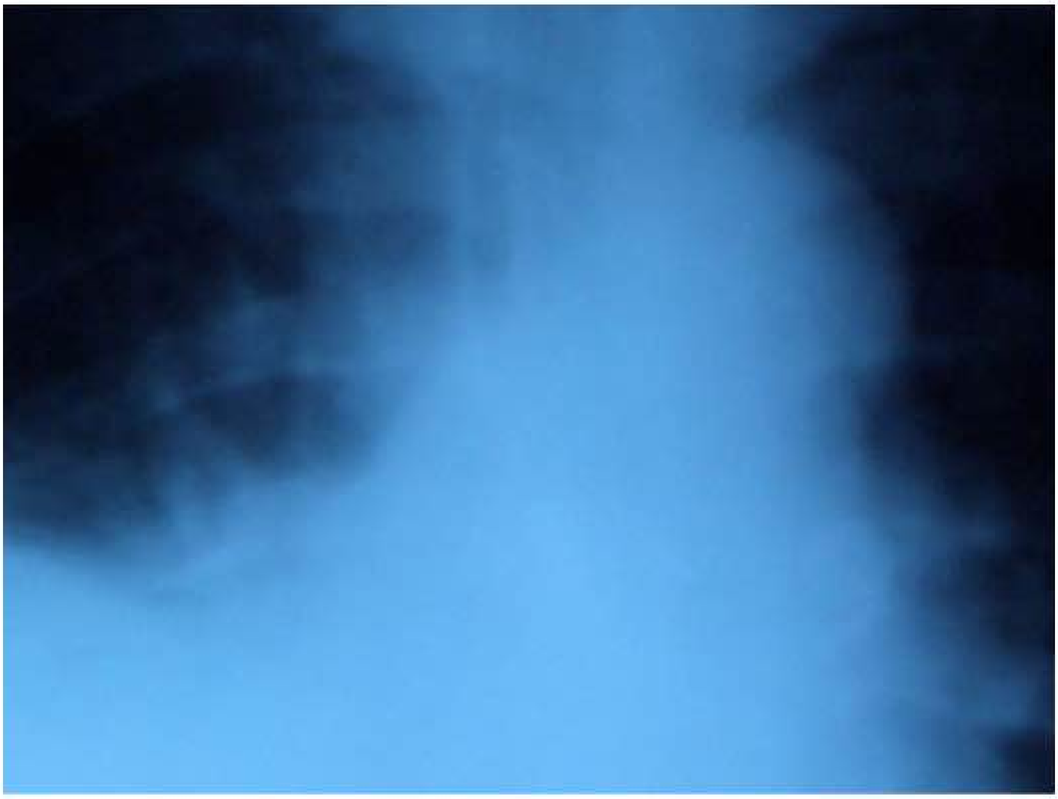
Investigations

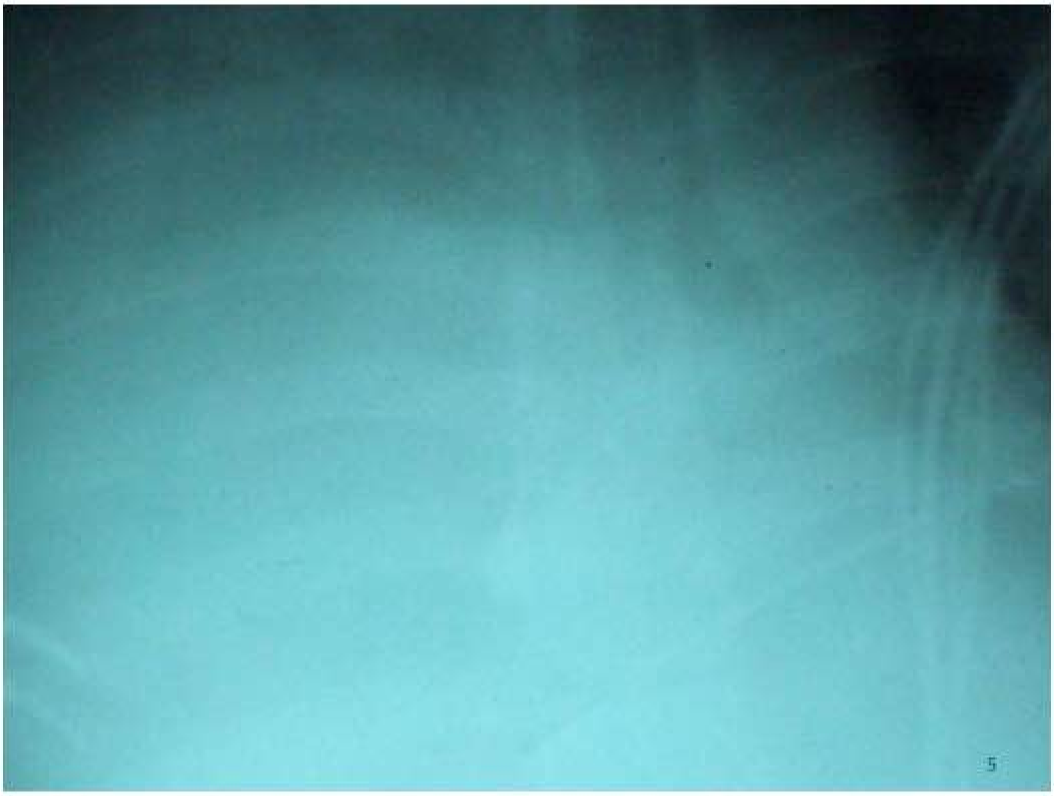
- CXR





Pleural Effusion on CXR

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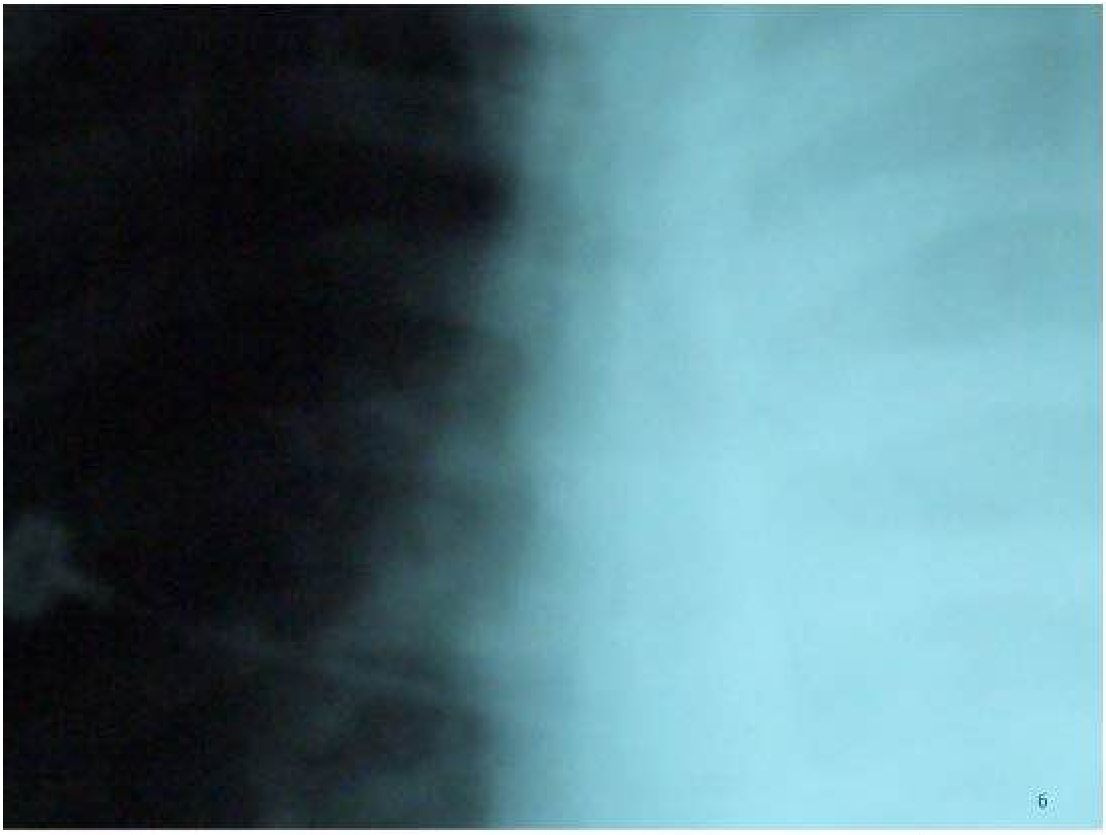
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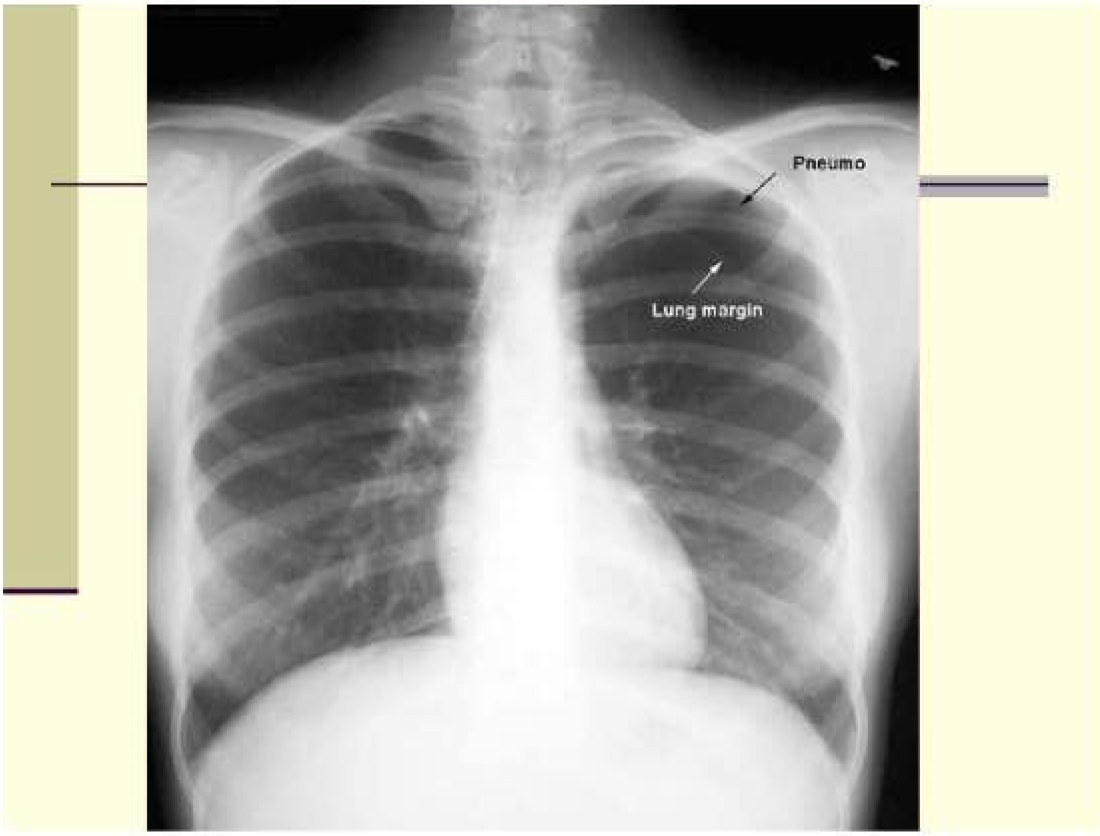
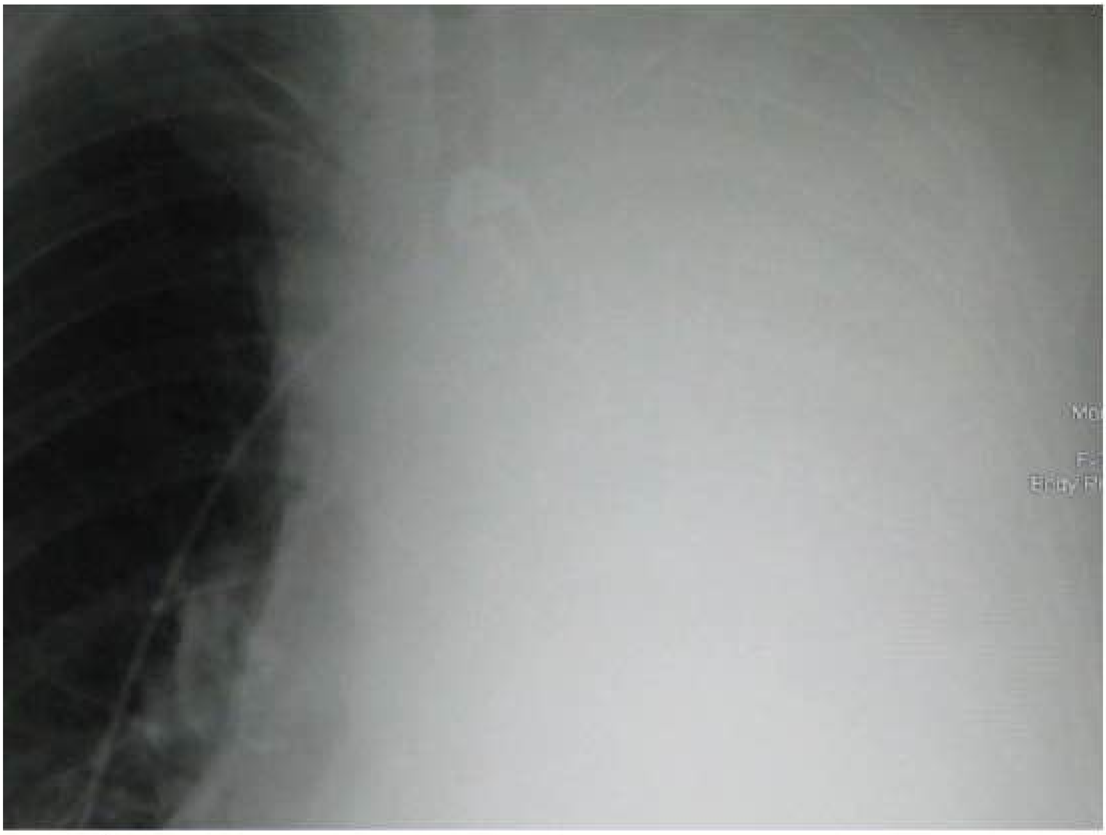
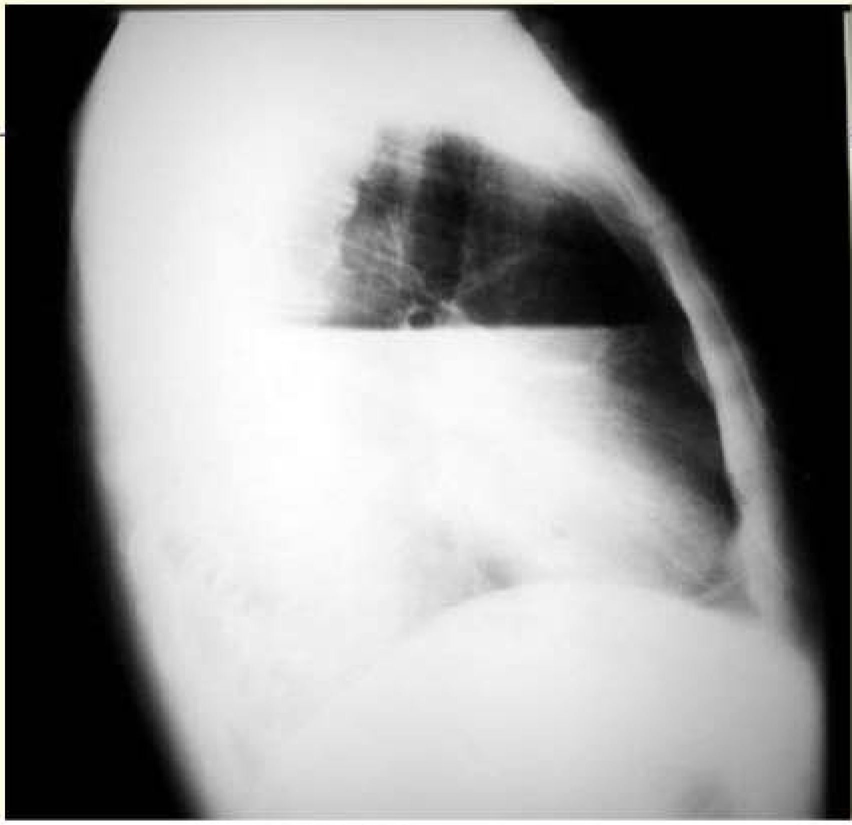
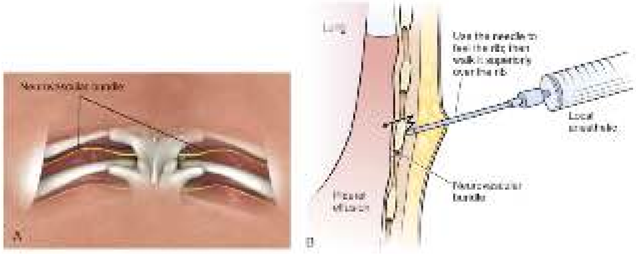

Pneumo
Lung margin





Thoracocentesis



- Diagnostic(not always needed)
- Therapeutic

TYPES

- Transudative
- Exudative
- Extrapleural:transmigration

Test	Sensitivity for Exudate	Specificity for Exudate
	%	
Light's criteria (one or more of the following three)	98	83
Ratio of pleural-fluid protein level to serum protein level >0.5	86	84
Ratio of pleural-fluid LDH level to serum LDH level >0.6	90	82
Pleural-fluid LDH level >two thirds the upper limit of normal for serum LDH level	82	89
Pleural-fluid cholesterol level >60 mg/dl (1.55 mmol/liter)	54	92
Pleural-fluid cholesterol level >43 mg/dl (1.10 mmol/liter)	75	80
Ratio of pleural-fluid cholesterol level to serum cholesterol level >0.3	89	81
Serum albumin level − pleural-fluid albumin level ≤1.2 g/dl	87	92

*LDH denotes lactate dehydrogenase.

- The above criteria misidentify ~25% of transudates as exudates. If one or more of the exudative criteria are met and the patient is clinically thought to have a condition producing a transudative effusion, the difference between the protein levels in the serum & the pleural fluid should be measured.
- If this gradient is greater than3.1 g/dL. the exudative categorization by the above criteria can be ignored because almost all such patients have a transudative pleural effusion.

Pleural fluid analysis

- Colour/turbid
- Smell
- Protein
- Sugar
- Cells
- TLC/DLC
- Smear
- Culture
- Cytology
- ADA
- HCT
- TG/Cholesterol
- Amylase

Disease specific pleural fluid tests

Suspected disease	Pleural fluid analyses
Pancreatic disease or esophageal rupture	Pleural fluid amylase
Drug induced pleural effusion	Pleural fluid eosinophilia
Congestive heart failure	Pleural fluid NT- Pro BNP
Chylothorax	Pleural fluid cholesterol and triglyceride
Hemothorax	Pleural fluid hematocrite
Rheumatoid disease	Pleural fluid glucose and pH
Amyloidosis	Congo red staining
Lymphoma	Flow cytometry

Transudate

- **Common**
- • Congestive cardiac failure
- • Liver cirrhosis
- • Hypoalbuminaemia
- • Nephrotic syndrome

- **Less common**
- • Nephrotic syndrome
- • Mitral stenosis
- • Peritoneal dialysis
- • Chronic hypothyroidism
- • Constrictive pericarditis
- SVC Syndrome
- Urinothorax

Exudate

- **Common**
- • Malignancy(lung, pleura)
- • Pleural infection(any organism)
- • Pulmonary embolism
- • Autoimmune pleuritis

- **Less common**
- • Drugs
- • Lymphatic disorders, yellow nail
- • Meigs syndrome,
- •post CABG, post cardiac injury,
- • asbestos exposure
- Subdiaphragmatic GI problems
- Sarcoidosis
- Uremia
- Trapped lung
- Radiation, pericardial disease
- Hemothorax, iatrogenic injury
- Ovarian hyperstimulation

Causes of lymphocytic pleural effusion

- Malignancy
- Tuberculosis
- Lymphoma
- Congestive cardiac failure
- Post-coronary bypass graft
- Rheumatoid arthritis
- Chylothorax
- Yellow nail syndrome

Causes of bilateral pleural effusions

- Congestive cardiac failure
- Hypoalbuminaemia
- Renal failure
- Liver failure
- SLE and other autoimmune diseases
- Widespread malignancy including abdominal/pelvic malignancy
- Bilateral pulmonary embolus

Pleural fluid lipid values in chylothorax and pseudochylothorax

- **<u>chylothorax</u>**
- Triglyserides - high> 1.24 mmol/liter or 110 mg/dl
- Cholestrol - low
- Cholestrol crystals - absent
- Chylomicrones - usually present

Pleural fluid lipid values in chylothorax and pseudochylothorax

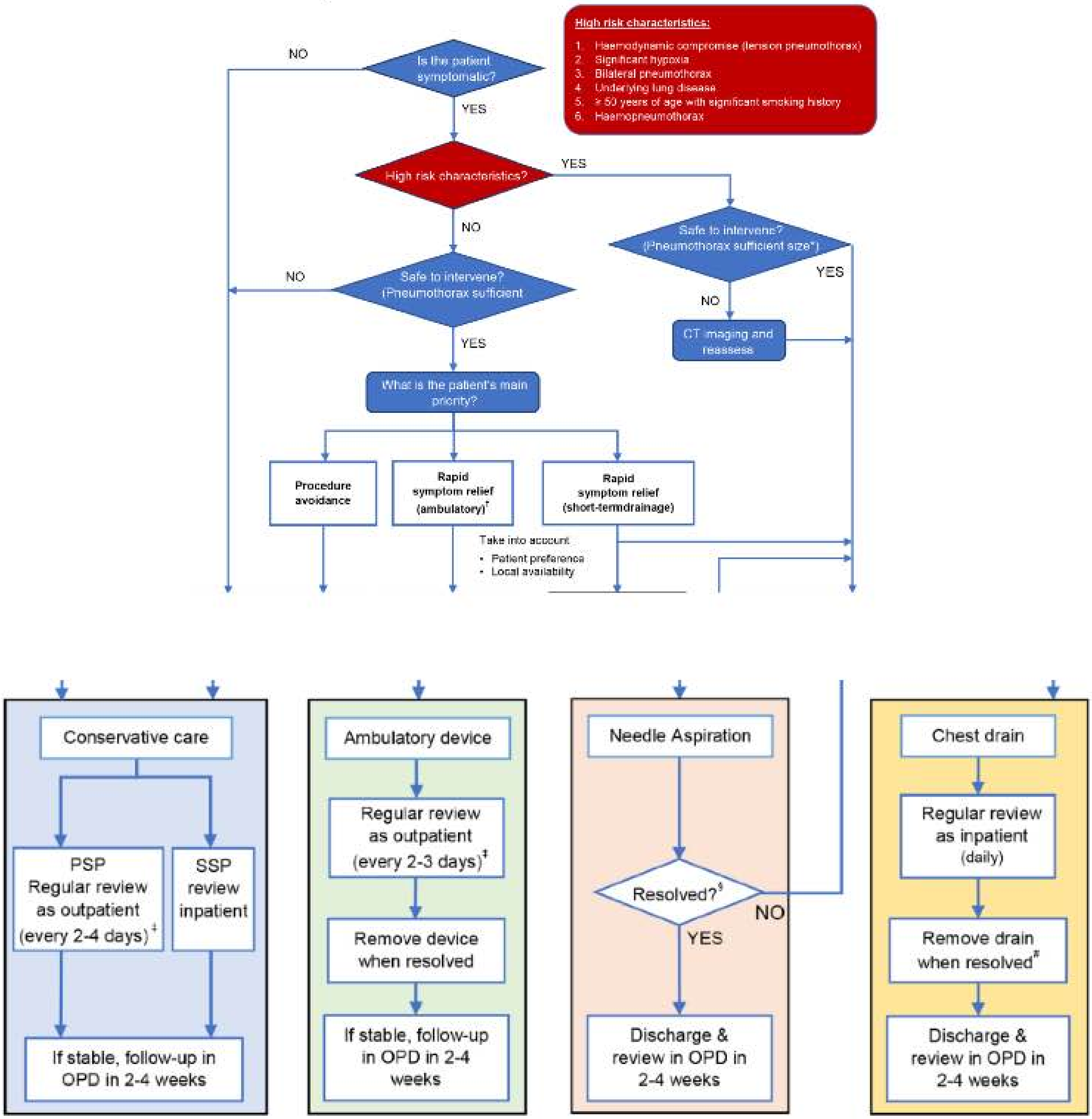
- **<u>Pseudochylothorax</u>**
- Triglyserides - Low
- Cholestrol - High > 5.18 mmol/liter (200mg/dl)
- Cholestrol crystal - Often present
- Chylomicrones - Absent

Causes of chylothorax and pseudochylothorax

- **Chylothorax:**
- • Trauma: thoracic surgery (especially if involving posterior mediastinum, for example, oesophagectomy), thoracic injuries
- • Neoplasm: lymphoma or metastatic carcinoma
- • Miscellaneous: disorders of lymphatics (including lymphangioleiomyomatosis), tuberculosis, cirrhosis, obstruction of the central veins, chyloascites
- • Idiopathic (about 10%)
- **Pseudochylothorax:**
- • Tuberculosis
- • Rheumatoid arthritis

Approach to pneumothorax , BtS 2023 Guide

Pneumothorax Pathway



* Pneumothorax of sufficient size to intervene depends on clinical context but, in general, usually ≥ 2cm laterally or apically on CXR, or any size on CT scan which can be safely accessed with radiological support.

† If ambulatory pathway available locally.

‡ At review, if enlarging pneumothorax or symptoms consider chest drain insertion and admission.

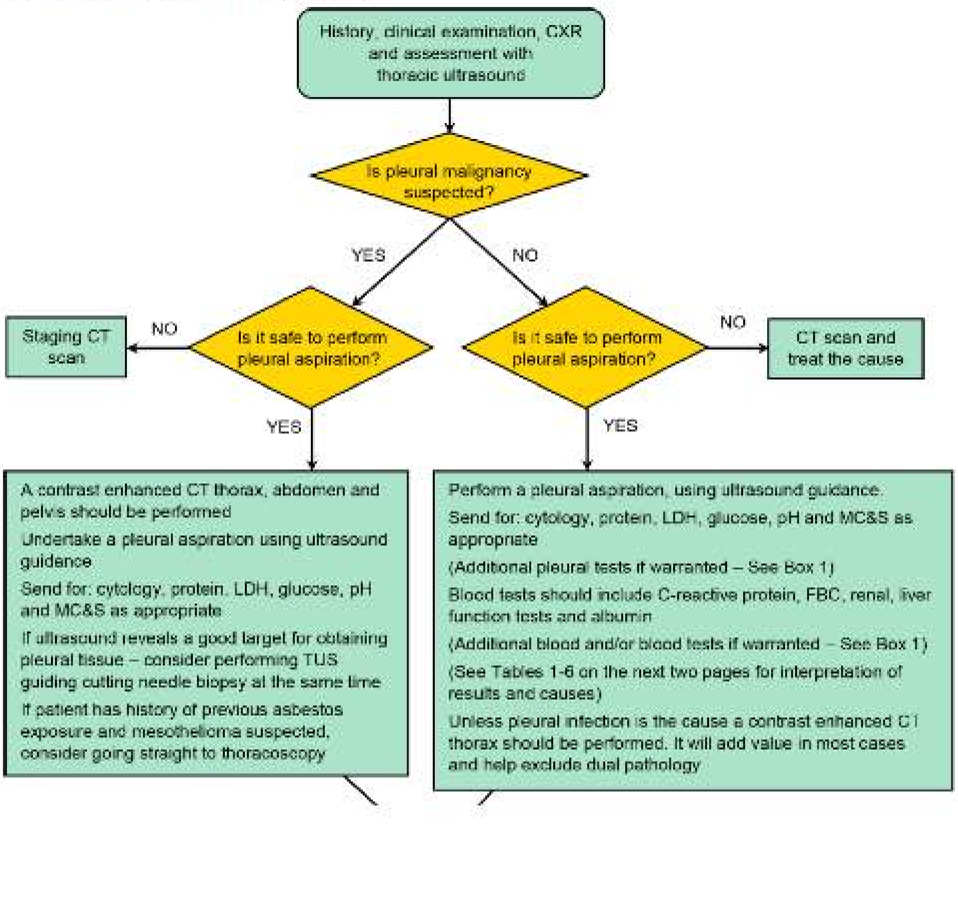
§ Success: improvement in symptoms and sustained improvement on CXR.

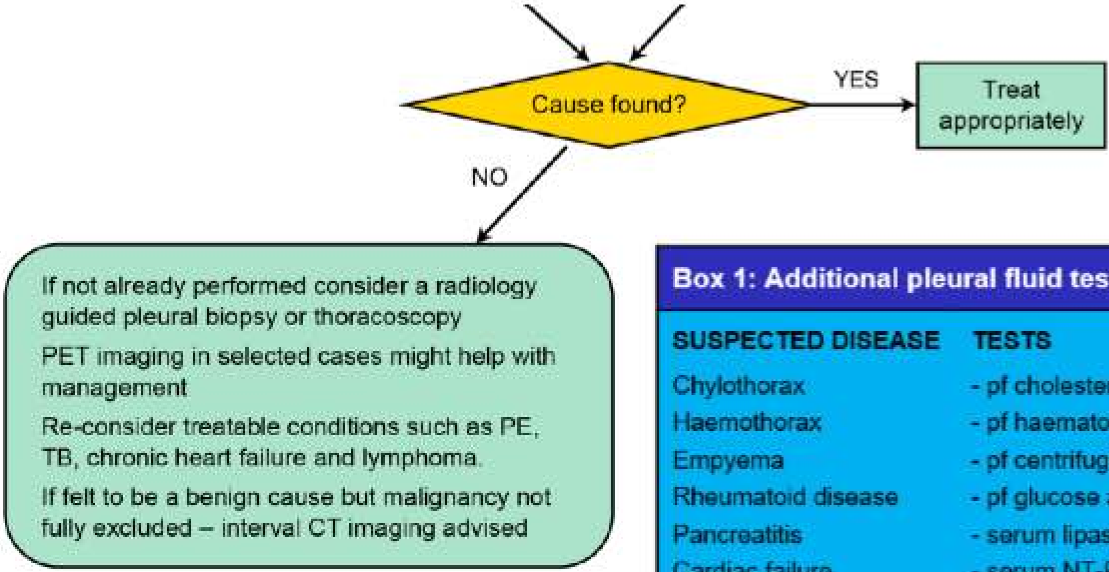
\# Talc pleurodesis can be considered on the first episode of pneumothorax in high risk patients in whom repeat pneumothorax would be hazardous (eg, severe COPD).

Figure 2. Thoracic endometriosis in a 49-year-old woman with catamenial pneumothorax. **(A)** Chest radiograph shows a visceral pleural line in the right hemithorax (arrows) and an air-fluid level (arrowhead) at the costophrenic angle with pleural effusion. **(B)** Coronal CT image (lung window) shows right pneumothorax. The pneumothorax is partly loculated with some pleural adhesions (arrows). **(C)** Thoracoscopic image from video-assisted thoracic surgery shows some holes in the right hemidiaphragm (arrowheads). (Case courtesy of Noriyoshi Sawabata, MD, PhD, and Takehiro Tanaka, MD.)

Unilateral pleural effusion approach BTS 2023

Unilateral pleural effusion diagnostic pathway





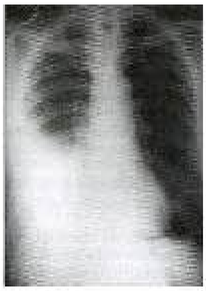
Box 1: Additional pleural fluid tests and blood tests

SUSPECTED DISEASE	TESTS
Chylothorax	- pf cholesterol and triglyceride
Haemothorax	- pf haematocrit
Empyema	- pf centrifuge
Rheumatoid disease	- pf glucose and pH
Pancreatitis	- serum lipase
Cardiac failure	- serum NT-ProBNP
Lymphoma	- pf lymphocyte subsets
Autoimmune disease	- serum autoimmune screen
IgG4 disease	- pleural biopsy and serum IgG4
Amyloid	- Congo red staining

Clinical Scenario

- A 25 yr male:prot 3.5,sugar 55,cells 2000,L-90%
- A 35 yr male:prot 5.5,sugar 25,cells 3000,P-90%
- A 65 male:prot 5.5,sugar 65,cells 1000,L-90%,Hhagic
- A 65 male:prot 1.5,sugar 65,cells 200,L-90%

CASE
Pleural Fluid Analysis



67 yo man with dyspnea and Rt. Pleural effusion

Pleural Fluid	Serum
Nucleated Cell Count 1700; >90%Lymphocytes	
Total protein: 4.0 g/dl	Total protein: 6.3 g/dl
LDH: 242 U/L	LDH: 143 U/L
Cytology : negative