Pleural diseases

VGH Jr & MSI Teaching - Sept 11, 2025

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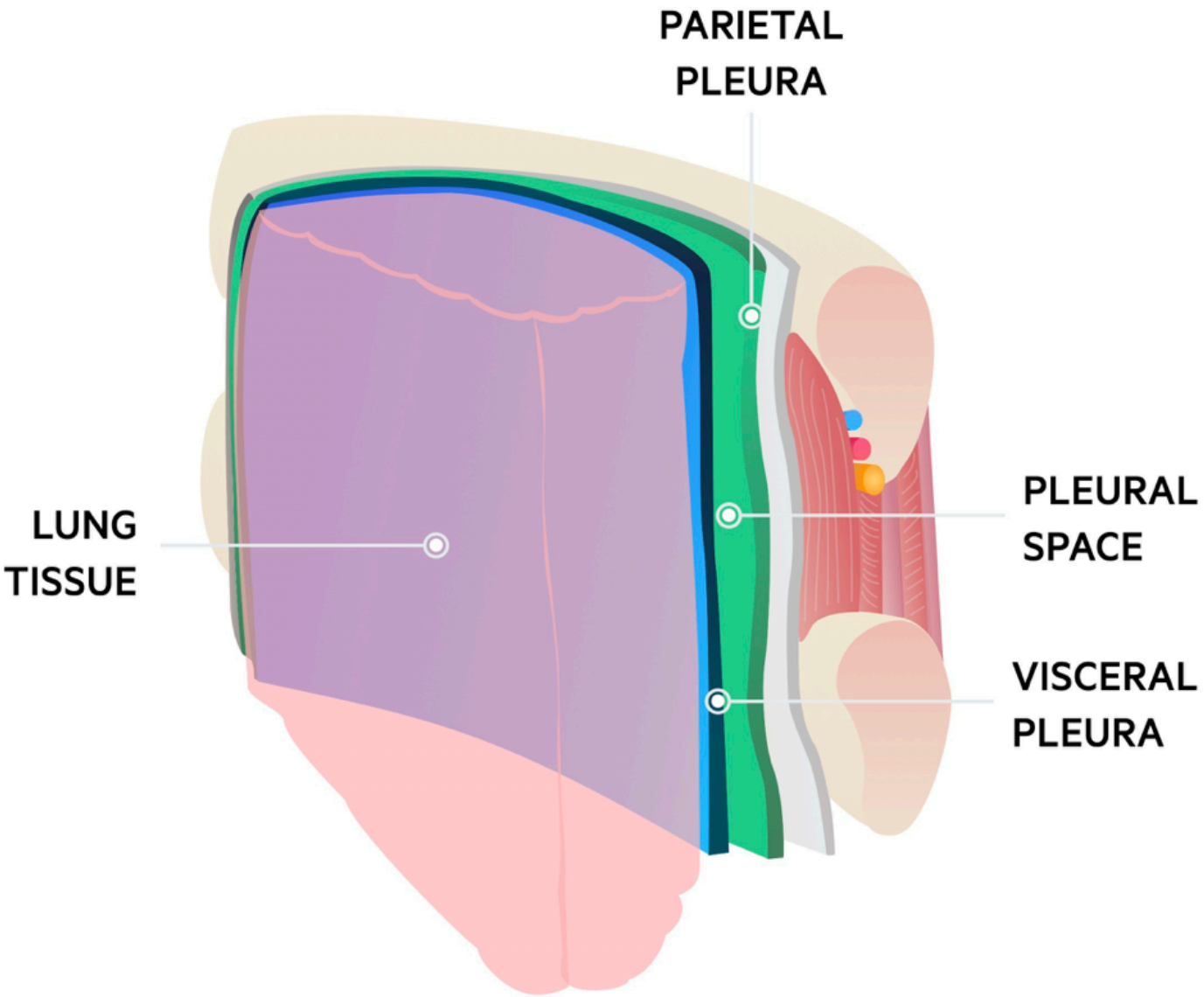
Objectives

By the end of this session, you'll be able to:

- Describe pleural anatomy and physiology
- Recognize common clinical presentations of pleural diseases
- Interpret key investigations (CXR, U/S, thoracentesis results)
- Outline initial management of:
  - Pleural effusions
  - Pneumothorax
- (If time: primer on chest tubes and their management)

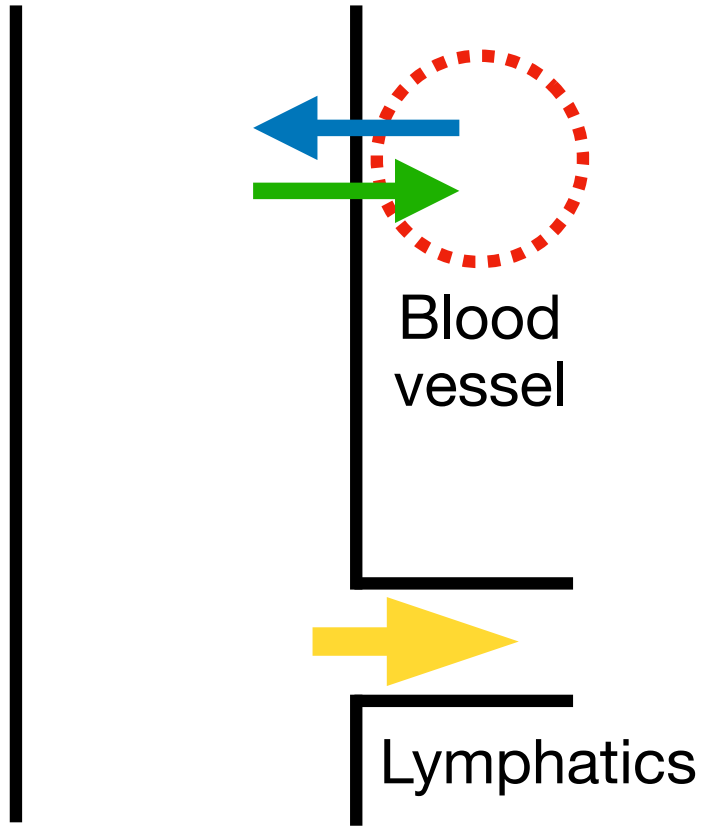
Pleural anatomy



Pleural fluid

Factors determining fluid collection:

net fluid leak = $k[(P_c - P_{pl}) - \sigma(\text{oncotic}_c - \text{oncotic}_{pl})]$



Permeability

Hydrostatic pressur

Oncotic pressure

Lymphatics

Why does pleural fluid accumulate?

Factors determining fluid collection:

net fluid leak = $k[(P_c - P_{pl}) - \sigma(\text{oncotic}_c - \text{oncotic}_{pl})]$

Mechanism	Example
Increased hydrostatic pressure	Heart failure
Decreased serum oncotic pressure	Cirrhosis, nephrosis
Increased vessel permeability	Inflammation, infection malignancy
Decreased lymphatic clearance	Lymphatic obstruction
Fluid moving across the diaphragm	Ascites

Clinical signs and symptoms

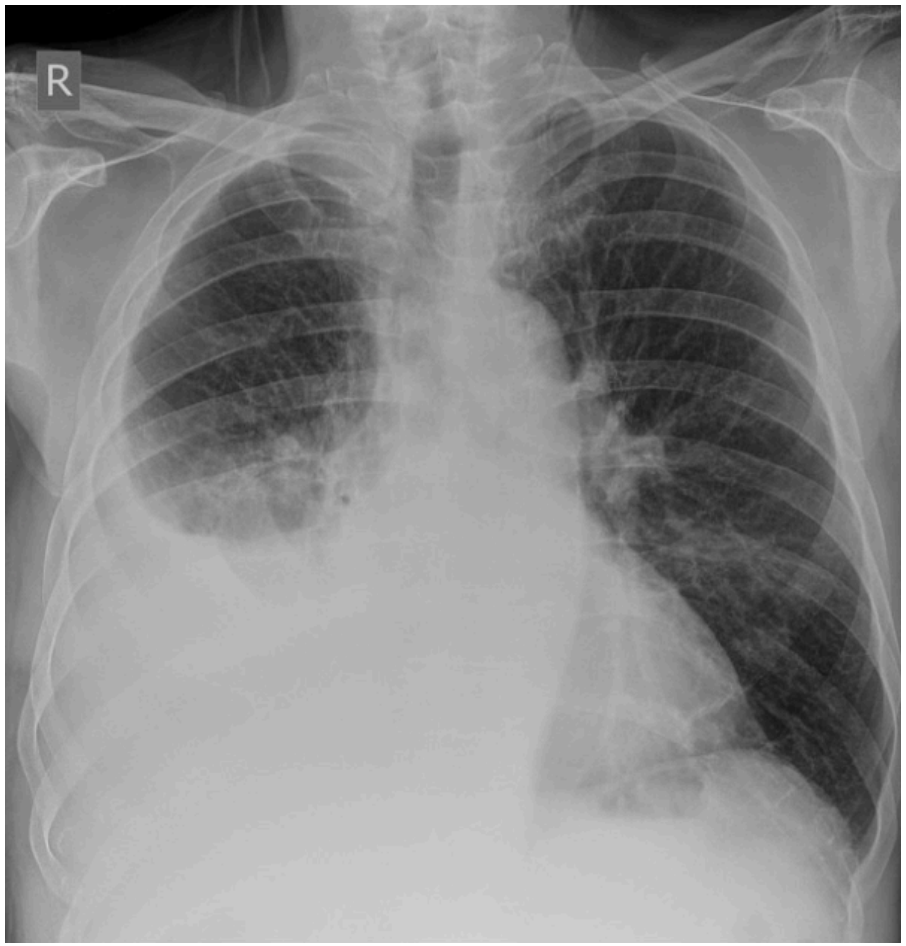
- Decreased tidal volume
- Dyspnea, worse on exertion
- Orthopnea if fluid collection is large
- Hypoxemia if large effusion or accumulates quickly (V/Q mismatch and shunting)
- Pain if the pleura is inflammed

Clinical signs and symptoms

- Decreased tidal volume
- Dyspnea, worse on exertion
- Orthopnea if fluid collection is large
- Hypoxemia if large effusion or accumulates quickly (V/Q mismatch and shunting)
- Pain if the pleura is inflammed
- Decreased chest movement
- Decreased breath sounds
- Decreased fremitus
- Dullness to percussion
- Pleural rub if inflammed

Imaging

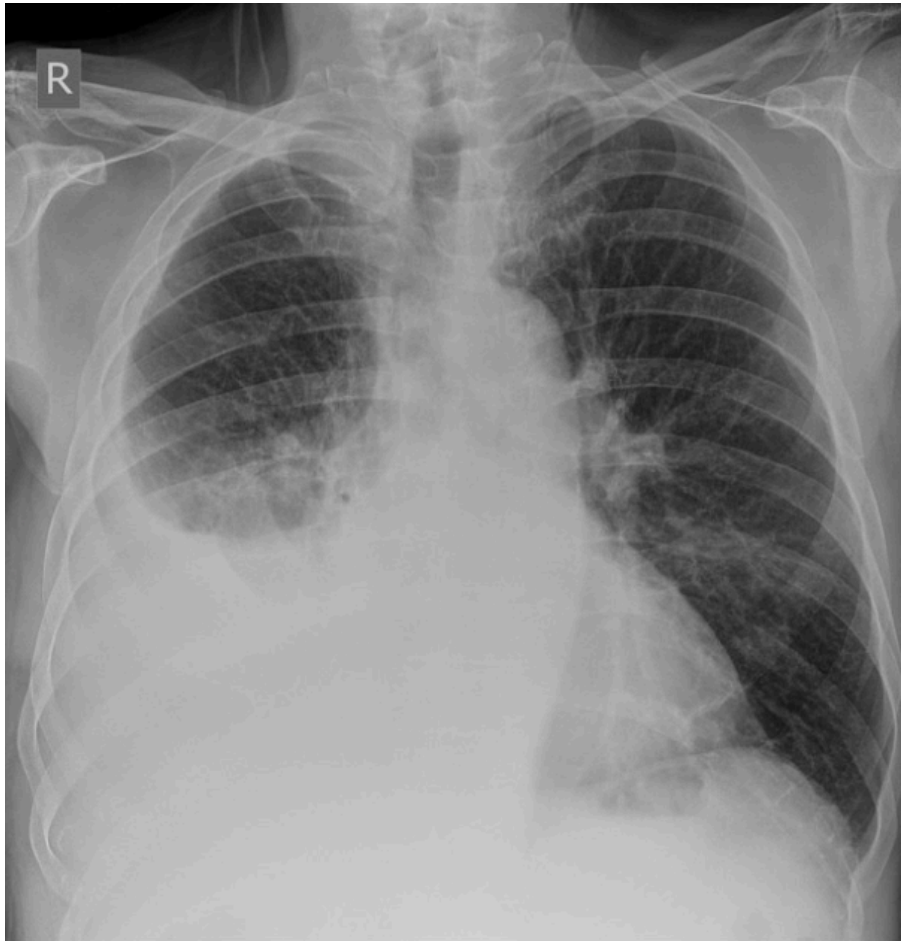
CXR

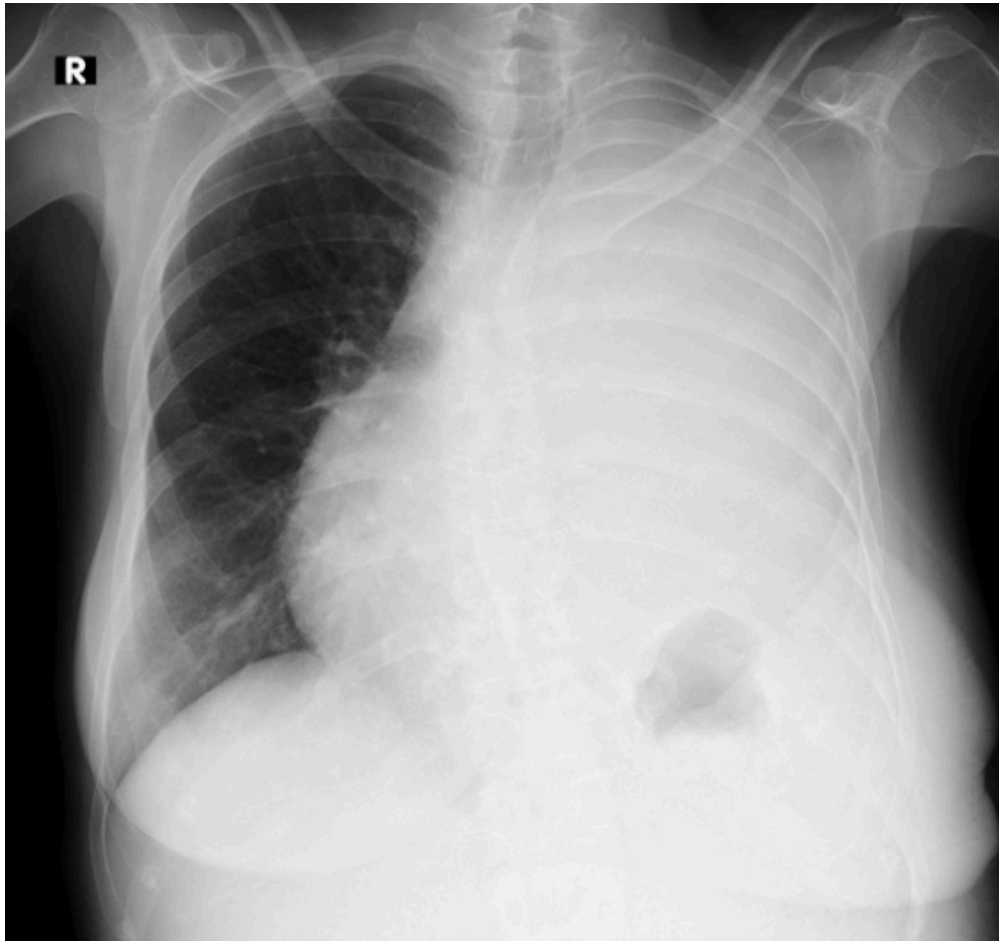


- Upward meniscus
- Homogenous density without a bronchograms (differentiates between intraparenchymal consolidations)
- Silhouetting of diaphragm
- Blunting of costophrenic angle

Imaging

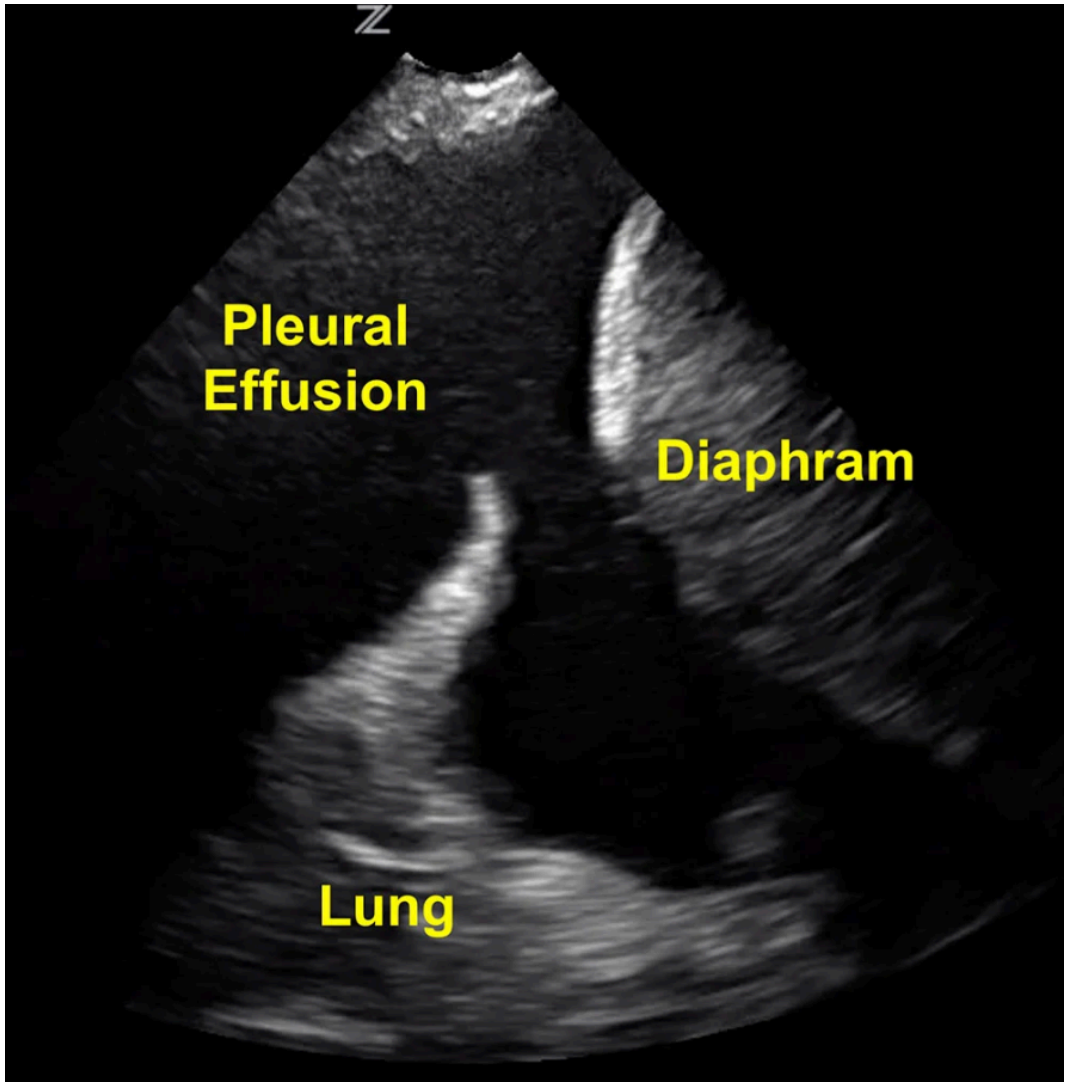
CXR

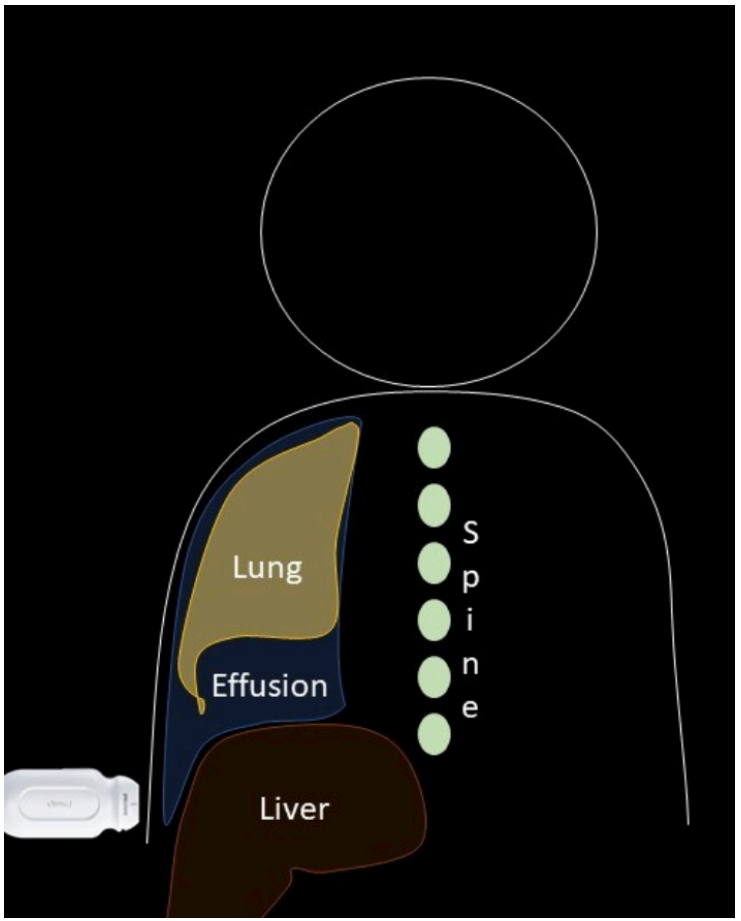




Imaging

Ultrasound

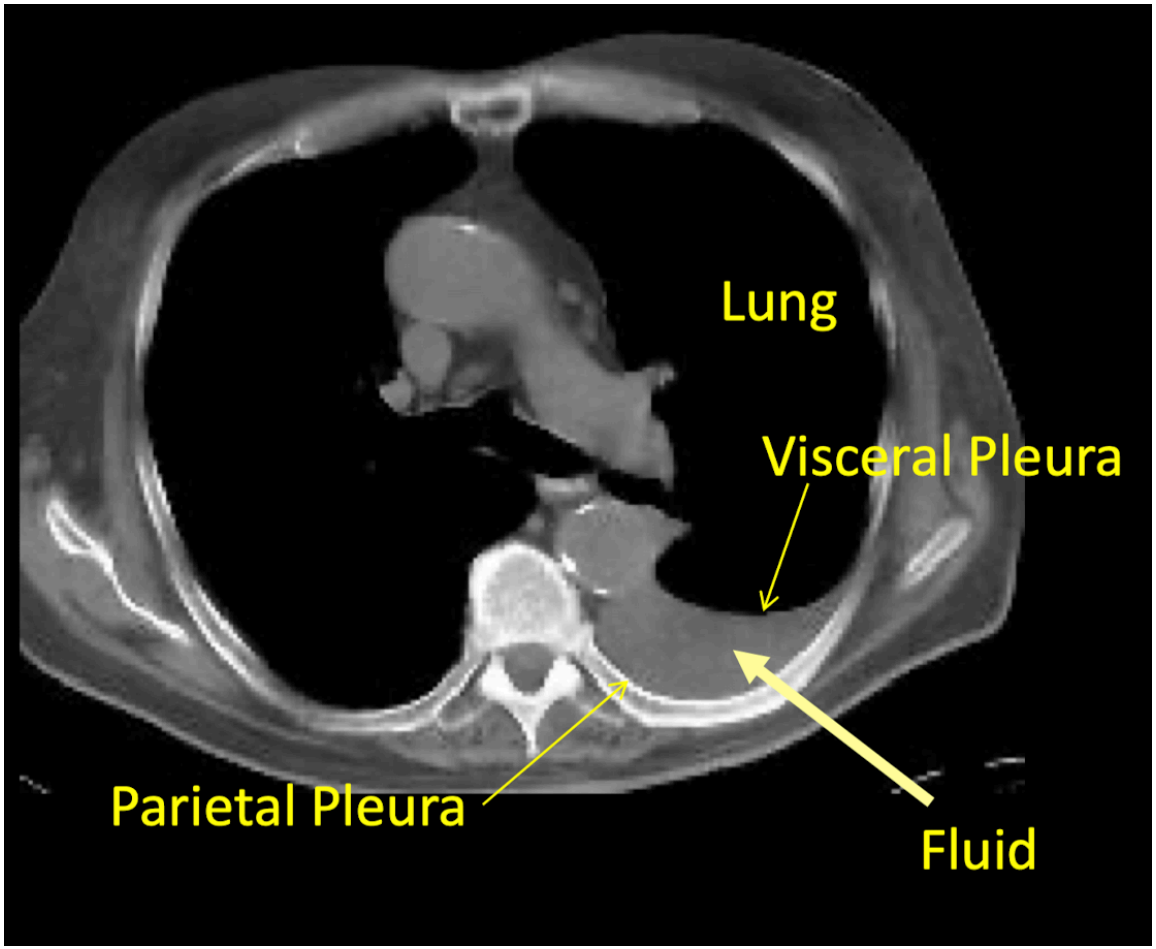




- Fluid is black on ultrasoun
- Ultrasound is useful for localizing/landmarking before inserting drains

Imaging

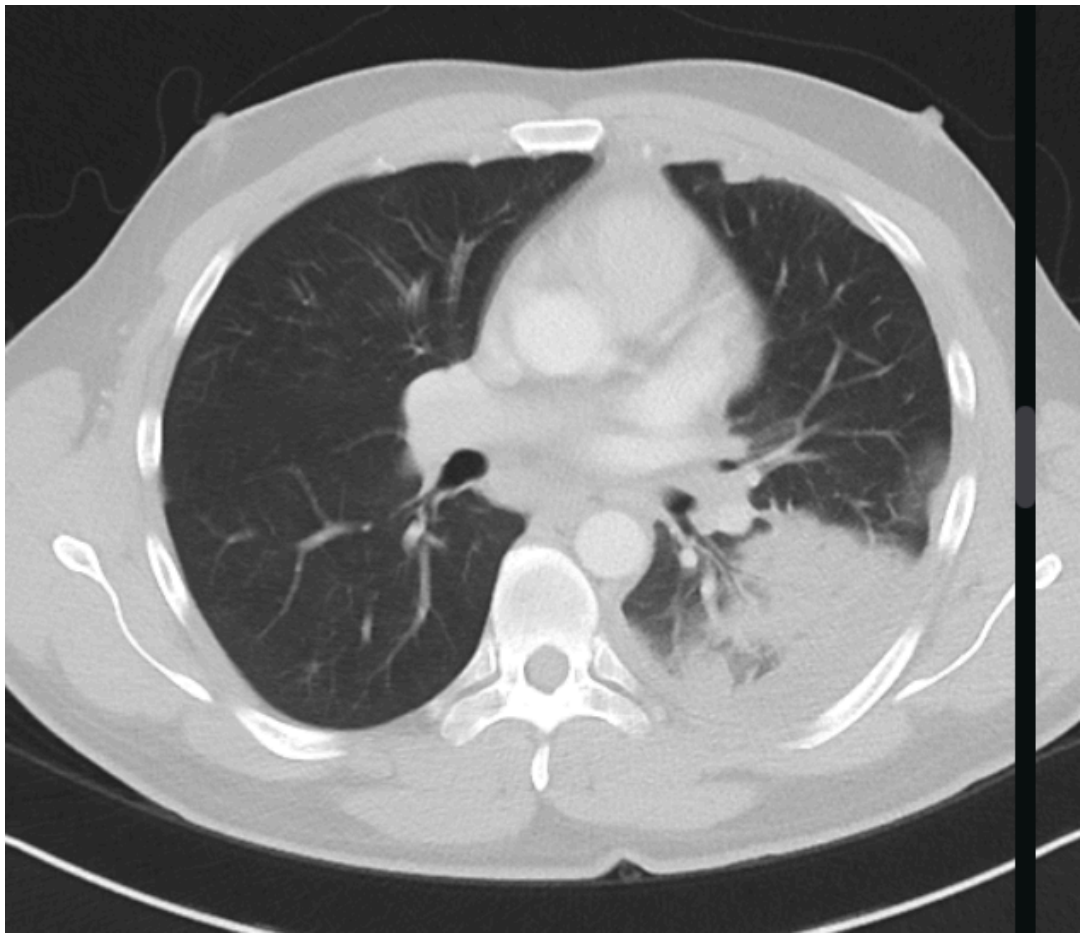
CT



- Helpful for distinguishir pleural effusion from consolidation
- Contrast study may demonstrate pleural thickening

Imaging

CT



- Helpful for distinguishir pleural effusion from consolidation
- Contrast study may demonstrate pleural thickening
- Also helpful for assessing underlying lung to help clarify etiology

Loculated effusions

- Fluid trapped in pockets in the pleural space
- Indicates fibrin adhesions due to an inflammatory process

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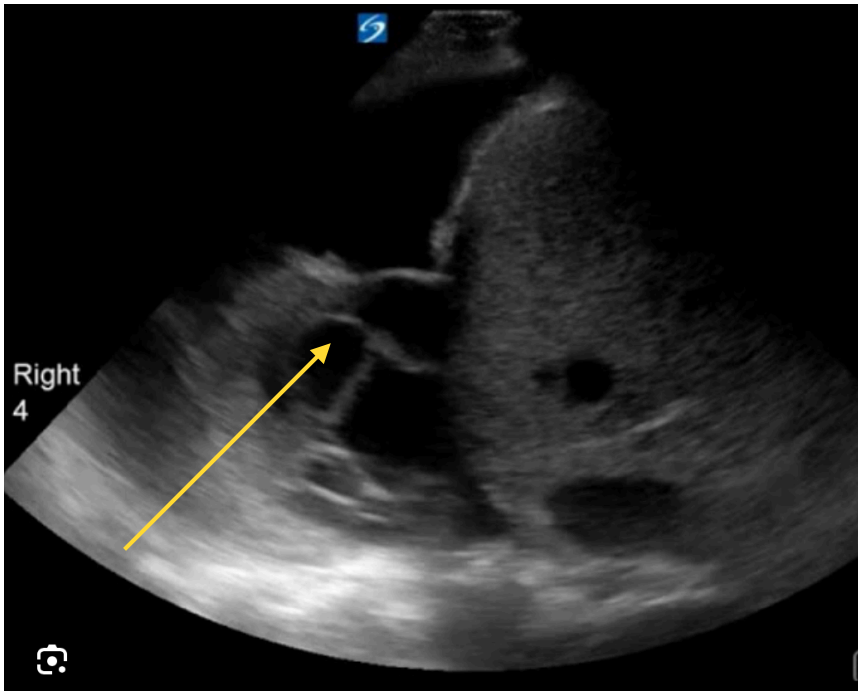
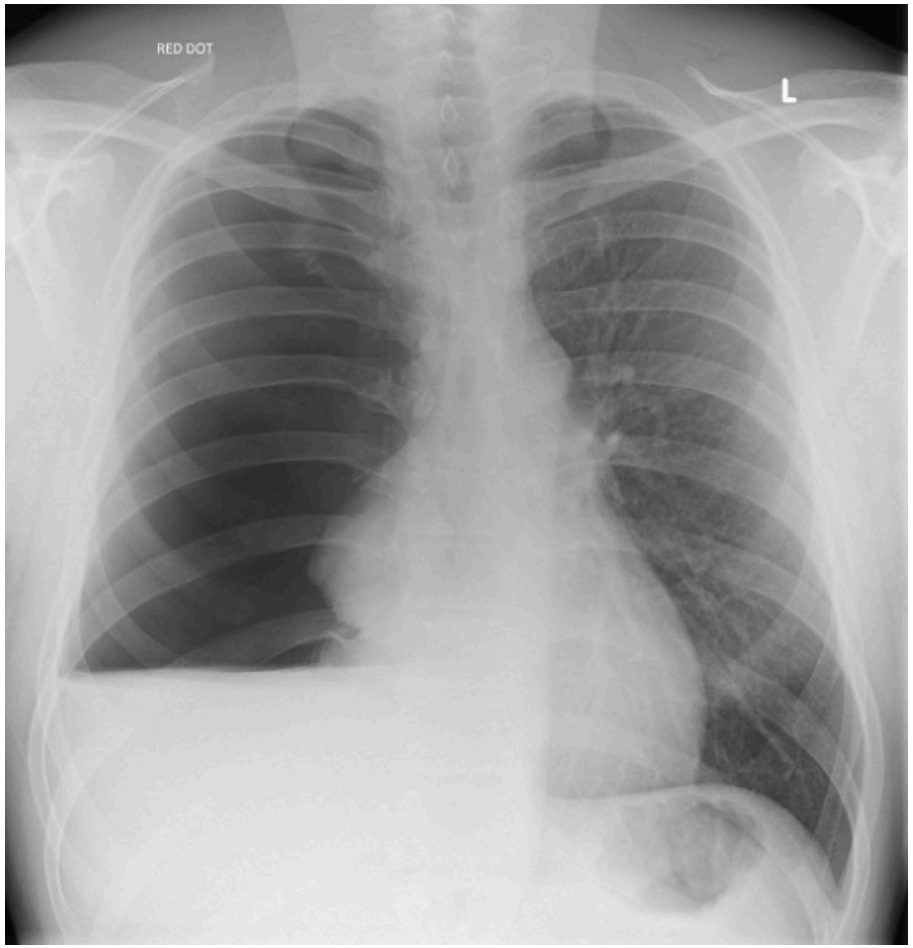
- Indicates fibrin adhesions due to an inflammatory process



Hydropneumothorax



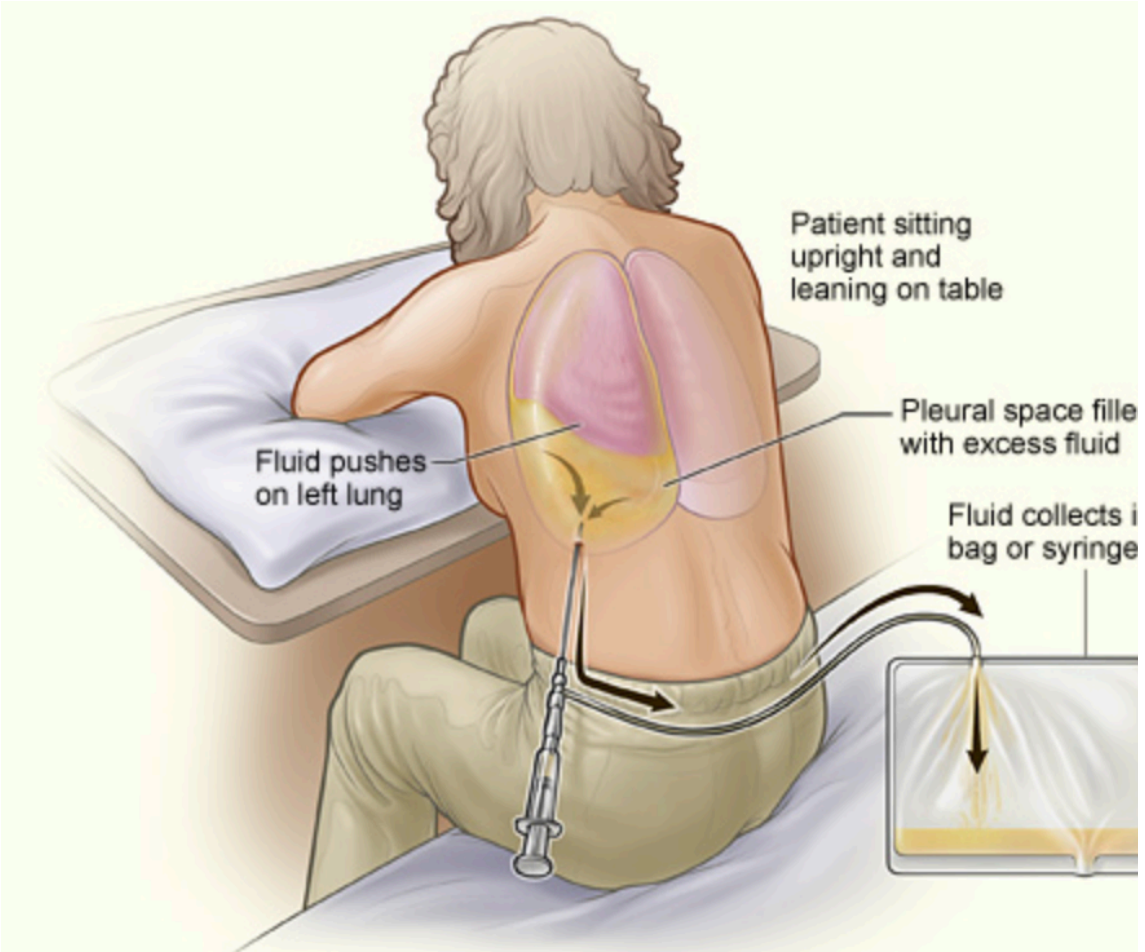
- Air-fluid level = fluid and air in pleural space
- Occurs due to gas forming infection in the pleural space, bronchopleural fistula, necrotic tumor, trapped lung

Diagnostic approach

Thoracentesis

Indications:

- New effusion
- Unknown cause
- Suspected infection, malignancy
- Large enough to safely sample



Diagnostic approach

Pleural fluid analysis

Send fluid for:

- Protein
- LDH
- pH
- Glucose
- Cell count + diff
- Gram stain + culture
- Cytology

Diagnostic approach

Pleural fluid analysis: Light's Criteria

Send fluid for:

- **Protein**
- **LDH**
- pH
- Glucose
- Cell count + diff
- Gram stain + culture
- Cytology

Finding	
Pleural Protein / Serum Protein > **0.5**	Pleural Effusion **EXUDATIVE** If any are true
Pleural LDH / Serum LDH > **0.6**	
Pleural LDH > **2/3** ULN Serum LDH	

Diagnostic approach

Pleural fluid analysis: Pleural fluid only light's Criteria

Send fluid for:

- **Protein**
- **LDH**
- pH
- Glucose
- Cell count + diff
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- Cytology

Finding	
Pleural Protein / Serum Protein > **0.5**	Pleural Effusion **EXUDATIVE** If any are true
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- Pleural fluid cholesterol > 40mg/dL
- Pleural fluid LDH > 0.6x ULN

Diagnostic approach

Pleural fluid analysis: Light's Criteria

- Transudative: fluid formed from increased pressure across normal pleural lining ("just water")
- Exudative: fluid formed from diseased/inflammed pleura ("has protein and LDH")

- **Light's criteria is very sensitive for exudates:
  - Very few false negatives
  - Can misclassify transudatives as exudative
    e.g. in diuresed CHF effusions

Management

Transudative effusions

Mechanism: increased capillary pressure, low serum protein, more negative pleural pressure (atelectasis), ascites moving across diaphragm

Treatment:
1. Reduce capillary pressure: diuresis, improve cardiac function
2. Replace protein: albumin
3. Remove/reduce ascites if present

Management

Exudative effusions

Mechanism: leaking of protein-rich pleural fluid

Cause/Treatment:
1. Infection (bacterial, viral, TB): appropriate therapies
2. Inflammation (CTDs): immunosuppression
3. Malignancy: depends on intent/malignancy
4. Infarction (e.g. PE): anticoagulation
5. Irritation (e.g. pancreatitis): supportive

Pleural space infections

Uncomplicated parapneumonic -> empyemas

Stepwise progression of parapneumonic effusions:

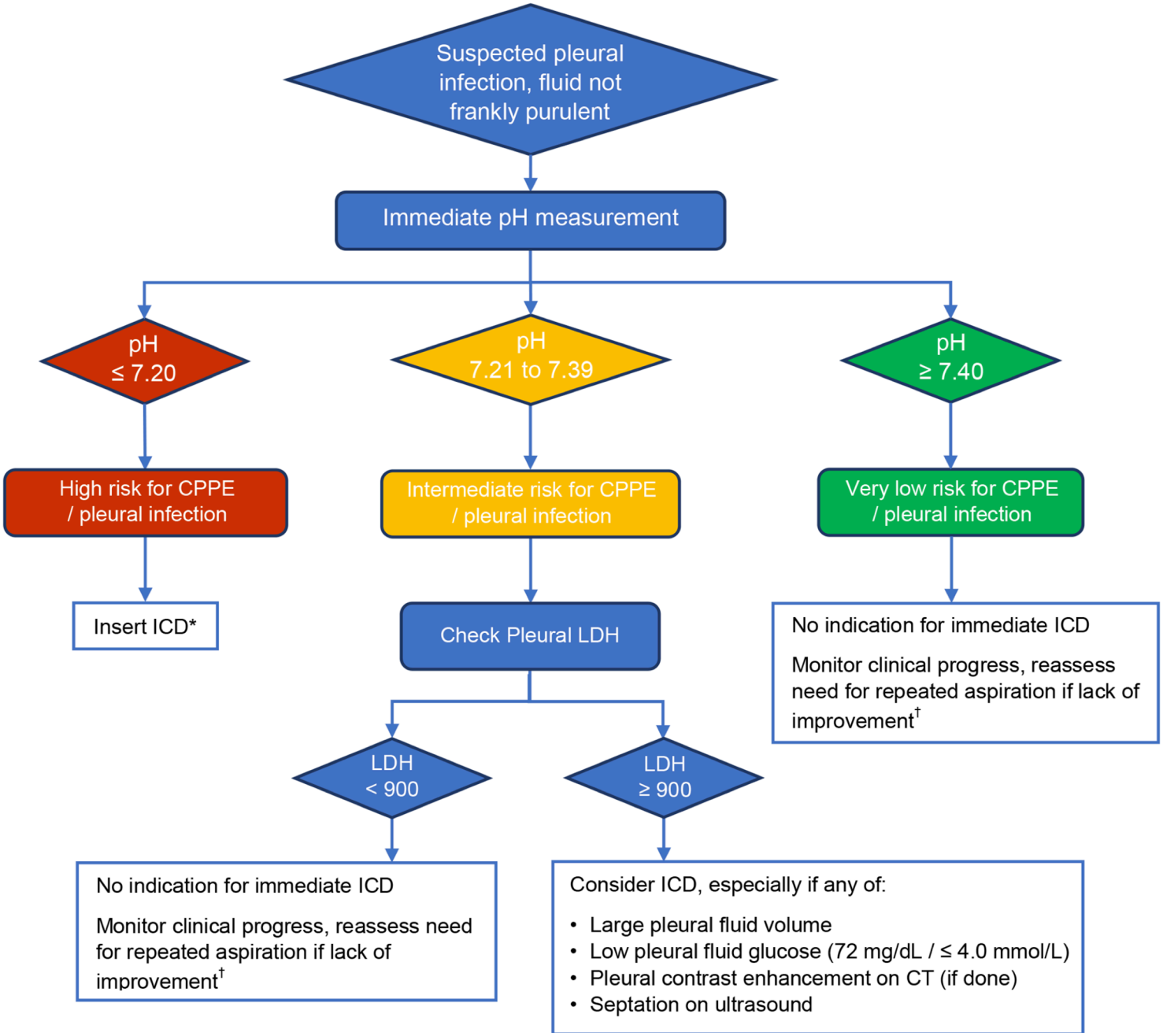
1. Exudative phase - sterile, thin, uncomplicated fluid

2. Fibrinopurulent phase - bacteria invade, glucose drops, LDH rises, fibrin deposition begins, loculations form

3. Organizing phase - fibroblasts lay down a “rind”, lung becomes trapped

**We often catch pleural space infections/people become symptomatic well before the organizing phase

Pleural space infections



Pleural space infections

al pH	Level of risk for CPPE / pleural infection	Initial action regarding drainage
2	High risk	Insert ICD, assuming ultrasound demonstrates safe volume of acces pleural fluid
.2 to < 7.4	Intermediate risk	Check LDH and review other parameters which may support CPP pleural infection. Consider ICD insertion if LDH > 900, especially if of the following: • Large pleural fluid volume • Low pleural fluid glucose (72 mg/dL / ≤ 4.0 mmol/L) • Pleural contrast enhancement on CT • Septation on ultrasound
4	Very low risk	No indication for immediate ICD

Pleural space infections

Empyemas

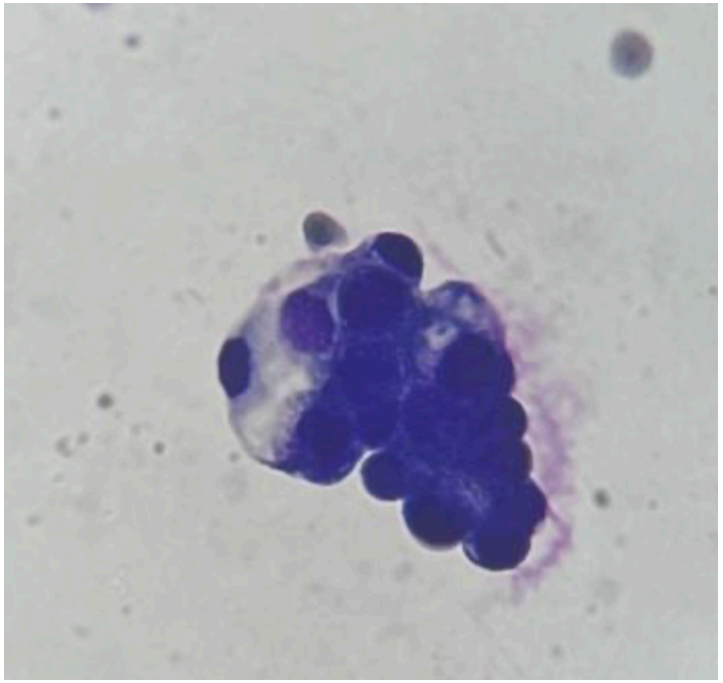
- Frank pus aspirated from the pleural space or positive bacterial culture
- Marker of severe infection, associated with high morbidity, always requires chest tube, sometimes requires surgery
- Patients are often septic, febrile, SICK

Pleural space infections

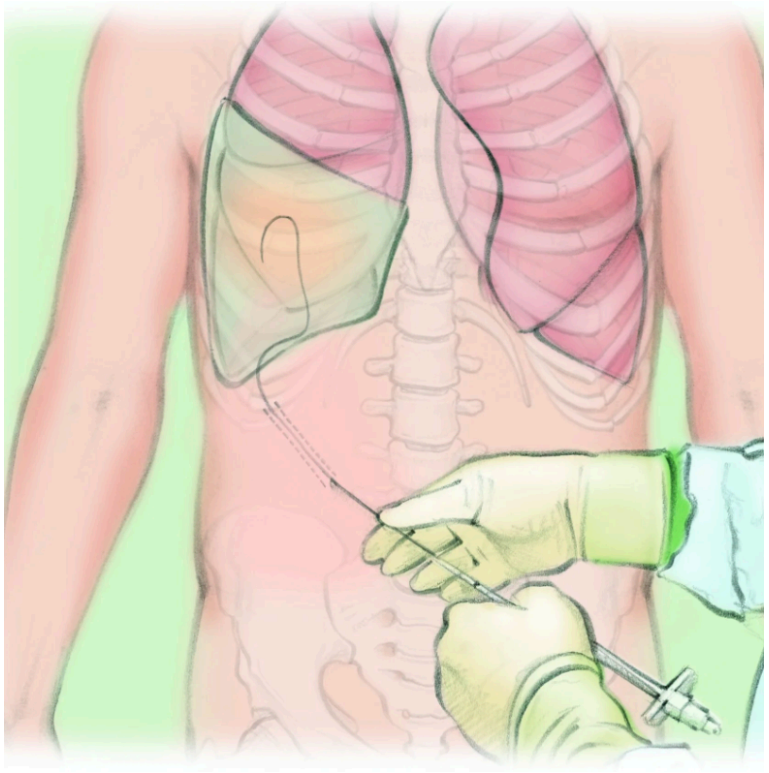
Empyemas - intrapleural fibrinolytic therapy

- Frank pus aspirated from the pleural space or positive bacterial culture
- Marker of severe infection, associated with high morbidity, always requires chest tube, sometimes requires surgery
- Patients are often septic, febrile, SICK
- MIST-1 (2005): intrapleural streptokinase vs placebo = no benefit
- MIST-2 (2011): tPA + DNase improved radiographic clearance, reduced surgical referral, shortened hospital stay than tPA, DNAse alone, or placebo. —> BID regimen x3d
- If non-resolving, needs thoracics for decortication

Malignant effusions



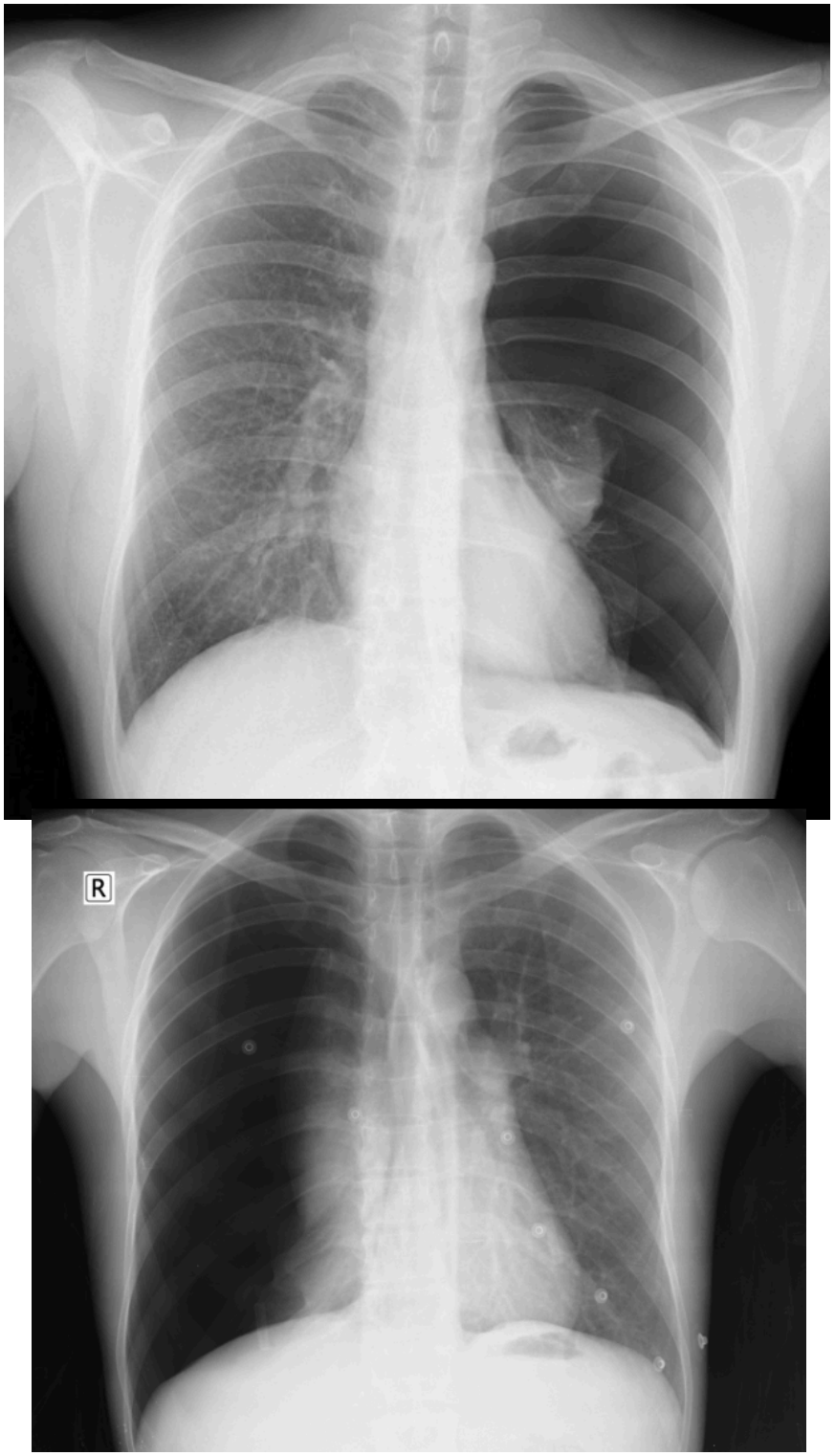
- Cancer cells in pleural fluid (+ve cytology)
- Indicative of stage 4 disease: usually lung, breast, lymphoma, skin in origin
- Often recurs, can cause quite significant symptoms
- Treatment: repeat thoracentesis, chemotherapy, pleurodesis, PleurX



Pneumothorax

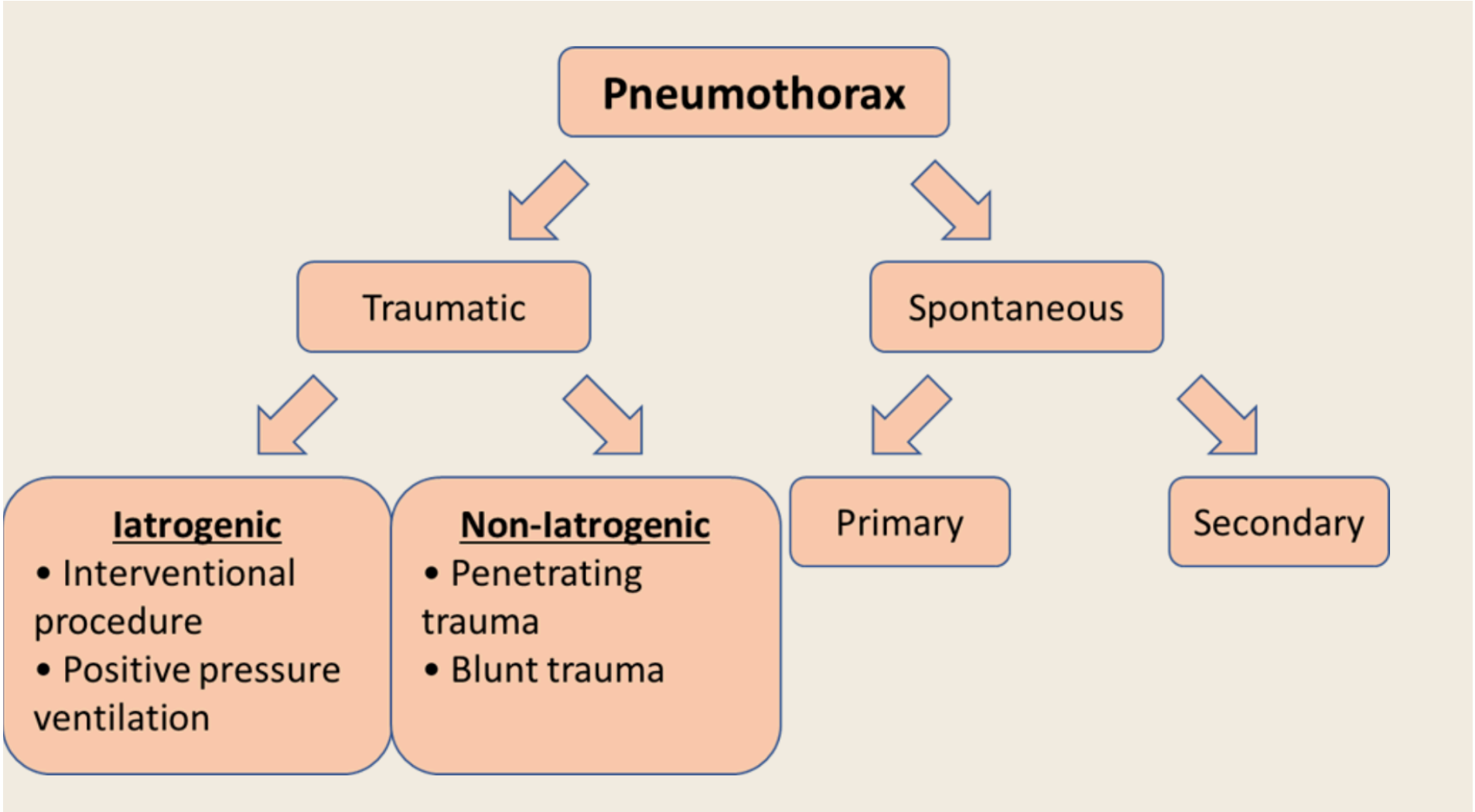
Air/gas in pleural space

- Asymptomatic
- Dyspnea
- Tachycardia and hypotension (tension)/shock
- Pleuritic chest pain



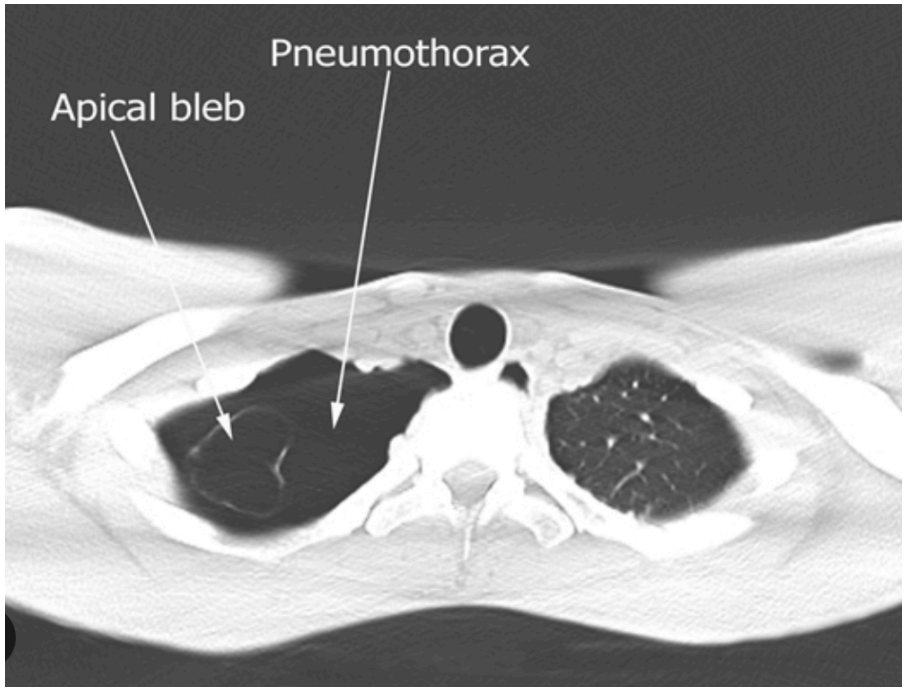
Pneumothorax

Etiologies/classification

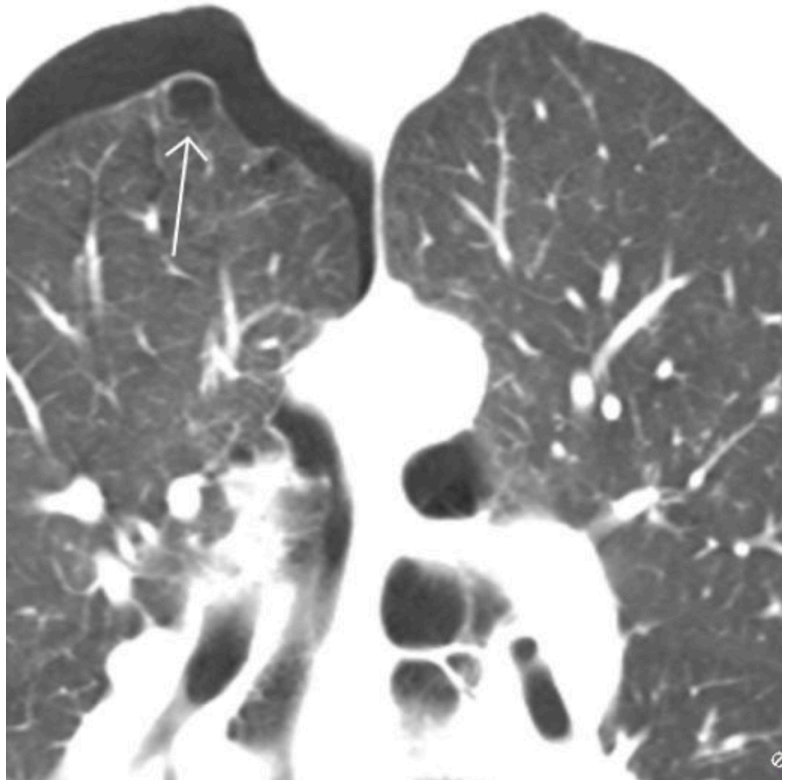


Pneumothorax

Primary spontaneous



- **NO** underlying structural lung disease
- Young patients (15-30), M>F
- Pathophys: thin walled subpleural blebs at lung apex that rupture and release air into the pleural space
- Usually thin, tall males, sometimes associated with CTDs (e.g. Marfan syndrome)
- Smoking/vaping increases risk



Management

Primary spontaneous

- BTS 2010: ≥ 2cm or symptomatic —> intervene
- BTS 2023: moving away from strict size cutoffs. Instead management based on patient stability and symptoms
  - Stable + minimally symptomatic —> observe, supplemental O2
  - Stable + very symptomatic —> needle aspiration
  - Unstable —> immediate decompression
- Sizing still documented, but to track progression instead of sole decision making

Management

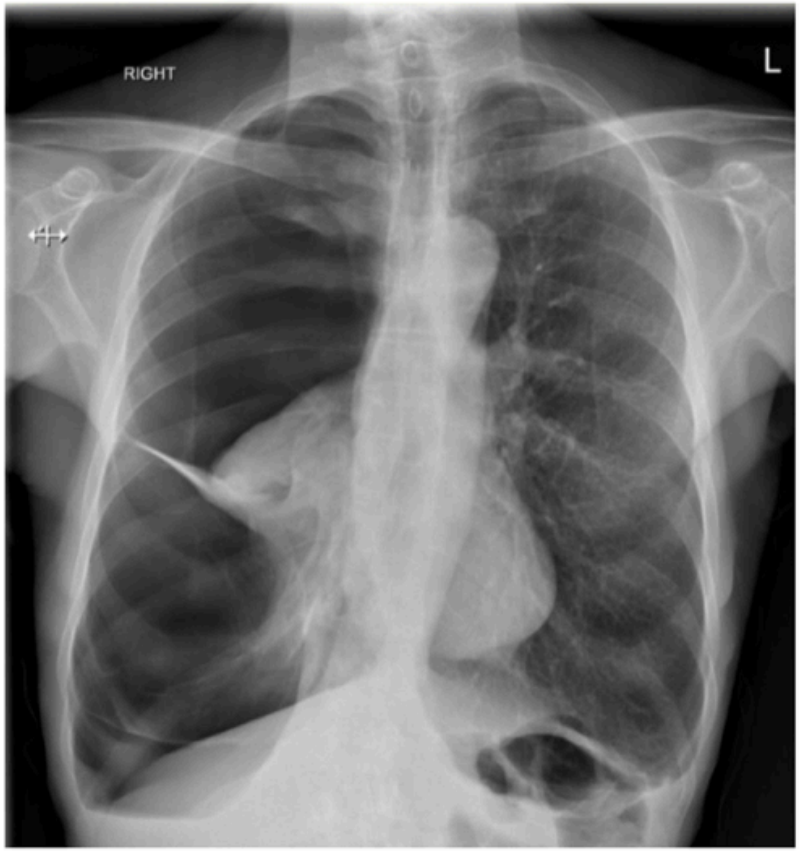
Primary spontaneous - RECURRENCE

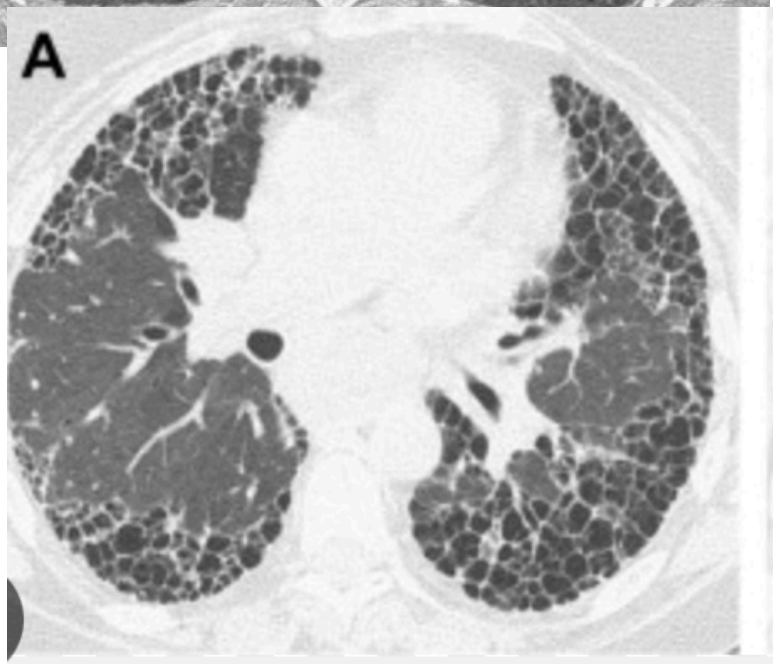
- Recurrence rate quite high ~40-50%
- Should get pleurodesis (chemical or surgical) if recurrence/ second episode
- Patients need to avoid air travel until full resolution, and may need long-term changes if no pleurodesis pursued (e.g. no scuba diving)

Pneumothorax

Secondary spontaneous

- Underlying structural lung diseas (e.g. COPD, cystic lung disease, interstitial lung disease)





Management

Secondary spontaneous

- Observation/conservative management usually not recommended
- Will often need chest tube and decompression
- If persistent air leak (>~5d, involve thoracics for pleurodesis (chemical vs surgical)
- In contrast to primary, pleurodesis is usually advised after first episode of secondary spontaneous pneumothorax

Chest tubes

- Purpose: drain air, blood, pus, fluid from pleural space
- Common indications:
  - Pneumothorax
  - Hemothorax
  - Empyema/complicated parapneumonic effusion
  - Malignant effusion causing symptoms
- Goal: re-expand the lung, relieve symptoms

Chest tubes

Different types

Small bore (pigtail, 8-14Fr)

- Usually inserted using Seldinger technique, has a curl to help keep it in place

Large bore (20-28Fr)

- Surgical chest tubes, usually done by thoracics

Tunneled indwelling catheters

- Management of malignant effusions

Chest tubes

Drainage systems

Water seal system:

- Thopaz or PleurEvac, one way valve that prevents air from going back into the chest

Evacuation methods:

- Suction - more negative than pleural space (e.g. -20cmH2O)
- Gravity

Chest tubes

Monitoring

- Bubbling - air leak
- Tidaling - normal with respiration
- Drainage amount/ character

Chest tubes

Troubleshooting & complications

- Persistent air leak - may indicate bronchopleural fistula
- Tube blockage/kinking - flush, reposition, or replace
- Infection at insertion site - d/c tube, abx
- Re-expansion pulmonary edema - fluid drained too quickly
- Dislodged/accidentally removed - cover with occlusive dressing

Thanks! Questions?