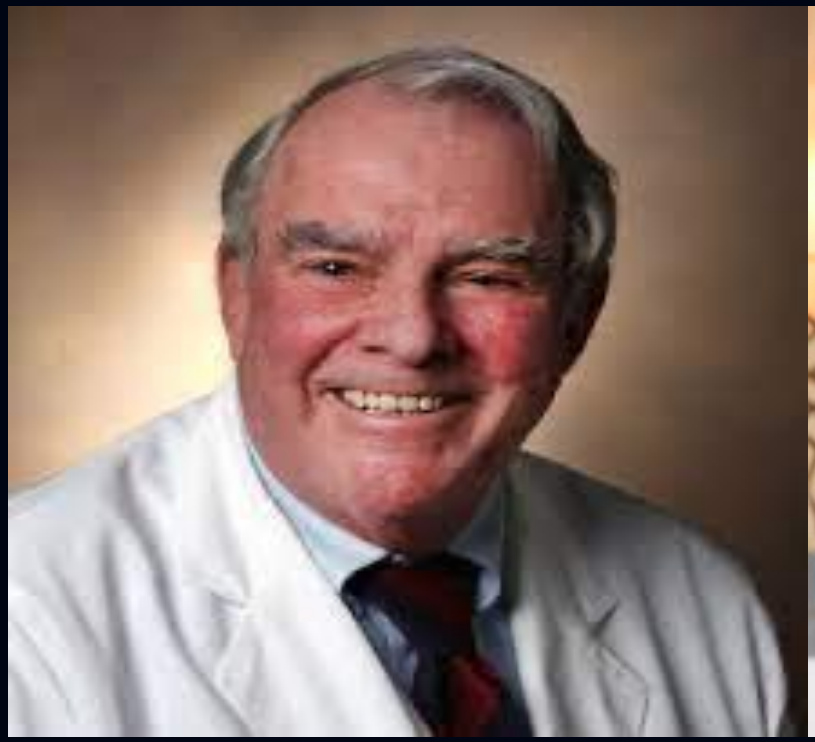
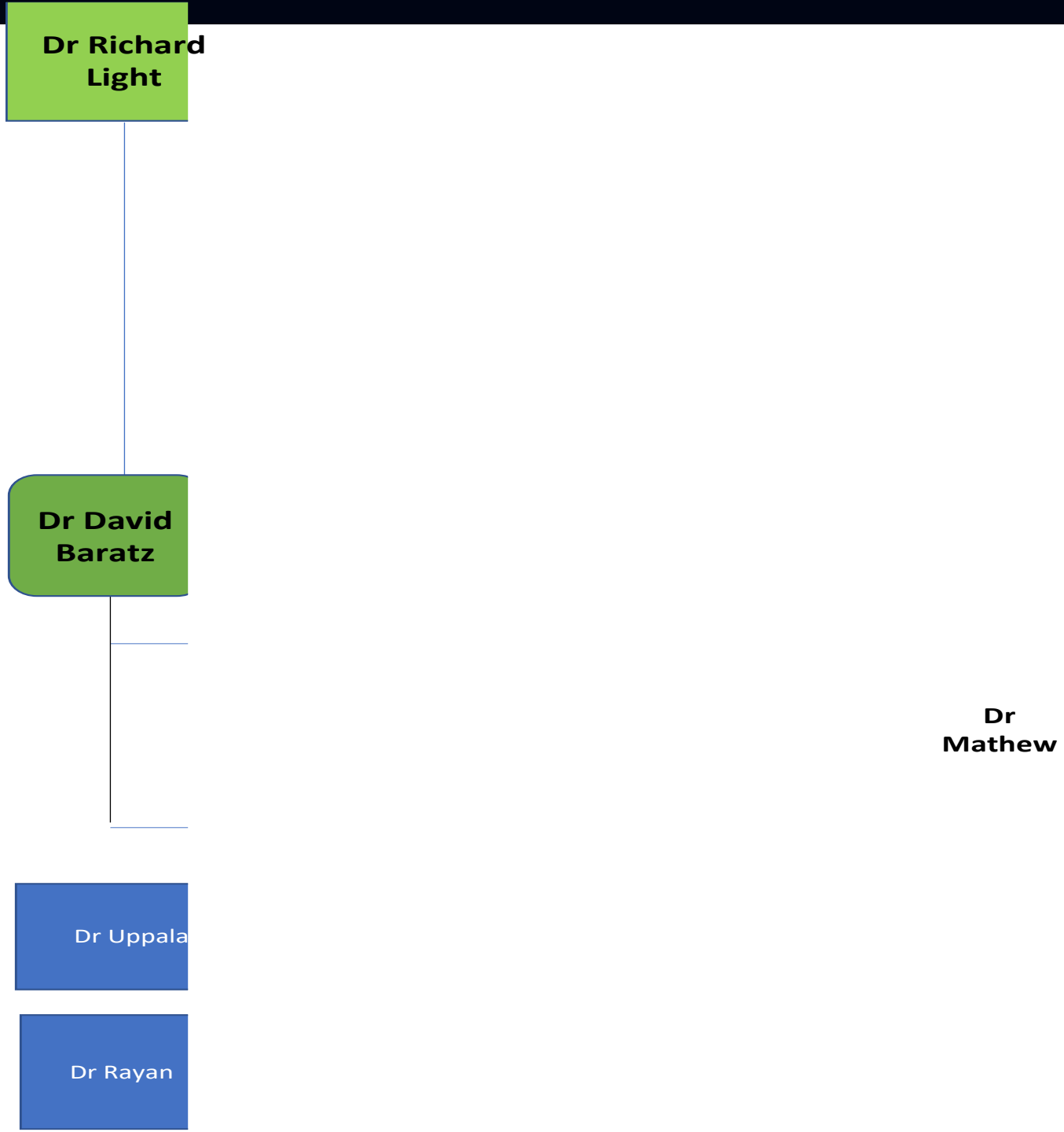
“If I have seen farther it is by standing on the shoulders of giants”

- Isaac Newton



Pleural Effusions

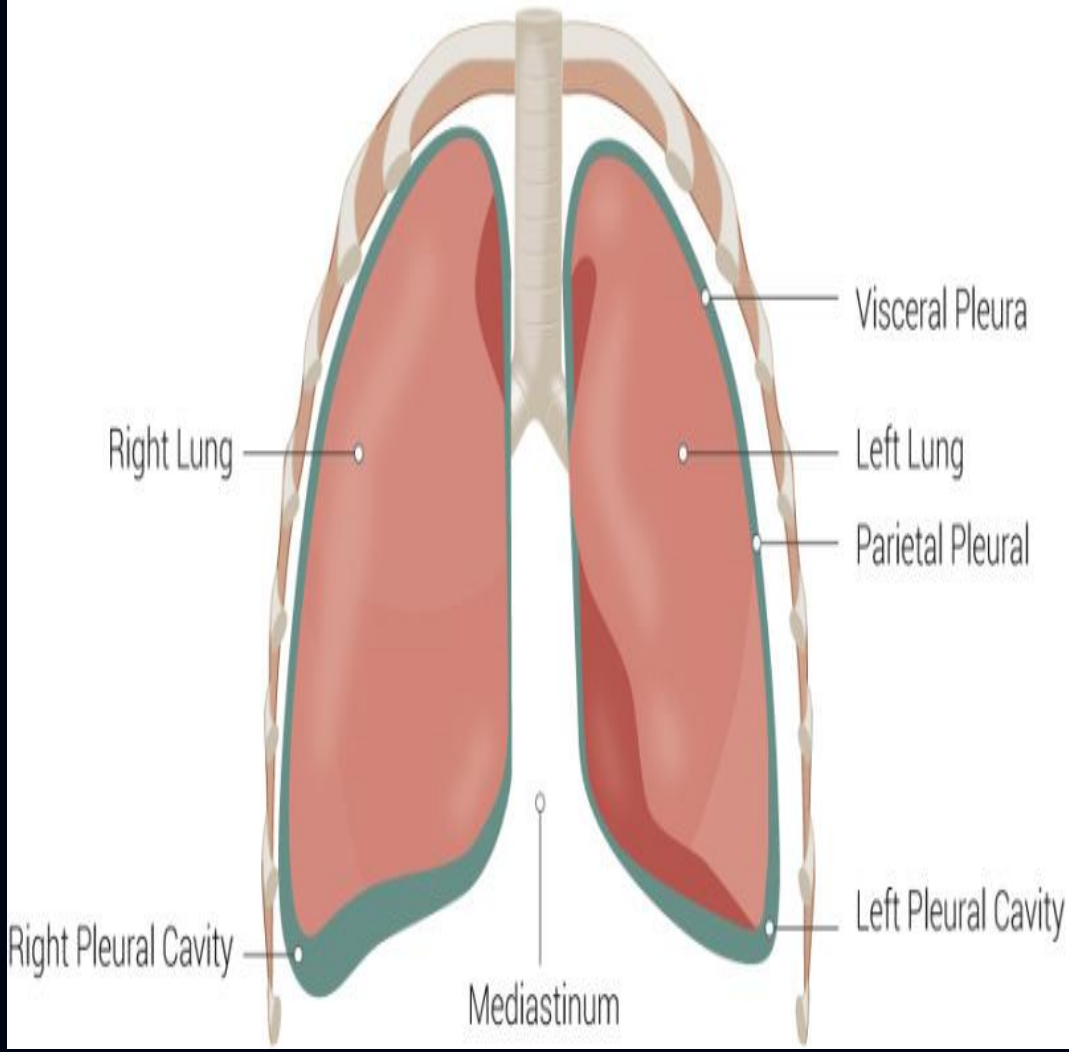
Manny Mathew, MD FCCP
Clinical Associate Professor Univ Of Az


Dr Richard Light
Dr David Baratz
Dr Mathew
Dr Uppala
Dr Rayan

Objectives

- Pleural Anatomy and Pathophysiology
- Fluid Analysis Exudative vs Transudative
  - Lights
  - Heffner
- Causes of Exudative vs Transudative
- Thoracocentesis and Fluid Analysis
- Parapneumonic Effusions
- Special Cases

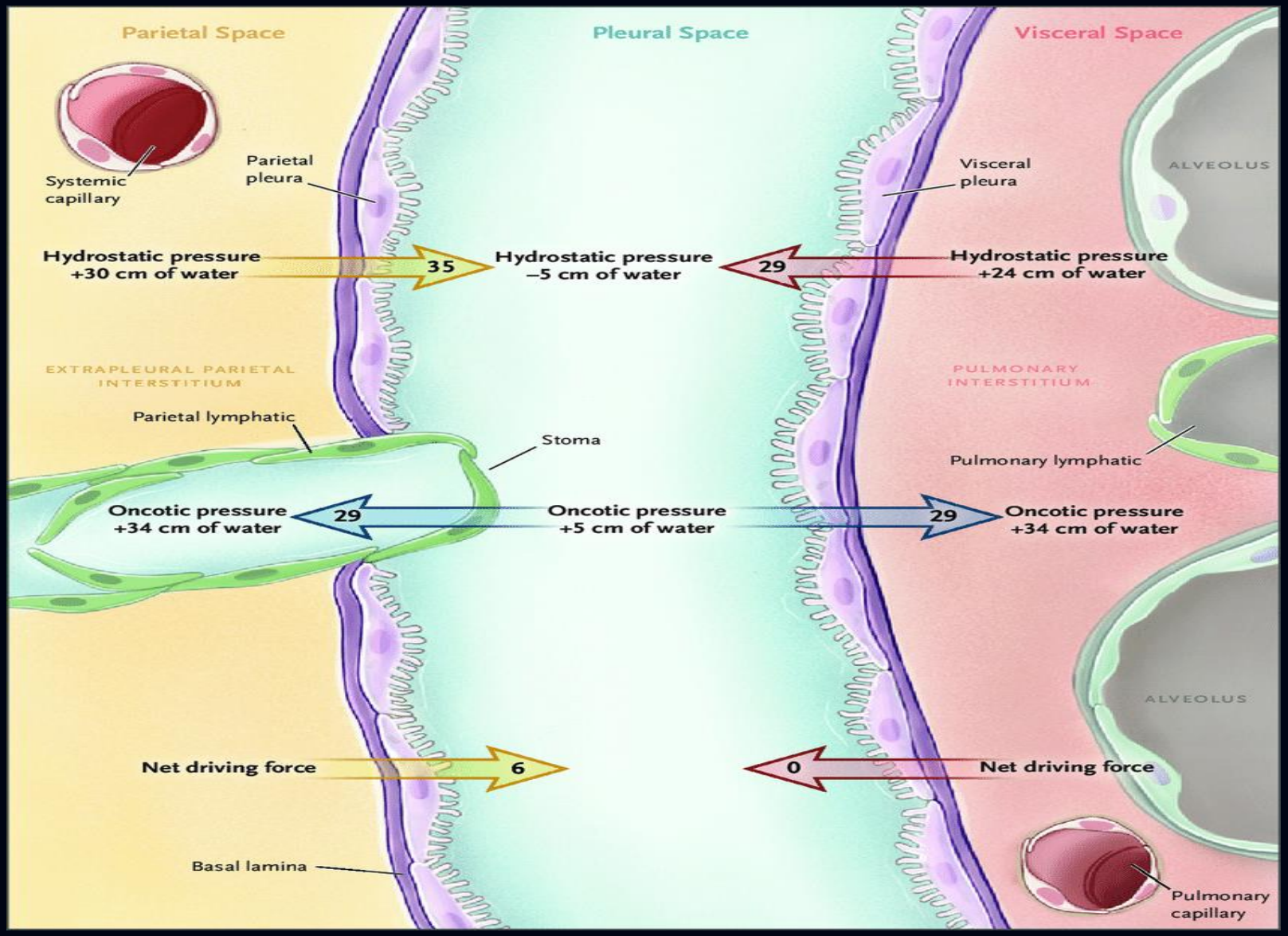
Anatomy



- Pleural Space 5-10cc fluid
- Extends to 10th ICS – Posteriorly
- Cardiac, Diaphragmatic recess

Parietal
Hydrostatic > Oncotic

Visceral
Oncotic > Hydrostatic



Physiology
Increased Pleural Fluid

1. Incr Capillary Hydrostatic Pressure (CHF)

2. increased negative pleural space pressure (Atelectasis)

3. Decr Plasma Oncotic Pressure (Hypoproteinemia, Nephrotic)

4. Obstruction of lymphatic drainage (Cancer)

5. Increased Pleural Permeability (Inflammation, Infection, Malig)

6. Anatomic Defects (hepatic hydrothorax)

- Think of Pleural Membrane like a filter
- Disorders b/w H & O press – Water

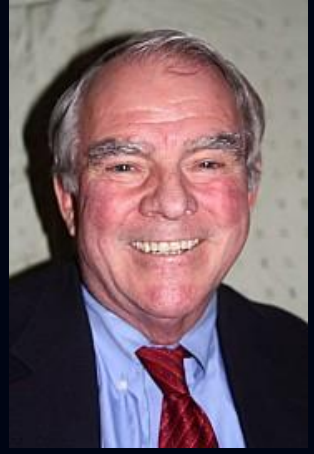
  Transudative Effusion
- Disorders within the Pleura - Larger Molecules Pass through

  Exudative Effusions

Objectives

- Pleural Anatomy and Pathophysiology
- ***Exudative vs Transudative***
  - ***Lights***
  - ***Heffner***
- Causes of Exudative vs Transudative
- Thoracocentesis and Fluid Analysis
- Parapneumonic Effusions
- Special Cases

Lights Criteria



- Discovered between 1968-1971 while he was an Intern at Johns Hopkins

- Published in 1972

Light RW, MacGregor MI, Luchsinger PC, Ball WC Jr: "Pleural effusions: the diagnostic separation of transudates and exudates". Ann Intern Med l972; 77:507-14.

Lights Criteria

- Pleural Fluid Prot/Serum Protein
  > 0.5 = EXUDATIVE

- Pleural LDH/Serum LDH
  > 0.6 = EXUDATIVE

- Pleural LDH > 2/3rds upper limit of Normal

**ONLY NEED 1 OF ABOVE TO BE EXUDATIVE*

Dr John Heffner

- Assoc Chief of Medicine Univ Of Az 1990-1998
- Exudative Effusion evaluation without serum labs
- Heffner JE, Brown LK, Barbieri CA. Diagnostic value of tests that discriminate between exudative and transudative pleural effusions. Primary Study Investigators. Chest 1997; 111:970.

Heffner Criteria

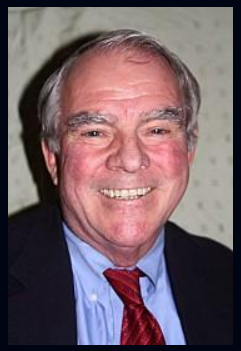
Heffner JE, Brown LK, Barbieri CA. Diagnostic value of tests that discriminate between exudative and transudative pleural effusions. Primary Study Investigators. Chest 1997; 111:970.

Three-test rule

- Pleural fluid protein greater than 2.9 g/dL (29 g/L)
- Pleural fluid cholesterol greater than cholesterol 45 mg/dL (1.165 mmol/L)
- Pleural fluid LDH greater than 0.45 times the upper limit of the laboratory's normal serum LDH

Two-test rule

- Pleural fluid cholesterol greater than 45 mg/dL
- Pleural fluid LDH greater than 0.45 times the upper limit of the laboratory's normal serum LDH



- Lights Criteria
- More specific for Transudative effusion
- 99% specific if all 3 criteria negative and not on diuretic

- Heffner Criteria
- More specific for exudative effusion
- 99% specific for Exudative with ”2 Test Rule”

Roth Criteria

Chest
. 1990 Sep;98(3):546-9.
doi: 10.1378/chest.98.3.546.

The serum-effusion albumin gradient in the evaluation of pleural effusions

- Useful in distinguishing an exudative vs pseudoexudate effusion CHF + Diuretics

- With Diuresis water is drawn out faster than protein and in CHF relief of hepatic congestion decreases serum LDH

Roth Criteria

- ***Serum albumin – Pleural Albumin***

  > 1.2 = Transudative

  < 1.2 = Exudative

***** Do this in addition to Lights or Heffner Criteria ******

Objectives

- Pleural Anatomy and Pathophysiology
- Exudative vs Transudative
  - Lights
  - Heffner
- ***Causes of Exudative vs Transudative***
- Thoracocentesis and Fluid Analysis
- Parapneumonic Effusions
- Special Case

Case

- 68 y/o F with PMH of CAD presents with SOB, and Leg swelling
- CXR is shown

All of the following are true except

- A. this is the most common cause of pleural effusion
- B. Effusions can be transudative or exudative
- C. PAWP is often normal
- D. Effusions are often Bilateral
- E. 'House of Payne' went from being a 90s Hip Hop Group a to a Stroke Unit at BUMC

Causes of Pleural Effusions

Transudative	Exudative
1. CHF	1. PNA
2. Cirrhosis	2. Malignancy
3. PE	3. PE

CHF EFFUSION

- Most Common cause of transudative effusion
- Bilat> R > Left
- Tx the CHF not the effusion
- Does not require pleural fluid analysis for diagnosis (clinical diagnosis)
- If you Tap……..

CHF effusion Studies

- Serum Total Protein – Pleural Total Protein > 3.1g = Transudative
- Serum Albumin – Pleural Albumin > 1.2 = transudative
- Pleural N-Terminal BNP > 1500 = 93% specific for CHF

Case

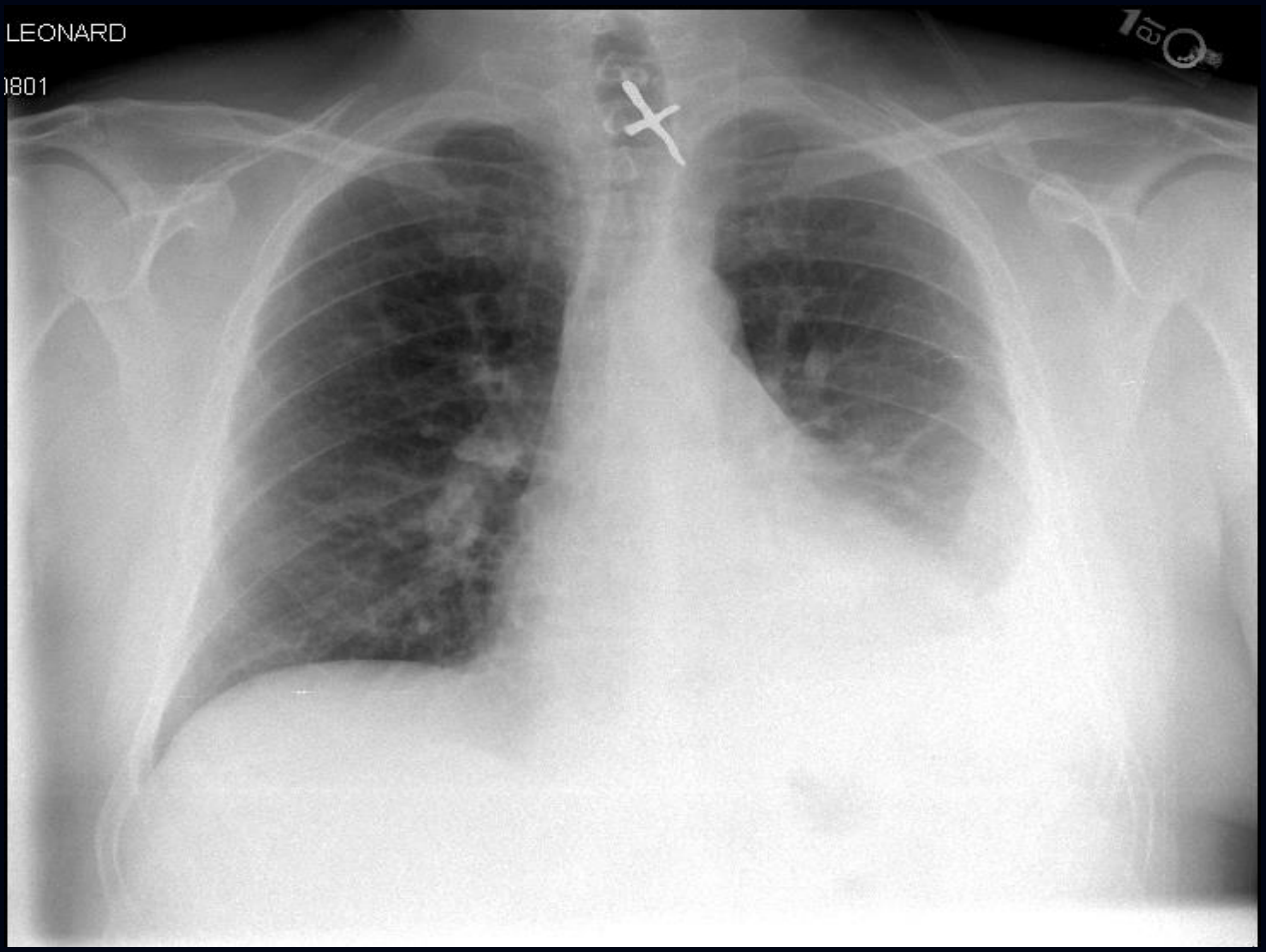
- 54 y/o M presents CC of Fever, SOB, Cough (brown sputum) and CP x 3 days

- O/E: T 101.5 , 02 Sat 90% RA

  Dullness to percussion over Left posterior chest

  Decreased breath sounds over left lower chest

  CXR: shown

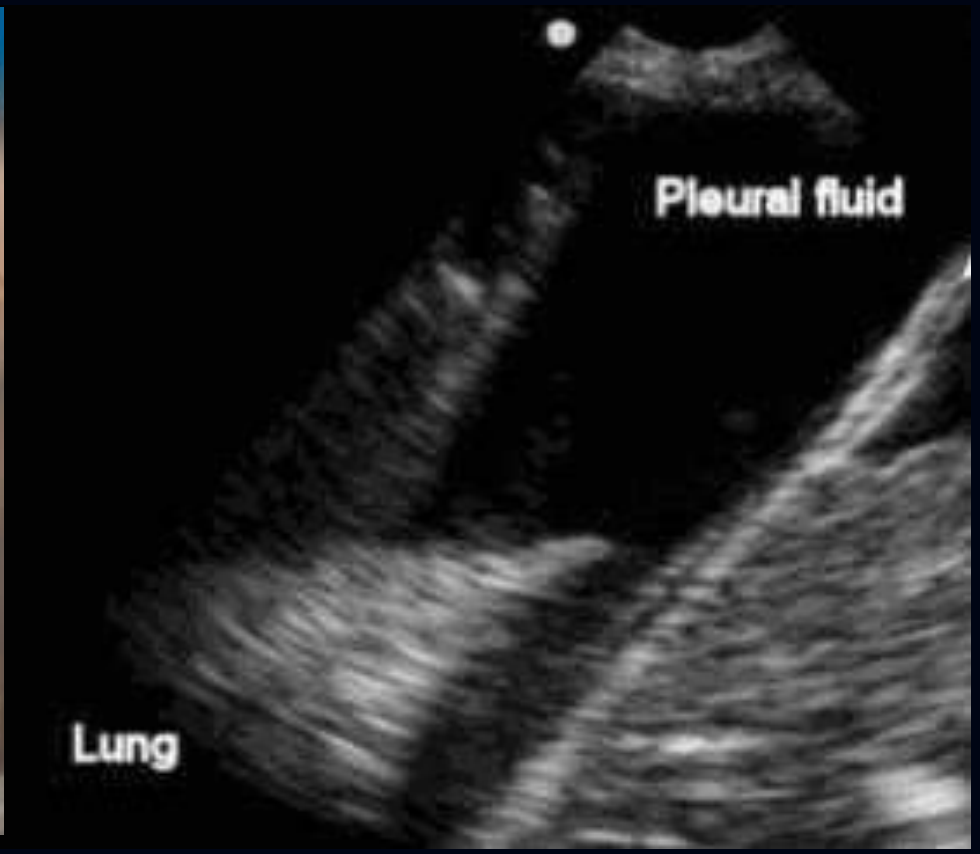

LEONARD
)801

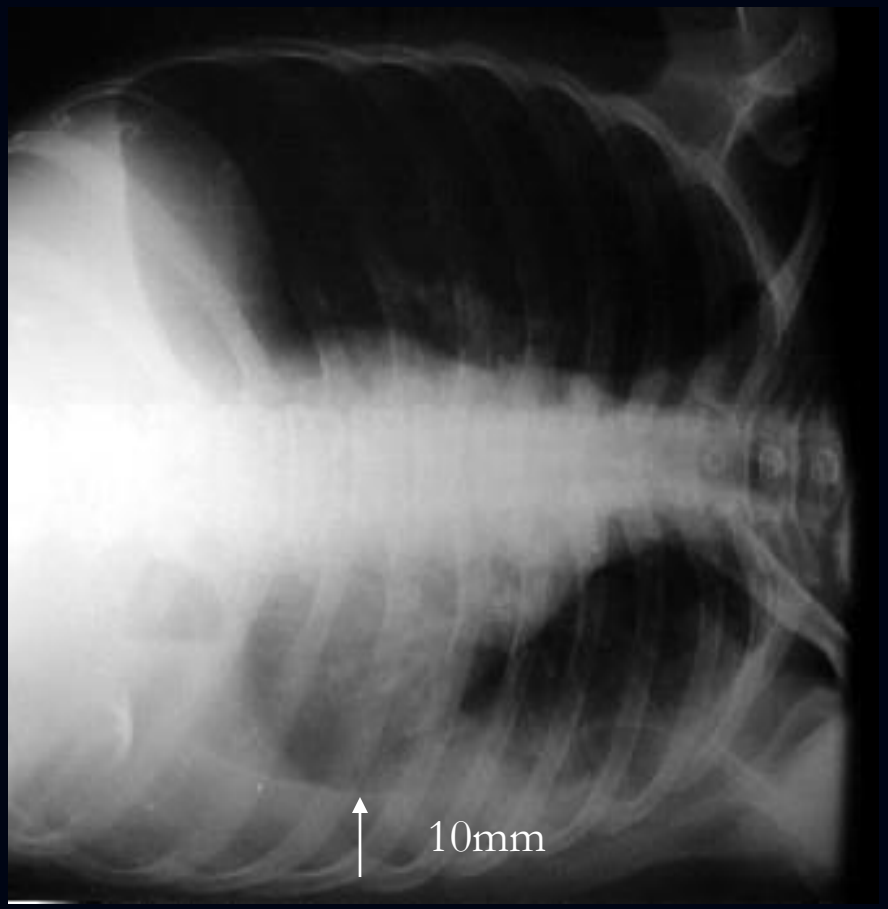
Case

What is the next best study?

1. Chest CT
2. USS eval and Thoracocentesis
3. Bronchoscopy
4. Lateral decub CXR


Ultrasound-Guided Thoracentesis


Pleural fluid
Lung



- Lat decub usefull to distinguish

  mass vs atelectasis – vs – effusion

- If > 10mm layering height of effusion – safe to tap

- Perform Bilat Decub if you suspect malignancy under effusion

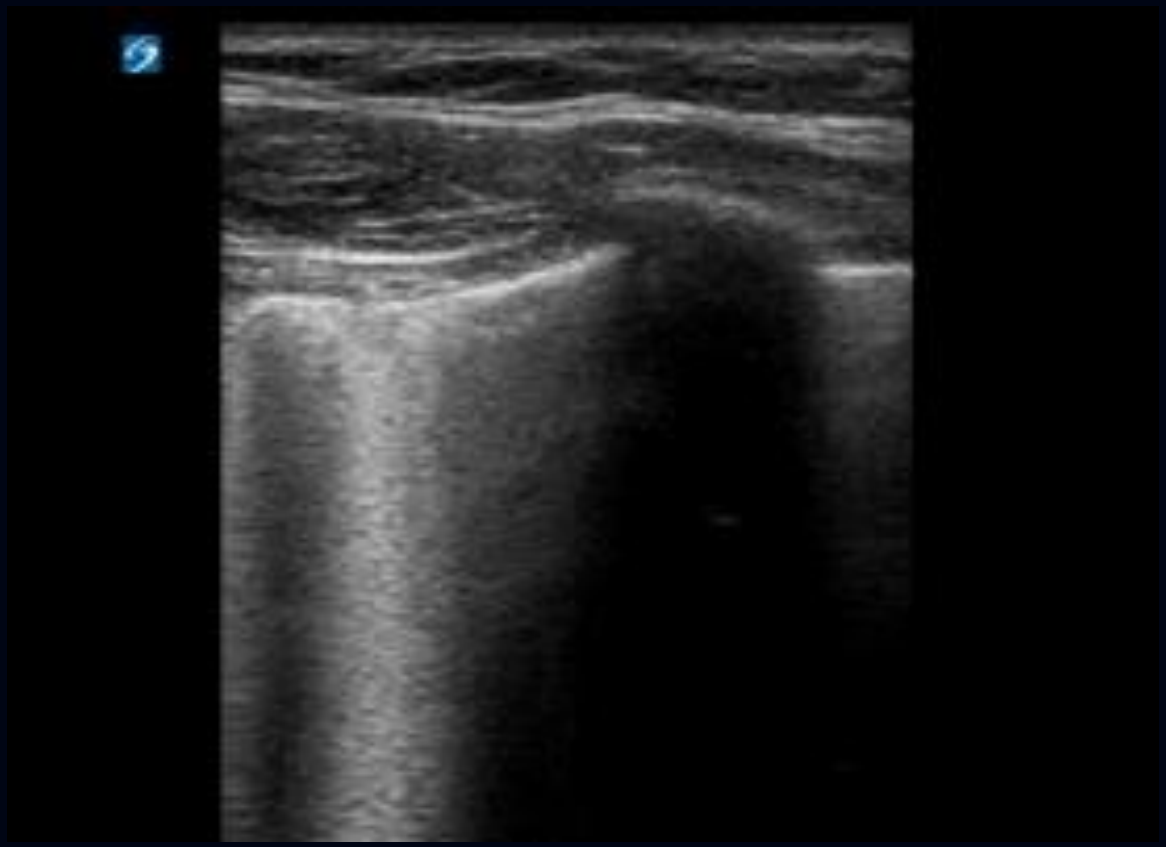
You have just completed a US guided Thoracocentesis. You removed 1100cc of Cloudy Yellow fluid,

There was no aspiration of free air. The patient did cough during the procedure. Post procedure

US showed presence of lung sliding. Your follow up should include?

A. CXR (insp hold)
B. No Imaging Needed
C. CT Chest
D. CXR (exp hold)

Lung Sliding = 100% NPV for PTX



Risks for PTX (2-5%)

Table 3—*Procedure-Related Factors Potentially Contributing to Pneumothorax Following Thoracentesis*

Predictor Variables	No. of Procedures n = 255	No. of Pneumothoraces (%) n = 14
Physician		
Fellow	194	10 (5.1)
Attending	61	4 (6.6)
Needle type		
Needle/angiocatheter	100	5 (5.0)
Boutin	84	4 (4.8)
Cope	71	5 (7.0)
Fluid removed		
No fluid (dry tap)	15	1 (6.7)
Fluid removed	240	13 (5.4)
Amount of fluid removed, mL		
<60	59	3 (5.0)
60 to 350	60	2 (3.3)
350 to 1,000	60	5 (8.3)
>1,000	61	3 (4.9)
First or subsequent thoracentesis		
Initial	215	9 (4.2)
Subsequent (≥ 2)	40	5 (12.5)*
Type of procedure		
Diagnostic	150	7 (4.7)
Therapeutic	28	2 (7.1)
Both diagnostic and therapeutic	77	5 (6.5)

*Statistically significant difference at $p < 0.05$.

- > 2 attempts
- Larger Needle size (20g)?
- Larger Volume ?

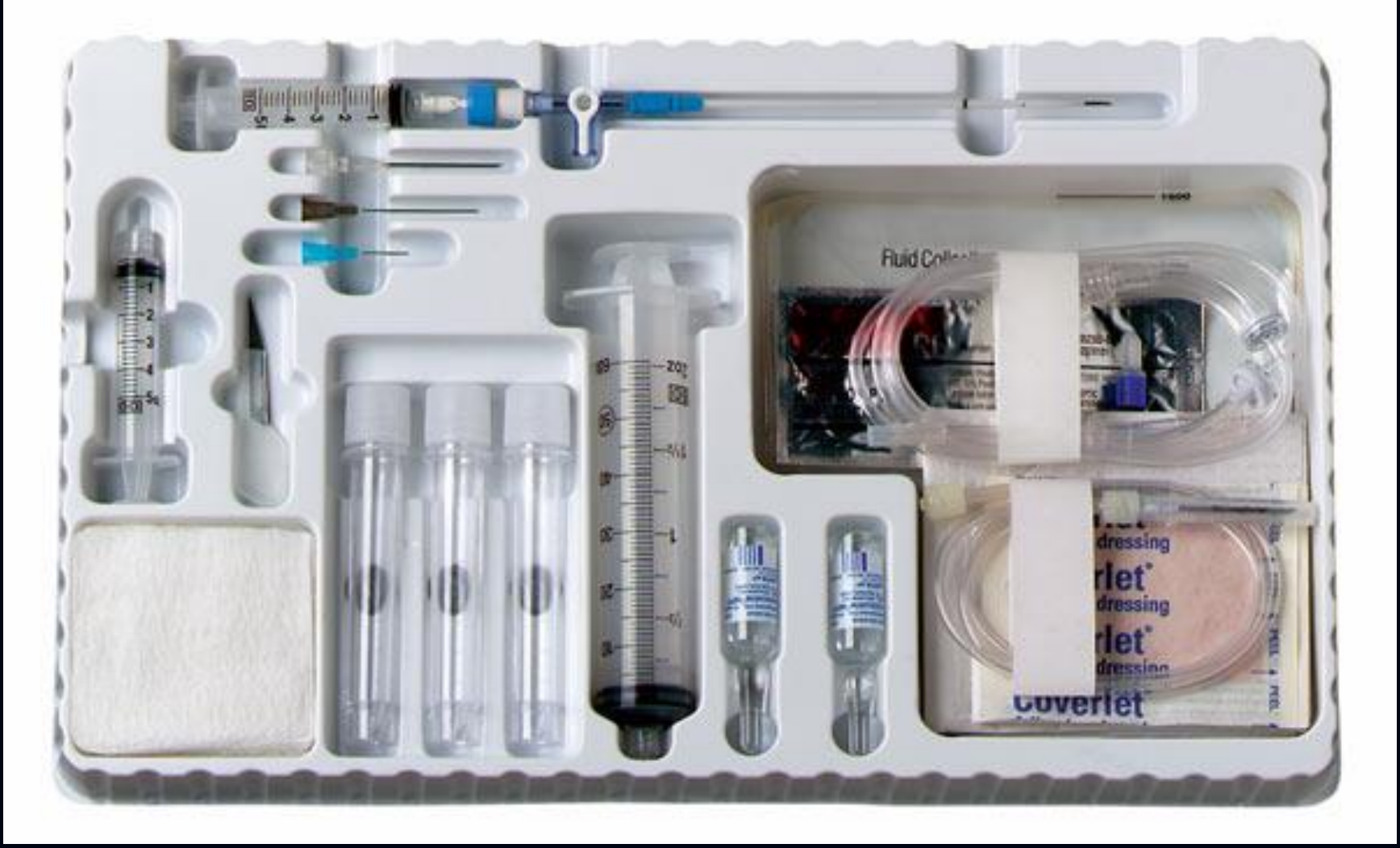
Evaluation of Patient-Related and Procedure-Related Factors Contributing to Pneumothorax Following Thoracentesis*

Henri G. Colt, MD, FCCP; Nancy Brewer, RVT; and Edward Barbur, MPH

Objectives

- Pleural Anatomy and Pathophysiology
- Exudative vs Transudative
  - Lights
  - Heffner
- Causes of Exudative vs Transudative
- ***Thoracocentesis and Fluid Analysis***
- Parapneumonic Effusions
- Special Cases

Thoracocentesis

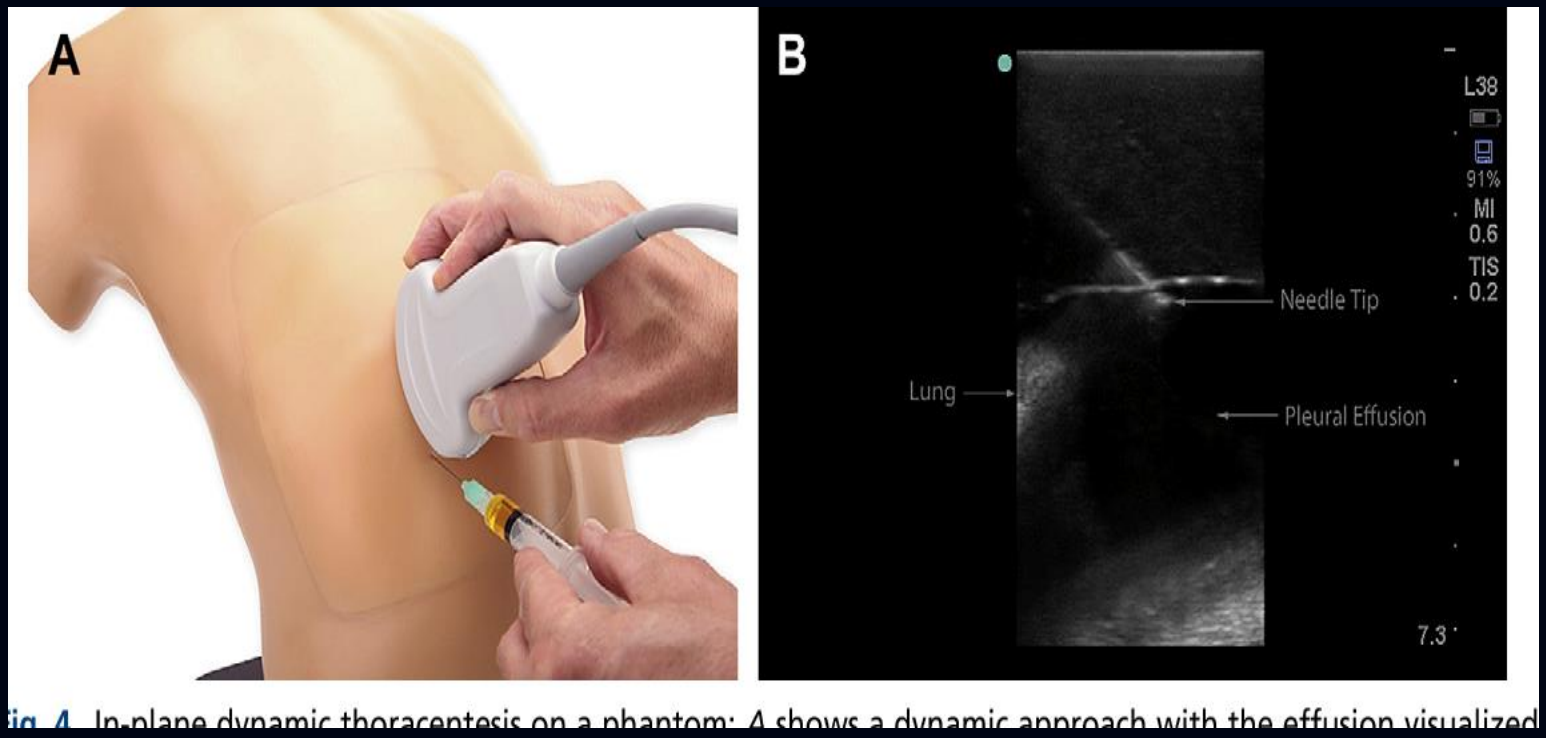


USS guided Thoracocentesis

- US guided Thora is standard of care
- Higher success rate, even after dry tap
- 58% of exam guided dry taps – b/c below the diaphragm
- should be done in real time (or at least at time of marking)

US Guided Thoracocentesis

- Pt seated upright
- 8th ICS, Medial to Post Axillary Line



ig. 4. In-plane dynamic thoracentesis on a phantom: A shows a dynamic approach with the effusion visualized

Thoracocentesis

- Pleural Pressure = -5
- Vacutainer Pressure = -1000
  - high neg pressure will kink cath
  - ? PTX
- Re-expansion Pulm Edema
  - when Pleural Pressure -20
- **Large volume thoracentesis and the risk of reexpansion pulmonary edema**
  CHEST, Oct, 2005 by David M. Berkowitz
  Retrospective eval of 602 cases
  245 cases > 1L removed = 1 case RPE

Thoracocentesis

Use Your Eyes

Clear/yellow	Normal	Routine
Bloody	Infect, Malig, PE, Hemothorax	HCT
Cloudy	Infect, Malig, Chylothorax	TG, Chol
Milky	Chylothorax, Pseudochylous	TG,Chol
Pus	Empyema	Cult

Fluid Studies

Pleural Fluid	Serum
Cell Count/Diff/Cult	
TP, Alb	TP, Alb
LDH	LDH
Gluc	
Ph	
Cholesterol	
Non-Routine Studies	
BNP	
HCT	HCT
TG	
Lipase, Amylase, Creat	

Pleural Fluid Studies

WBC count means very little, nonspecific

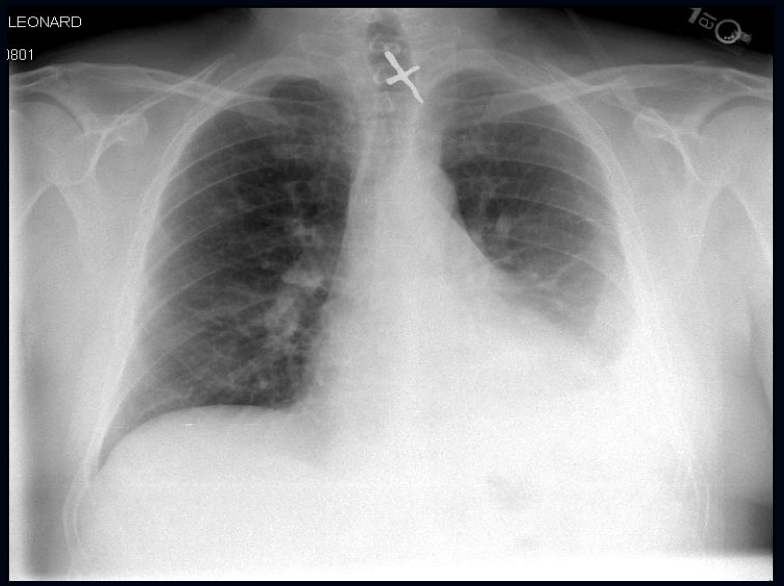
Differential Changes everything

- > 10% **Eos** ----- Eosinophilic Effusion
  PTX, PE, Asbestos, Malig, Drugs, Parasitic
- > 50% **Lymph** -- Lymphocyte predominant
  Tb, Malig, Post Pericardiotomy (CABG)
- > 5% **Mesothelial** cells, virtually rules out Tb

Case

Pleural Studies

- Drained 1100cc
- Cloudy
- LDH 1560 / (serum 170)
- TP 5.6 / (serum 4.7)
- Ph 6.9
- WBC 3330 (90% segs)
- GS: Gram + cocci



What's the diagnosis?

Objectives

- Pleural Anatomy and Pathophysiology
- Exudative vs Transudative
  - Lights
  - Heffner
- Causes of Exudative vs Transudative
- Thoracocentesis and Fluid Analysis
- *Parapneumonic Effusions*
- Special Cases

Parapneumonic Effusion

- Def: any effusion that is associated with bacterial **PNA, lung abscess, bronchiectasis**
- Most common cause of an exudative effusion
- **40-55%** of bacterial pneumonia cases develop parapneumonic effusions

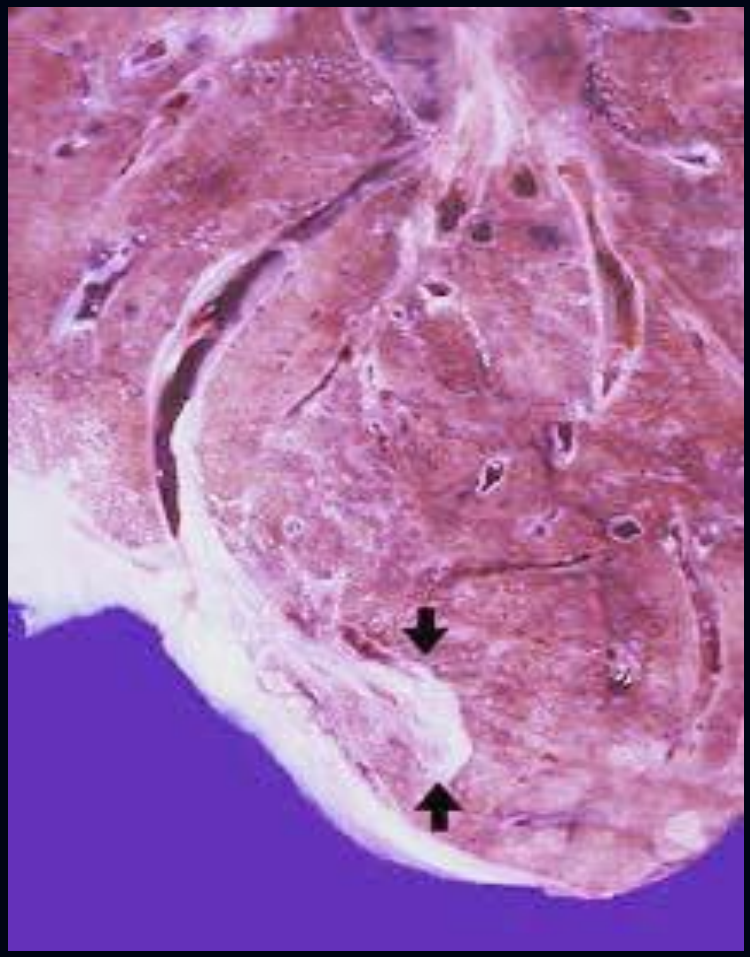
Parapneumonic Effusion

- 1. Uncomplicated ….exudate, sterile
- 2. Complicated……..exudate, infected
- 3. Empyema…….frank pus

STAGES

1. Exudative (Acute = < 72hrs)
2. Fibropurulent (Transitional = 3-10d)
3. Organization (Chronic > 10d)

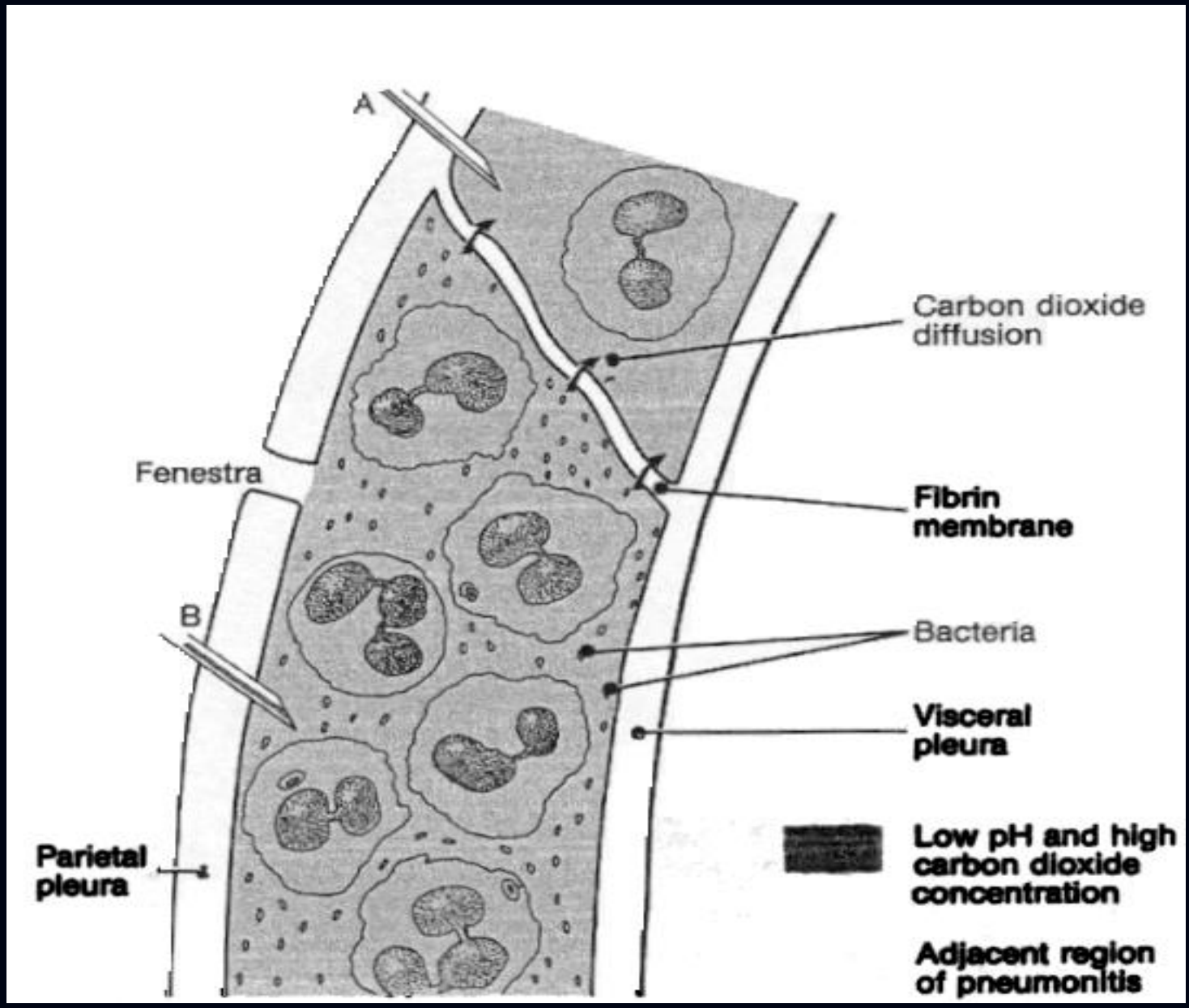
Fibropurulent → Organization



Question

- Which of the following is the best indicator of a complicated parapneumonic effusion?

A. LDH
B. Glucose
C. pH
D. WBC


A
Carbon dioxide diffusion
Fenestra
Fibrin membrane
B
Bacteria
Visceral pleura
Parietal pleura
Low pH and high carbon dioxide concentration
Adjacent region of pneumonitis

Heffner et al; Pleural fluid chemical analysis in parapneumonic effusions. A meta-analysis Am J Respir Crit Care Med 1995 152(2):823

Review of 7 studies showed **ph is most accurate** in discerning b/w uncomplicated and complicated PPE

Treatment

- Abx and Drainage are Crucial
- Drainage Needs to be Prompt
- Consult Pulm Early !!
- Chest Tube + TPA + Dnase

  Can Improve Imaging, reduce hosp days and Surg referrals……. *N Engl J Med 2011;365:518-26*

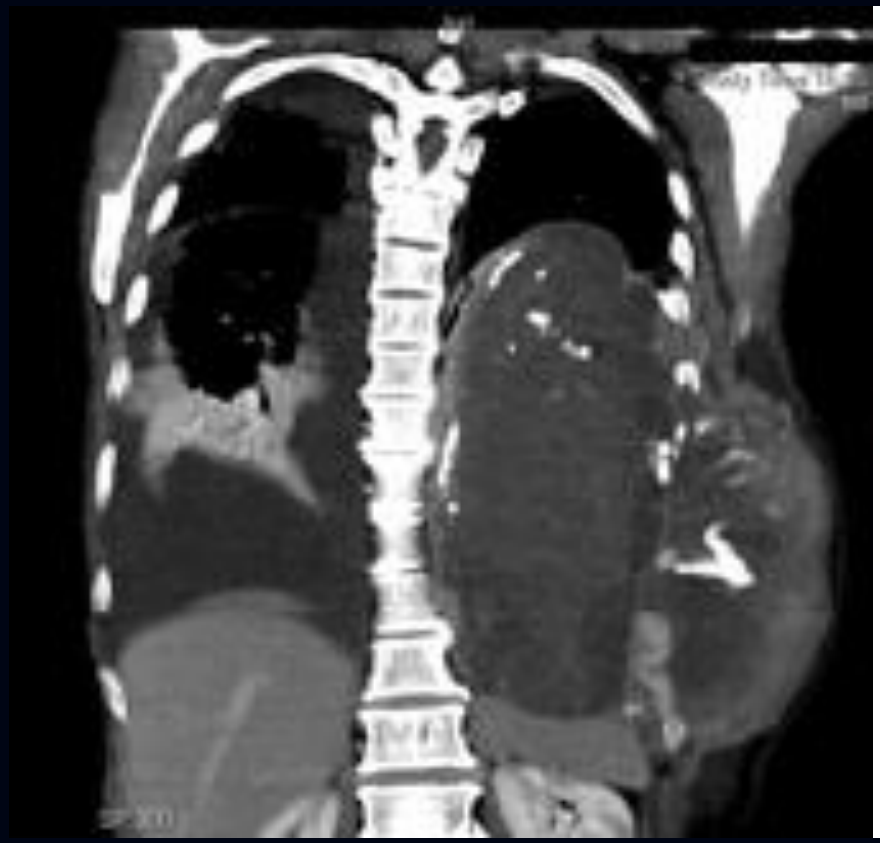
Chest Tube Fibrinolytics

- Ask IR to place Chest tube with 3 way stopcock

- Ask pharmacy to make up mixture of ***TPA 10mg and Dornase 5mg and 20cc of saline in syringe to instill***

- Instill into chest tube and clamp of chest tube x 1 hour then open to suction

Record output from tube



Empyema Neccessitans


BRAVEHEART AND THE PASSION OF THE CHRIST
HACKSAW RIDGE
ONE OF THE GREATEST HEROES IN AMERICAN HISTORY NEVER FIRED A BULLET
NOVEMBER 4

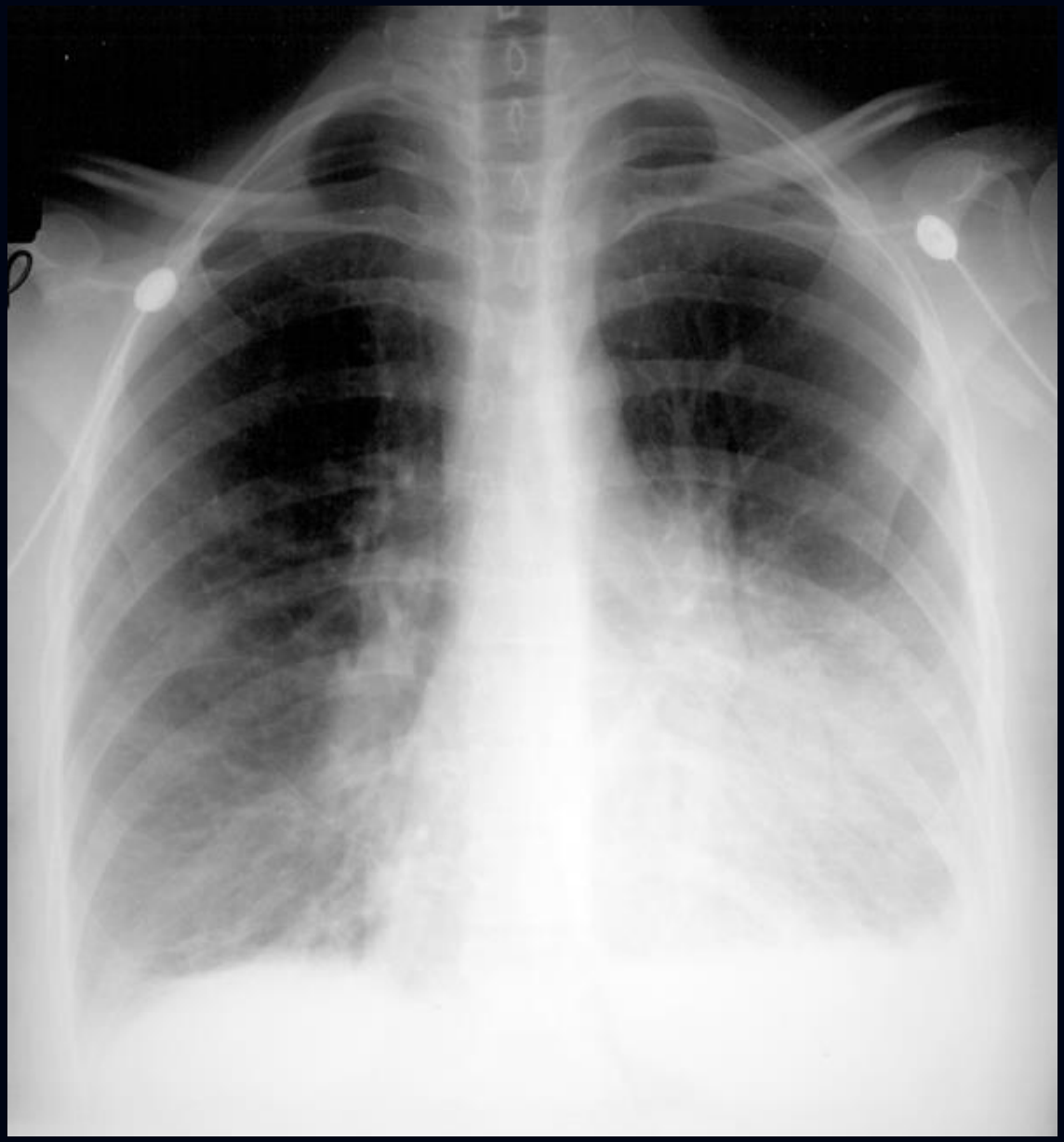
Objectives

- Pleural Anatomy and Pathophysiology
- Exudative vs Transudative
  - Lights
  - Heffner
- Causes of Exudative vs Transudative
- Thoracocentesis and Fluid Analysis
- Parapneumonic Effusions
- ***Special Cases***

Case

- 45 y/o M with ESLD presents with progressive abd distension and SOB x 2wks.

- CXR is shown.



Case

All of the following are true except

A. Hepatic Hydrothorax is likely

B. Isolated L effusion excludes hepatic hydrothorax

C. Cause of pleural effusion with pleural TP <1

D. Chest Tube drainage is contraindicated

E. Even Chinese people find Dr Wong hard to understand

Hepatic Hydrothorax

- Incid: 6%
- Usually have Ascites
- 70% R side
  15% L side
  15% Bilat
- Transudative with low protein (often <1)
- MAA scan of Peritoneal and Pleural Cavity

Hepatic Hydrothorax

- If Pleural fluid

  Segs > 500 + neg cult

  Segs > 250 + pos culture

  → **Spontaneous Bacterial Pleuritis**

- Do not need Peritonitis to have SBPL/SBE

  (40% cases have no SBP)

  (25% cases with no clinical ascites)

Hepatic Hydrothorax

- Diuresis

- Intermittent Thoracocentesis = Okay early on

- ***Chest Tubes = Avoid = leads to vol, prot, Ig loss***

- Pleurodesis = rarely effective

- Indwelling Catheters = Palliative

Special Cases

- Malignant Effusions
  - Can be Transudative (15%)
  - Can be Exudative
  - Highest yield on Pleural Fluid Cyto if Metastatic

    Adeno CA

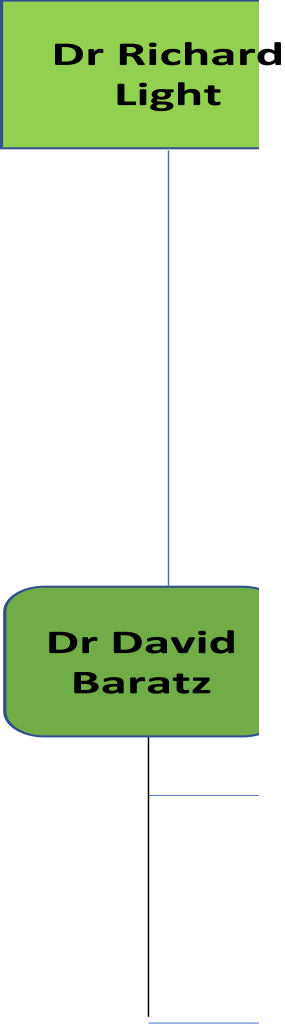
- Pleural Biopsy indicated for Effusion of unknown Etiology

Take Home Points

- Most common Transudative effusion is CHF
- Most common Exudative effusion is PNA
- 3 Lights Criteria is 99% specific for Transudative effusion
- Heffner Criteria (LDH + Pleural Chol > 45) is 99% specific for exudative effusion
- 3 Most common causes of Exudative and Trans Effusion
- Be careful using Vacutainers for smaller effusions, Avoid > 2 attempts

Take Home Points

- USS guidance for Thoracocentesis.
- Post thora = If Lung Sliding present post thora = 100% NPV for no PTX
- Re-expansion Pulm Edema is not that common, control RATE rather then volume
- Parapneumonic effusions = if it layers ----Tap it…CALL US
- Hepatic Hydrothorax, Leave them alone, Tap if symptomatic….don't place chest tube !!
- Pleural biopsy indicated for effusion of unknown etiology



Dr Mathew

You all