Investigation of Lung Diseases

Objectives:

1. Type of pulmonary diagnostic procedures
2. Role of various specialized pulmonary procedures in diagnosing lung diseases
3. When to apply specific tests

★ **Resources Used in This lecture:**

Slides , kaplan CK and video, davisone , radiopedia.com , uptodate

Done by: Rawa AlOhali & Hadeel AlSulami
Revised by: Reem Labani & Hussain Alkaff
Special thanks: Abdulrahman Alkaff

1. Pulmonary function tests (PFT's)

Mainly for

1- Categorization of different types of lung diseases→ Knowing whether it restrictive or obstructive.

2- Assessment of diseases severity e.g. pre – operation or stage of obstruction.

3- Post-treatment evaluations of lung function: easement of drug efficacy.

TEST	What is it ?	Measure
Spirometry	- Measures the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled. - Assess abnormality in airways ★ Indication: Obstructive lung disease→ Asthma, COPD ★ Suggest restrictive lung disease but can't diagnose.	**(FEV1 , FVC , FEV1\FVC)** (FEV_1[1]): is the volume exhaled in is disproportionately in the first second. → predicted[2] >90% (FVC[3]) is the total volume exhaled → predicted >90% - FEV1/FVC = >75 ★ If ratio is less than 75→ obstructive ★ If ratio normal or more → suggest Restrictive (but must confirm with → volume test)
Lung volumes	Measure lung capacity ★ Diagnose restrictive lung disease ★ Diagnose air trapping ★ Suggest obstructive lung disease	- Total lung capacity (TLC) [4] : value of gas in lung after maximal inspiration , >90% predicted - Vital capacity (VC) : the greatest volume of air that can be expelled from the lungs after taking the deepest possible breath. >90% predicted - Residual Volume (RV) : lung volume representing the amount of air left in the lungs after a forced exhalation; - RV :[5] > 90% predicted ★ If TLC , VC , RV< 90→ it is restrictive.
Diffusion capacity	- Measure the ability of gases to diffuse from the alveoli into the pulmonary capillary (Gas exchange) - By giving patient → Carbon monoxide (CO),not normally present in lungs or blood but it's more soluble in blood than lung tissues. - Inhalation of small amount of CO Reflect loss or damage to the gas exchanging surface of the lung. Normal: >80%	★ Decrease in: Emphysema, interstitial lung. diseases & Pulmonary vascular disease. ★ Normal in diseases that affect upper part of respiratory system e.g. bronchitis. ★ DLCO is normal or increased in Asthmatics. ★ Increased DLCO in : alveolar hemorrhage that is caused by (wegener disease, goodpasture syndrome and SLE).

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[1] The forced expired volume in 1 second
[2] Means normal.
[3] the forced vital capacity
[4] Total lung capacity
[5] Residual volume

Respiratory muscle strength	Measured by pressure transducer at the mouth when subject make a maximal inspiratory effort from full expiration or maximal expiratory effort from full inspiration. ★ Diagnose diseases that affect the muscle in Resp. system.	PImax, PEmax PI→ reflect inspiratory muscles as diaphragm. PE → expiratory muscles as abdominal muscles. ★ Motor neuron disease, metabolic disease, C.T disease (myositis), Drugs (steroids for long period).

- Spirometry should be repeated following inhaled short-acting β 2 adrenoceptor agonists (e.g. salbutamol); a large improvement in FEV1 (over 400 mL) and variability in peak flow over time are features of→ asthma.
- ● Remember we can't diagnose restrictive lung diseases from spirometry.
- ★ **First** To differentiate if it is obstructive or restrictive →by spirometry, **Secondly** we give bronchodilator to know if it's reversible (asthma) or irreversible (COPD), **Lastly** →DLCO to know what type of COPD is it (emphysema → decreased, bronchitis → normal).

19.4 How to interpret respiratory function abnormalities

	Asthma	Chronic bronchitis	Emphysema	Pulmonary fibrosis
FEV$_1$	↓↓	↓↓	↓↓	↓
VC	↓	↓	↓	↓↓
FEV$_1$/VC	↓	↓	↓	→/↑
TL$_{CO}$	→	→	↓↓	↓↓
K$_{CO}$	→/↑	→	↓	→/↓
TLC	→/↑	↑	↑↑	↓
RV	→/↑	↑	↑↑	↓

(RV = residual volume; see text for other abbreviations)

Spirometry Interpretation Overview
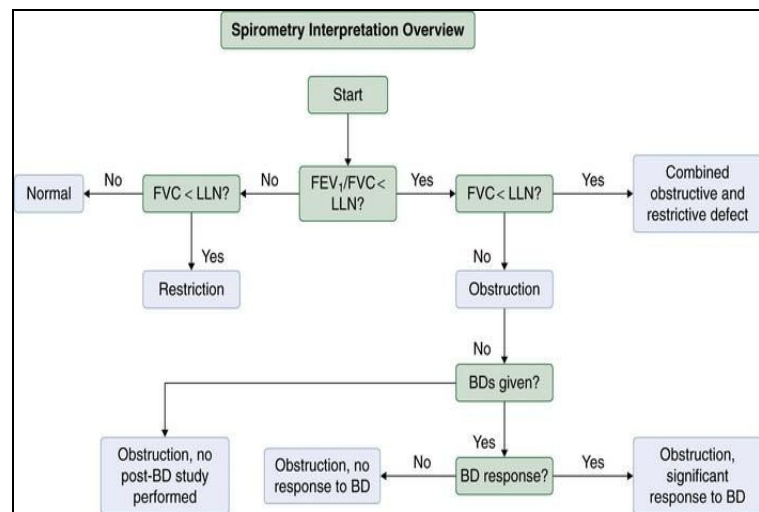
2. Thoracentesis

is a procedure to remove fluid from the space between the lining of the outside of the lungs (pleura) and the wall of the chest for diagnostic or therapeutic purposes. Ex: Pleural effusion & Empyema[6]. Fluid is removed (drained) from the pleural cavity with a **needle (aspiration).**

The needle is always inserted above the ribs → Because all the vessels are below the ribs.

[6] Pus in pleural cavity

Before doing the procedure you have to do		
laboratory tests	**1) Complete blood count** Make sure that this patient does not have **bleeding diathesis**. ★ if the platelets count is less that 50,000 mcL, you will not insert your needle)	
	2) Coagulation profile ★ PT,INR,APTT + Ask is the patient is taking any coagulation modifiers.	
	3) Kidney function ★ Check for uremia → it can affect **bleeding time**.	
Confirm Pleural Effusion	**1) Decubitus film** ★ Can determine whether fluid is free flowing or loculated, fluid have to be >1cm.	
	2) Ultrasounds ★ To know the depth of the needle, how far you want to go.	

What to look for in thoracentesis?

1. Appearance
   a) Blood→ Hemothorax
   b) Pus→ Empyema (indicating infection)
2. Gram stain, and cultures
   a) If positive→ complicated parapneumonic effusion (infected pleura)
3. pH
   a) If acidotic → empyema, renal failure
4. Chemistry (glucose, amylase, LDH[7], protein)
5. Cytology

Complication of thoracentesis:

- Pneumothorax
- Bleeding
- Infection
- Hypotension
- Hypoxemia
- Air embolism
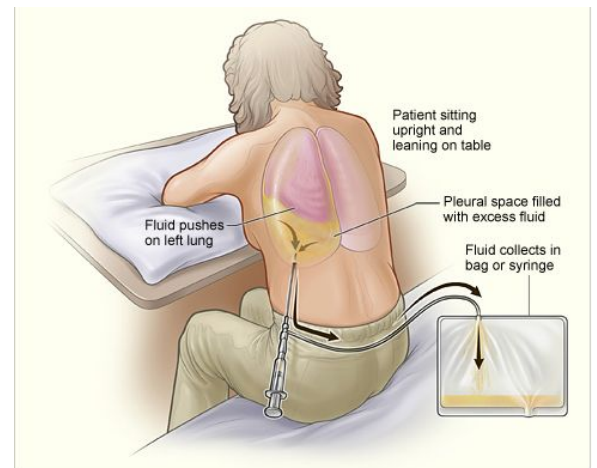
> NEVER do thoracentesis for patient with collapsed lungs → you well cause pneumothorax on top of collapse.
>
> Instead, do bronchoscope.

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[7] Lactate dehydrogenase

Type of Fluids

Transudate or Exudate? only needs 1 to be positive to be classified.

| LIGHT CRITERIA	Transudate	Exudate
LDH effusion	<200 IU/mL	>200 IU/mL
LDH effusion/serum ratio	<0.6	>0.6
Protein effusion/serum ratio	<0.5	>0.5

> 💡 **NOTE:** If the fluid's appearance is Pus→ Gram stain positive→ pH below 7.2 → **Chest tube immediately**
>
> ★ You have to drain it immediately or else it will heal by fibrosis

Indication for chest tube insertion

- Empyema
- Complicated parapneumonic effusion
- Symptomatic pleural effusion
- Hemothorax
- Pneumothorax
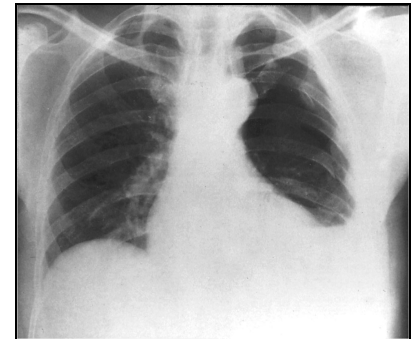
> **Difference between Pneumonia and Pleural effusion**
>
> 1- Tracheal deviation presents in pleural effusion while absent in pneumonia.
> 2- In tactile fremitus : Reduced vocal resonance in pleural effusion while increased in Pneumonia.
> 3- In percussion: Stony dullness in pleural effusion while dullness in pneumonia.
>
> **Difference between pleural effusion and lung collapse**
>
> 1- In collapse, you won't hear the bronchial breath sound.
> 2- Stony dullness doesn't appear in lung collapse. 💡

3. Pleural Biopsy

A procedure in which a sample of the pleura (parietal) is removed with a special biopsy needle or during surgery to determine if **Granulomatous disease, malignancy or another condition is present.**

Indication of pleural biopsy

- **Exudative effusion** without pus or blood, gram stain and pH is 7.20.
- Recurrent pleural effusions of unknown etiology.
- Pleural mass or thickening.
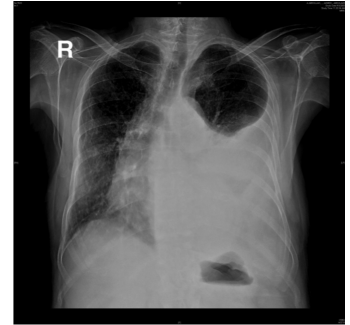
4. Bronchoscopy:

Bronchoscopy is an instrument inserted from the mouth or nose for an endoscopic technique of visualizing the inside of the airways for **diagnostic and therapeutic** purposes.

Diagnostic indication	Therapeutic indication
- Suspected lung cancer - Abnormal CXR - Hemoptysis - Unexplained cough - Localized wheeze - Positive sputum cytology	- Remove foreign bodies - Remove abnormal endobronchial tissue - Difficult endotracheal tube intubation - Endobronchial stent placement

> NOTE: When we want to visualize the trachea we go by the bronchoscopy only through the tracheal lumen . But when you have mediastinal lymph node and you want to see them or take a biopsy the scope can't do it→ Instead, we use endobronchial ultrasound.
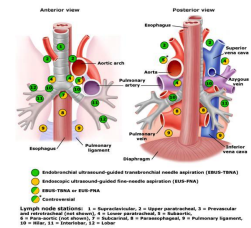
5. Computed tomography (CT)

Provides detailed images of the pulmonary parenchyma, mediastinum, pleura and bony structures.

6. HRCT (high resolution ct scan)

Designed for detailed evaluation of interstitial structures of the lung ,Use narrow slice thickness (1-2 mm) compared with 5-10 mm for routine scan.

Principal indications

- Suspected interstitial lung disease
- Characterization of interstitial lung disease
- Characterization of solitary pulmonary nodules
- Diagnosis of bronchiectasis

> Provide detailed images of the pulmonary parenchyma and is particularly useful in assessing diffuse parenchymal lung disease, identifying bronchiectasis and assessing type and extent of emphysema.

7. CT Angiography (spiral CT)

Inject the patient with contrast→ rapid helical images taken very quickly and reconstructed→ you see everything white. If you saw black area there is an area of defect (most likely PE).

Advantage	Contraindications
● Critically ill patients ● Children ● Less volume of intravenous contrast ● Permits greater processing of the raw data	● Renal failure ● Allergy to contrast ● Pregnancy

> 💡 ● Gold standard for the confirmation of Pulmonary Embolism diagnosis.
> ● We have to do V/Q scan instead of CT angiography if the patient is contraindicated to confirm→ PE.

8. Lung Scans: V/Q (Ventilation/ Perfusion scan)

Technetium (Tc) radionuclide is tagged to macroaggregated albumin to make small radioactive particles,When Tc decays→ it emits a gamma ray detected by the nuclear medicine gamma camera→ a nuclear medicine image is formed by detection of many gamma rays.

Ventilation	Perfusion
- Radioactive tracer gas inhaled to lungs → picture here shows areas of lung that are not receiving enough air or retain too much air.	- Radioactive substance injected into the vein→ to lungs→ shows areas in lung which are not receiving enough blood.

> 💡 ● A normal scan essentially exclude a clot → the chance of PE is ZERO.
> ● V/Q is first only in the pregnancy → for diagnosis of Pulmonary embolism.
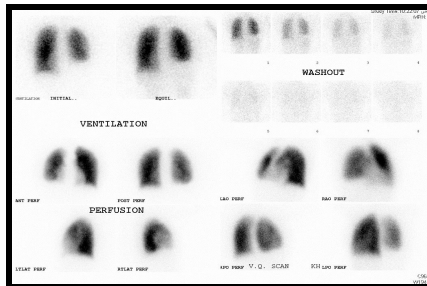
Normal
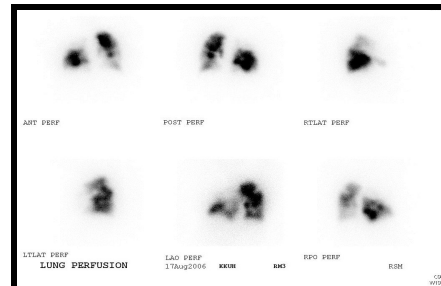
P.E Note: The decreased perfusion
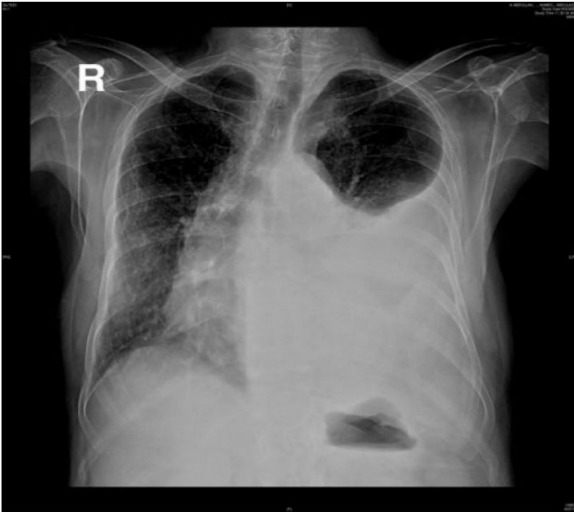
Cases:

Scenario 1

History: 33 years old male present with cough, fever and SOB for 3 days.
Physical exam: Tracheal deviation to the opposite side, stony dullness , absent vesicular breath sounds and heard bronchial breath sound above the affected area.
Investigation: CXR shows Pleural effusion.

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Answer:
Diagnosis: is Parapneumonic effusion (we don't know if it is complicated or not).
Steps of management of patient:
 1- Give patient oxygen and check ABC (airway, breathing , circulation)
2- Order CBC, Liver function tests, Renal function tests. Patient with renal failure have sticky platelets ,so we can't do thoracocentesis.
3- Ultrasound or lateral decubitus to determine the site and depth of applying thoracocentesis.
4- Thoracocentesis: check 5C (Cytology, Culture, cell count , chemistry and color).
Notes : If the pleural fluid contains pus (empyema) or blood (hemothorax), we have to drained fastly by chest tube.

Scenario 2

 History: 55 years old male patient with unknown origin of fever for 6 months with reported weight loss.
Physical exam: Stony dullness in percussion , absent breath sound on affected side, tracheal in center.
Investigation: CXR reveals pleural effusion.
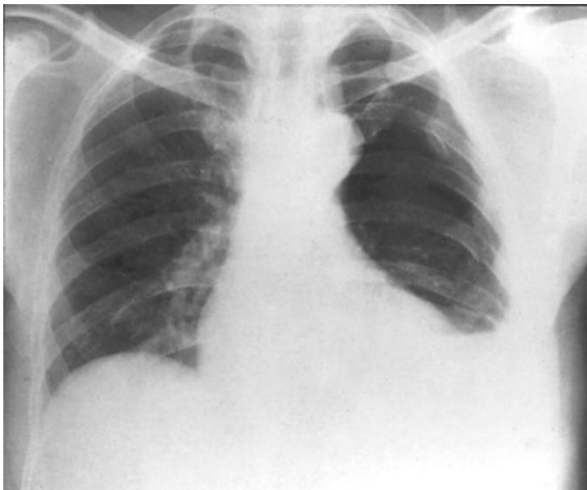
Answer:
→ Needs pleural biopsy
Diagnosis: Malignancy or TB

Scenario 3

History: 30 years old male patient present with sudden SOB for a day.
Physical exam: Tracheal pulled to affected side, dullness in percussion and absent breath sounds.
Investigation : CXR reveals atelectasis (lung collapse) and there is obstruction in bronchi.

Answer:
Diagnosis: by bronchoscopy

Senario 4

History: 50 years old male with SOB and cough for 3 years.
Physical exam: Clubbing and bilateral inspiratory crackles.
Investigation: •CXR: reticulation bilateral •ABG: hypoxic respiratory failure •PFT: restrictive defect with significant impairment in DLCO
Answer :
Diagnosis is done by HRCT because we would like to look for lung parenchyma.

Scenario 5

History: 45 years old female with Right sided chest pain for 1 day
Investigation: 1- ABG : pH 7.32, $PaCO_2$ 28, PaO_2 50, O2sat 88% 2-ECG: sinus tachycardia 3- CXR : normal
Answer:
Diagnosis is most likely is pulmonary embolism → confirm by CT angiography.