# INVESTIGATIONS OF LUNG DISEASES

## MADE BY; MEDICINE TEAM

Including the lecture outlines said by the doctor

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unclear notes justified from online and Davidson's

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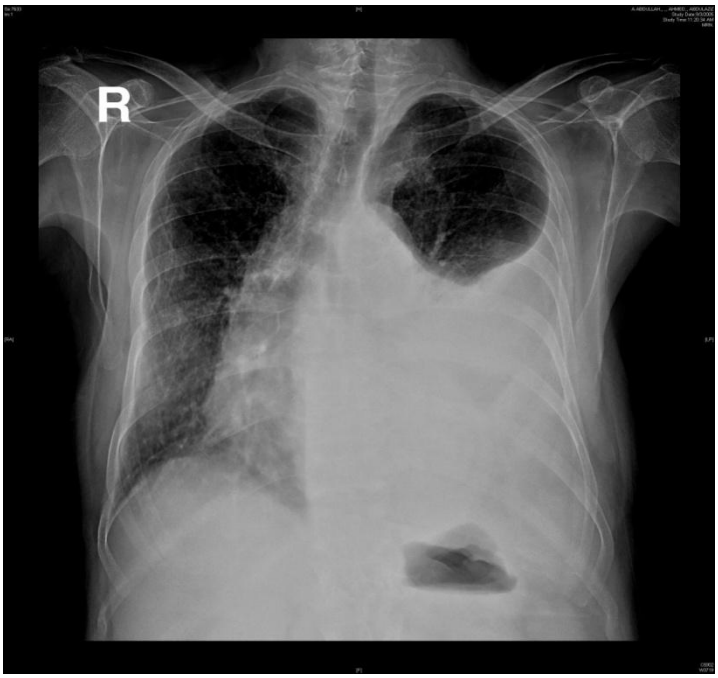
## 1. Case of acute pleural effusion

**30 years old male presented with** cough**,** fever **and** shortness of breath **for** 1 week. **On** *Clinical Examination***, he** looked sick **with blood pressure of** 100/80mmHg, **oxygen saturation of** 90% **and temperature of** 38°C. **He has** reduced chest expansion on left side **which also showed** stony dullness on percussion **and** absent breath sounds**. Chest X-ray is the following:**




**A)** Diagnosis Left **pleural Effusion. (supported through CXR and physical examination)**

**Not** pneumonia (consolidation) because:

**- On Physical Exam: Breath sounds wont be absent and there wont be dullness.**

**- On CXR: layering of fluid which is going to the bases.**

**(when you see a sliding layer, it's 100% pleural effusion)**

Pleural Effusion

**The accumulation of serous fluid in pleural effusion, frank pus in empysema, blood in hemothroax, and chyle (lymph fluid) in chylothorax. If it's** *Transudate***, it accumulates due to *increased hydrostatic pressure* or *decreased osmotic pressure* (as seen in cardiac, liver, or renal failure). If it's** *Exudative***, it accumulates due to *increased microvascular pressure* in diseases of the pleural surface itself, or injury to the adjacent lung.**

**B)** Approach

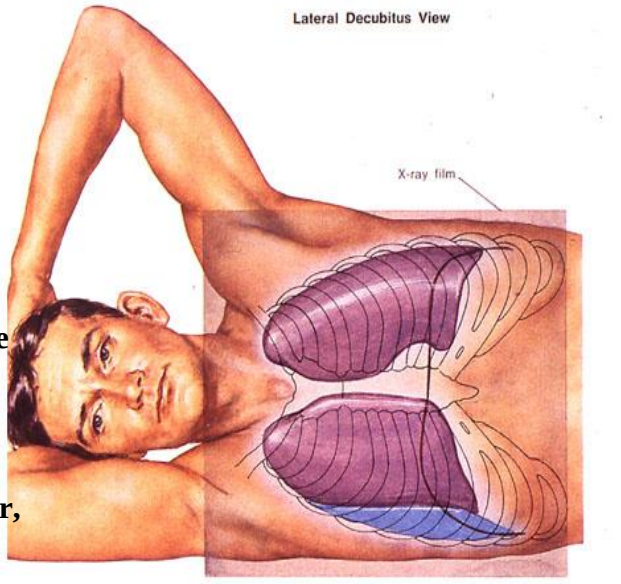
- Check for ABC **(Airway, Breath and Circulation) to make sure he is safe.**
  **1- if hypoxic, give $O_2$.**
  **2- BP is borderline (he is going into sepsis) then give IV cannula.**
- Order a CBC **(Cell Blood Count) which is <u>always</u> requested to check the three:**
  **1- WBCs (infections?). 2- Hemoglobin. 3- Platelets (coagulation status).**
- Order ABG **(Arterial Blood Gas) to check for values of:**
  **1- $PO_2$ 2- $PCO_2$ 3- PH**

**C)** Intervention: **Aspiration of pleural fluid, but before so, we make sure of patient's position:**

- **Patient's concent about complications from this procedure (list without terrifying him):**
  - **Pneumothorax**
  - **Inserted needle below the costal rib (where veins and arteries are) may cause bleeding (should always be <u>above</u>)**
  - **Hypotention or hypoxia due to draining huge amounts. (more than 1.5 liters in one episode is inadvisable).**
  - **Air embolism**
  - **If the insertion was too low, it may cause a splenic and liver laceration**
- **Platelets count (there will be a needle introduced which might trigger bleeding)**
- **The type of the fluid if it's free or not. Must make sure it is free either by: (free gathers on the affected site while not-free one gathers in separate sites).**
  - **Decubitus film (ask patient to lay on affected site and if fluid is free it will move)**
  - **Nowadays, Ultrasound guided thoracentitis which shows immediately where the fluid is.**

Fluid Aspiration:

- **Epicardiocentesis (epicardium)**
- **Paracentesis (abdomen)**
- **Thoracocentesis (chest)**




**D)** Causage:

**It should be made immediately on the spot. If it was hemorrhagic or pussy (empysema or hemothorax), the management changes. If it was in between (you couldn't tell), we proceed in work up and gram stain:**

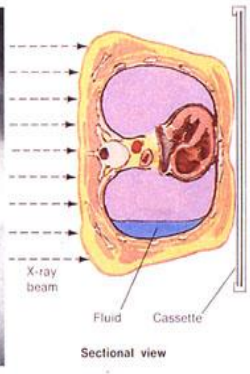
Fluid Chemesitry and Cytology:

- **Analyze fluid PH (acidic: empysema, cancer, rupture of the esophagus, ruputure of a splenic pseudocyst).**
- **Transudate or Exudate?**

Light's Criteria: **pleural fluid of** *one or more* **of the following criteria are met:**

- ☑ ***Pleural fluid* protein: *Serum* protein ratio > 0.5**
- ☑ ***Pleural fluid* LDH: *Serum* LDH ration > 0.6**
- ☑ ***Pleural fluid* LDH is > from two thirds of the upper limit of normal *serum* LDH.**

lateral decubitus x-ray film: fluid in r. pleural space



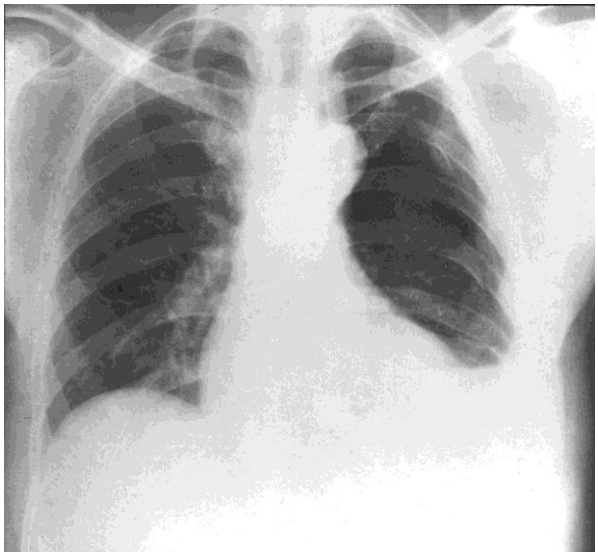

Insertion of Chest Tube: **(Large bar catheter to evacuate in a rush).**

**When the pleural fluid is:** Gram +ve, Pussy and acidic **(PH>7.2) to prevent complicatons.**

***Naural healing of an infection is*** *fibrosis* ***which is a complication here that's called*** *Fibrothorax* ***which is a major tragedy (needs surgery that has a high incidence of morbidity and mortality).***

## 2. Case of chronic pleural effusion

**45 years old male, was in prison 6 months ago, came complaining of** fever **and** night sweats **over the past 3 months and** shortness of breath **since 2 months. On Physical examination he appeared fine with no obvious illnesses. Blood Pressure and hemodynamics were normal. $O_2$ Saturation was normal. While respiratory examination, he had** stony dullness on percussion **at the base of the lung, and** absent breath sounds **at the same place. Chest X-ray was the following:**



**A)** Diagnosis: **Left chronic pleural effusion**
**(limited differential diagnosis due to history: in prison?** TB. **Smoker?** Lung Cancer**)**

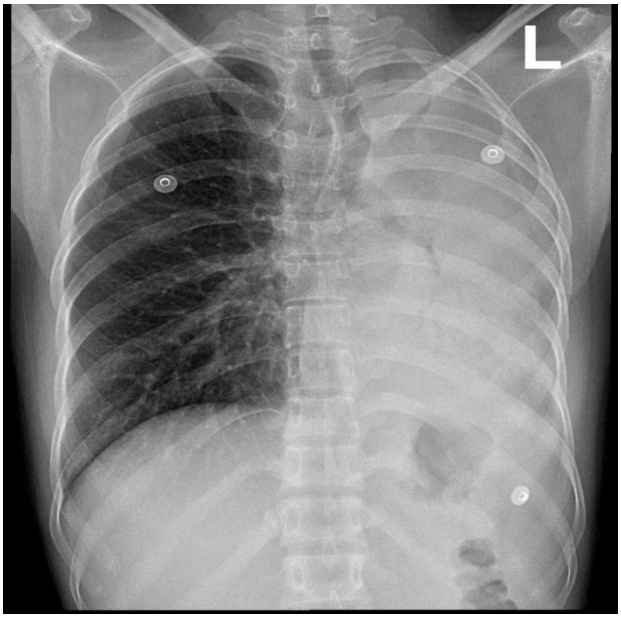
**B)** Approach: ***same as acute pleural effusion***

**C)** Intervention:

- Thoracocentesis: **if the aspirate was** *exudates***, we still can't tell if it's TB or cancer (it may give a hint by lymphocytosis and low sugar in pleural fluid).**
- Pleural biopsy: **to rule out if cancer or TB.**

## Case of Lung Collapse

**30 year old male with no prior medical illness presented with** shortness of breath **for 3 weeks. He denied any history of fever or hemoptysis. On physical examination, his blood pressure was** 100/60mmHg**.,** 80% $O_2$ Saturation **and temperature of** 37°C. **To exclude effusion, we do Chest X-ray:**




**A)** Diagnosis: Left Lung Collapse

**- Complete opacity of right side.**
**- Trachea shifted to affected side.**
**(if a massive pleural effusion, it would've shifted into opposite side).**
**- Cut-off sign (sudden loss of air in left bronchus).**

**B)** Approach: ***same*** **in addition to:**

Bronchoscopy: **(a tube with camera inserted through the airway – nostril or mouth). a diagnostic and therapeutic procedure.** Diagnostic Indications:

- **Suspected lung cancer.**
- **Abnormal CXR**
- **Unexplained cough**
- **Positive sputum cytology**
- **Unexplained pleural effusion**
- **Staging of lung cancer**
- **Airway trauma**
- **Diffuse lung disease**
- **Refractory cough**
- **Hemoptysis**
- **Localized wheeze**
- **Mediastinal lymph nodes**
- **Lung abscess**
- **Obtain culture material**
- **Tracheoesophageal fistula**

Therapeutic Indications:

- **Remove foreign bodies**
- **Remove abnormal endobronchial tissue**
- **Endobronchial stent placement**
- **Difficult endotracheal tube intubation**

Endoscopic Bronchoscopy Ultrasound-Guided (EBUS):
**Introducing scope inside the airway and have it connected to US to see the lymph nodes and aspirate from them.**

## 3. Other modalities of Lung Disease Investigations:

Pulmonary Function Tests **(4 main tests)**:

### a. Spirometry[i]:

**The most common of the** *lung function tests***. It measures the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled, which might be affected in some of the diseases such as** COPD, asthma **and** restrictive lung defect **(**pulmomary fibrosis **and** cystic fibrosis**).**

**The most common measurements used are:**

1. Forced expiratory volume in one second (FEV1). **This is the amount of air you can blow out within one second. With normal lungs and airways you can normally blow out most of the air from your lungs within one second.** Predicted to be > 90%.
2. Forced vital capacity (FVC). **The total amount of air that you blow out in one breath.** Predicted to be > 90%.
3. FEV1 divided by FVC (FEV1/FVC). **Of the total amount of air that you can blow out in one breath, this is the proportion that you can blow out in one second.** Predicted to be > 75%

**Less than 75:(COPD) Obstructive Lung Disease.**
**More than 76: suggests RLD (restrictive lung disease).**
**When giving inhalers it improves: bronchial asthma**

### b. Lung Volumes:

**Measurements of lung volumes are important to confirm or clarify the nature of lung disorders. The flow volume loop (spirometry) may indicate an obstructive or restrictive or obstructive/restrictive pattern, but a further test of lung volume is often necessary for clarification especially for restrictive diseases[ii]. Also diagnoses Air Trapping (obstructive). There are four lung volumes and four lung capacities.** *The four lung volumes*[iii]**:**

- **Tidal volume (TV):** Volume inspired or expired with each normal breath.
- **Inspiratory reserve volume (IRV):**
  Maximum volume that can be inspired over the inspiration of a tidal volume/normal breath. Used during exercise/exertion.
- **Expiratory reserve volume (ERV):**
  Maximal volume that can be expired after the expiration of a tidal volume/normal breath.
- Residual volume (RV):
  Volume that remains in the lungs after a maximal expiration **(how much air trapping)**. Predicted > 90%

*The four lung capacities* **(the summation of volumes):**

- Total lung capacity (TLC):
  The volume of the lung after maximal inspiration.
  (The sum of all four lung volumes). Predicted > 90%
- **Inspiratory capacity (IC):** Volume of maximal inspiration.
- **Functional residual capacity (FRC):**
  Volume of gas remaining in lung after normal expiration
- **Vital capacity (VC):** Volume of maximal inspiration and expiration.

## c. Diffusion Capacity (DL):

**Measurement of the single-breath diffusing capacity for carbon monoxide (DLCO). Measures the ability of gases to diffuse from the alveoli into the pulmonary capillary blood. CO is not normally present in lungs or blood and it is more soluble in blood than in lung tissues[III].**

If it was increased (↓DLCO), **it reflects:**

- **Loss or damage to the gas exchanging surface of the lung**
- **Emphysema (distinguish emphysema from chronic bronchitis or chronic asthma).**
- **Interstitial lung disease**
- **Pulmonary vascular disease**

## d. Respiratory Muscle Strength:

**Measurement of maximal inspiratory and expiratory pressures is indicated whenever there is an unexplained decrease in vital capacity or respiratory muscle weakness is suspected clinically. Maximal inspiratory pressure (PImax) is the maximal pressure that can be produced by the patient trying to inhale through a blocked mouthpiece. Maximal expiratory pressure (PEmax) is the maximal pressure measured during forced expiration (with cheeks bulging) through a blocked mouthpiece after a full inhalation[III].**

PImax; **reflects Diaphragm, and** PEmax; **reflects Abdominal muscles.**

**If there's abnormality, it would be either a *motor* or a *neuron* disease.**

**(e.g. gullain barre disease; acute inflammatory demyelinating polyneuropathy)**

| SPIROMETRY | Pred | Pre | %Pred/P |
|---|---|---|---|
| FVC (L) | 5.04 | 3.13 | 62.1 |
| FEV 1 (L) | 4.25 | 2.53 | 59.5 |
| FEV 1 FVC | | 80.91 | |
| MMEF 75/25 (L/s) | 4.93 | 2.46 | 49.9 |
| PEF (L/s) | 9.73 | 7.88 | 81 |
| FIF (50 (L/s) | | 4.09 | |
| FEF 50 (L/s) | 5.45 | 4.23 | 77.6 |
| **BODY PLETHYSMOGRAPH** | | | |
| VC (L) | 5.27 | 3.13 | 59.4 |
| TLC (L) | 6.9 | 4.51 | 65.4 |
| ITGV (L) | 3.25 | 3.58 | 110.2 |
| ERV (L) | 1.59 | 2.2 | 138.4 |
| RV (L) | 1.66 | 1.38 | 83.1 |
| RV % TLC | 24.49 | 30.58 | 124.9 |
| PI MAX (kPa) | 10.96 | 7.11 | 64.9 |
| PE MAX (kPa) | 14.51 | 11.55 | 79.6 |
| **DIFFUSING CAPACITY** | | | |
| TLCO SB (mmol/min/kPa) | 11.63 | 5.27 | 45.3 |
| Hb (g/100ml) | | 16.2 | |
| TLCOc SB (mmol/min/kPa) | 11.63 | 5.06 | 43.5 |
| KCO (mmol/min/kPa) | 1.68 | 1.54 | 91.7 |
| TLC-He (L) | 6.75 | 3.42 | 50.7 |

both Low, FEV1/FVC= 95.8% (High)
→ **ratio is high, low parameters (might be obstructive or restrictive)**

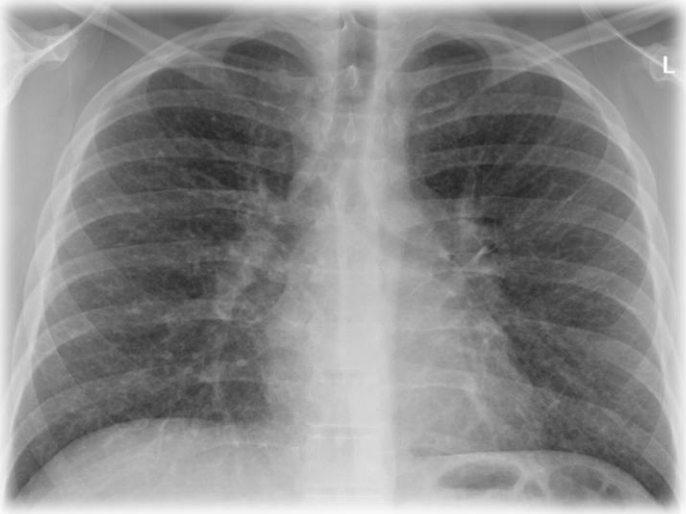
**Not air trapping → restrictive**

**Reduced muscle force**

**Impaired gas exchange**

## 4. Case of Intersitial Lung Disease

**50 year old male with** SOB **and** cough **for 3 years, examination showed** clubbing **and** bilateral inspiratory crackles**. CXR was ordered and it showed** bilateral reticulation**. On investigations, ABG results indicated** hypoxic respiratory failure, PFT **indicated** restrictive defect **with** significant impairment in Dlco.




Differential Diagnosis:

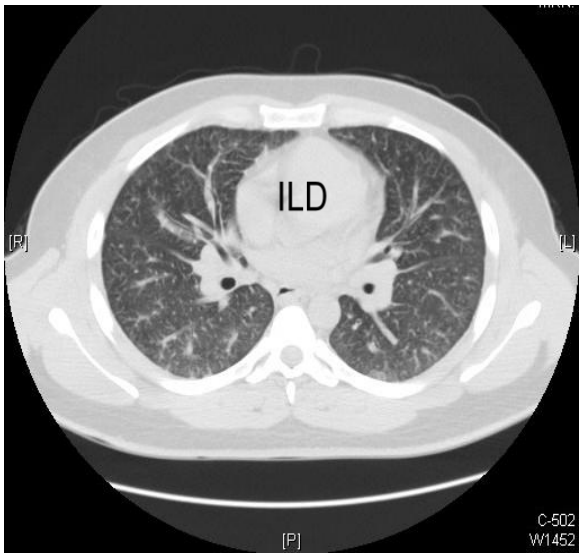
**History of long illness, bilateral crackles, reticulation of CXR and hypoxia, all suggests** interstitial lung disease. **To confirm, we do CT-scan**.

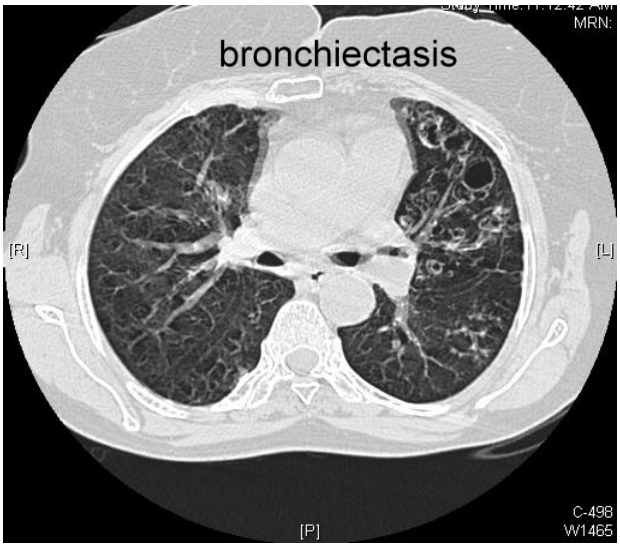
CT-scan types:
1- **V/Q scan**
2- **High Resolution CT scan**
3- **Spiral CT scan**

### HRCT-scan:

**Designed for detailed imagination evaluation of interstitial structures of the lung, uses narrow slice thickness of 1-2 mm. (narrow in comparison with 5-10 mm for routine scans). Its principle indications:**

- **Suspected** ILD
- **Characterization of the** ILD
- **Characterization of** solitary pulmonary nodules
- **Diagnosis of** Bronchiectasis



## 5. Case of Pulmonary Embolus

45 year old female with **right sided chest pain** for **1 day (acute onset).**
Differential Diagnosis:

- Pneumothorax (excluded with CXR)
- Pulmonary Embolus (Needs Spiral CT scan or V/Q scan).

Investigations:

**A)** ABG pH 7.32, PaCO2 28, PaO2 50, O2sat 88% → hypoxic respiratory failure?
**B)** EKG sinus tachycardia not pneumothroax
**C)** CXR normal (not pneumothorax)
**D)** CTscan→ patient with no allergy to contrast, spiral. Patient with allergy to it V/Q.

### Spiral CR:

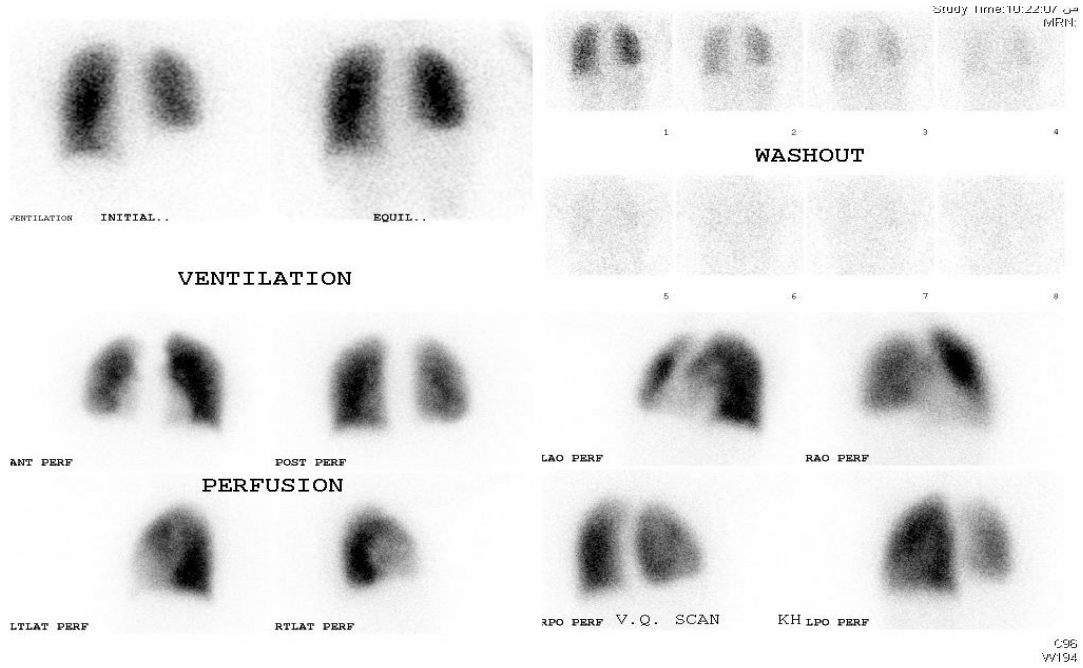
Image data are acquired continuously as the tube and detector rotate within the gantry and the patient moves continuously through the gantry. Gives pictures similar to the angiogaphy.
**With advantages:**

- Fast; for critically ill patients
- Suitable for children
- Less volume of IV contrast that angiogram
- Permits greater processing of the raw data

Pulmonary embolism in the Pulmonary Trunk >>>

## V/Q lung scans:

- Ventilation perfusion scan via **Technetium (Tc) 99 m** radionuclide, being 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. When injected via periphral venous site, the first capillaries encountered are the pulmonary capillaries
- **If perfusion is present at the capillary level of the lungs (normal),** nuclear medicine perfusion image demonstrate activity in the periphery of the lungs.
- **If there is an obstructing vascular lesion in the pulmonary arterial circulation → blocked perfusion to the distal capillary level → nuclear medicine perfusion image demonstrate no activity in the periphery of the lungs**




[i] http://www.patient.co.uk/health/Spirometry.htm

[ii] http://www.morgansci.com/choose-your-pft-solution/what-is-a-pft-test/pft-lung-volumes.php

[iii] http://en.wikipedia.org/wiki/Lung_function_test