Chest and Abdominal X-ray Interpretation: Honing Your Skills

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Disclosures

- Owner – Wright & Associates Family Healthcare @ Amherst and @ Concord
- Partner – Partners in Healthcare Education
- Speaker Bureau: Novartis, GSK, Sanofi-Pasteur, Takeda, Merck, Vivus, Boehringer
- Consultant: Vivus, Takeda, Sanofi-Pasteur

Objectives

- Upon completion of this lecture, the participant will be able to:
  - Identify a step approach to the interpretation of chest and abdomen
  - Discuss various abnormalities identified on x-rays of the chest and abdomen
  - Systematically interpret x-rays of the chest and abdomen

Radiography

- X-rays account for > 80% of all diagnostic studies ordered
  - Chest x-rays and extremity films are the 2 most commonly ordered x-rays
- X-rays are meant to be used in combination with the patient's history and physical examination to assist with an accurate diagnosis

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Remember…

- The goal of this workshop is not to make you a radiologist but…
- It will provide you with a great starting point to begin chest x-ray interpretation

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Radiography

- X-rays are made when an x-ray beam passes through an area on the patient producing different shadows on the films
  - The amount of shadowing is determined by the type of material or tissue the beam is flowing through
  - Denser structures such as bone absorb more x-ray whereas air (least dense of all) absorbs very little

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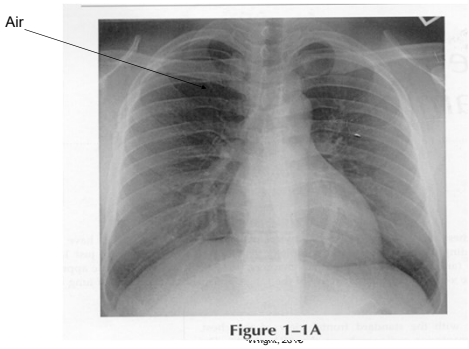
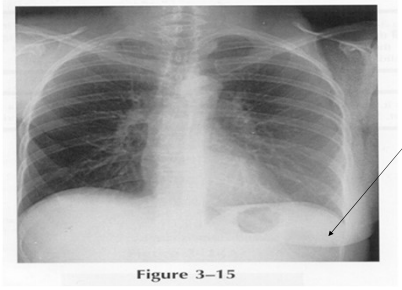
Four Basic Densities or Shades

- 4 basic shades/densities on a film
  - –Air: does not absorb much radiation
    - Air in the lungs – x-ray appears dark
  - –Fat: absorbs some x-ray beam
    - Appears gray on x-ray
    - Darker than muscle or blood

Figure 1-1A: PA View



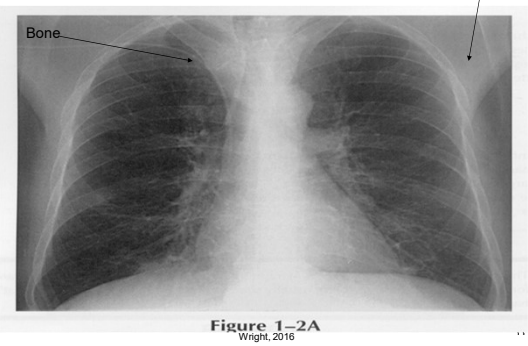
Fat



Four Basic Densities or Shades

- 4 basic shades/densities on a film
  - Water (blood and soft tissue)
    - Gray
    - Lighter than fat
  - Bone
    - Appear almost white on x-ray

Figure 1-2A: PA View



In Addition

- The following also appear white:
  - Metal
  - Contrast material

Terminology

- Density: brightness or any area of whiteness on an image
- Lucency: blackness on an image
- Shadow: anything visible on an image: any density or lucency
- Edge: visible demarcation between a density and a lucency
- Line: thin density with lucency on both sides
- Stripe: Any edge or line
- Silhouette: another term for an edge

Adapted from Procedures for Nurse Practitioners; Springhouse: Penn; 2001

X-rays

- Two dimensional look at the body (which is 3 dimensional)
  - Therefore, multiples views of an area are often standard
  - This is why PA and lateral views are often performed on the chest (in an upright patient)
  - Provides additional view that may identify something not visible on a single view

PA View

- Patient's chest is against the film
- X-ray beam passes from posterior region (patient's back) to the anterior region (chest)
- X-ray machine is approximately 6 feet away
- Great view of things that sit anterior:
  - This view is better to see the heart (because heart is anterior)

Figure 1-1A: PA View

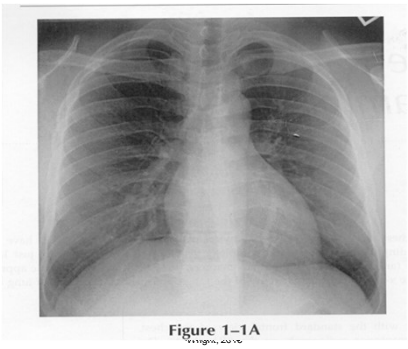


Figure 1–1A

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Figure 1 – 2B: Lateral View

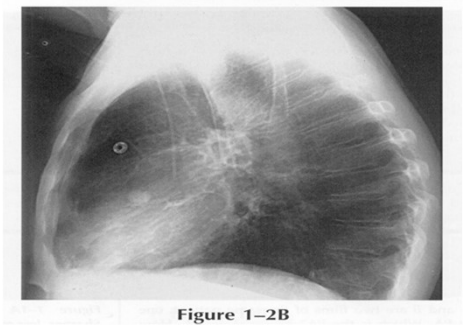

Figure 1–2B

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Additional Terminology

- Patient position
  - Supine
  - Upright
- Chest radiographs
  - PA (posteroanterior)
    - X-ray beam entered the patient posteriorly and exited anteriorly
  - AP (anteroposterior)
  - Left lateral decubitus
  - These terms refer to the direction in which the x-ray beam traversed the patient on the way to the film

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Basic Information

- First and foremost, x-ray interpretation requires a systematic, logical approach
- You must approach the x-rays in the same way every time to prevent omissions
- You must also have an understanding of basic anatomy and physiology
- So, let's begin…

Chest X-Rays

Indications for Chest X-ray

- Based upon your history and physical examination, a chest x-ray may be ordered to assess to:
  - Detect and assess lung disease
    - Pneumonia, CHF, COPD, Cancer
  - Assess for chest trauma
  - Placement of tubes/devices

Basic Information Regarding Chest X-rays

- The most common chest film is a PA film
  - Performed at a distance of 6 feet
- AP is often done on hospitalized patients (portable or supine film)
- If the clinician just writes for a Chest x-ray: Lateral view is also routine
  - Left side is against the cassette
  - Lateral view is essential for any lesions behind the heart, mediastinum, or diaphragm as these are often missed on a PA film

Figure 1-1A: PA View

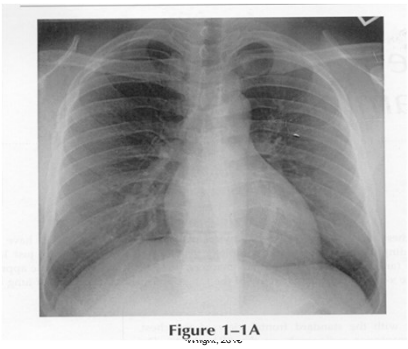

Figure 1–1A

Figure 1-1B: AP View

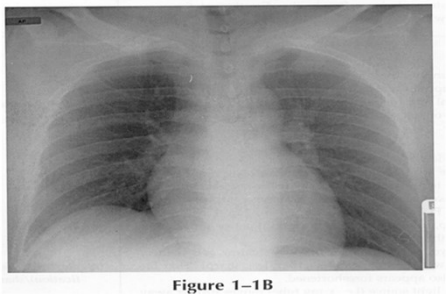

Figure 1–1B

Look at the differences

Chest X-rays

- Chest X-rays are performed with the individual in inspiration
- This causes the hemidiaphragm to descend to the level of the 10th posterior ribs
  - This is important because…if the diaphragms are at the 7th ribs posteriorly, the chest is hypoinflated
  - Conversely, if the hemidiaphragms are at the 12th rib posteriorly, the chest is hyperinflated

Figure 1-1A: PA View

10th rib

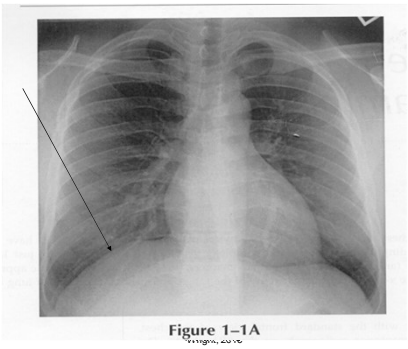

Figure 1–1A

You Can Order An Expiration Film

- When would you order an expiration film?
  - Seems to be good for identifying focal air trapping from:
    - Pneumothorax
    - Partial bronchial obstruction
  - Foreign body aspiration
  - Clinical pearl: if you hear a unilateral wheeze that does not clear with coughing – an expiratory film may be a good idea
  - Normally, a deflated lung will appear whiter while the obstructed lung will appear unchanged

Figure 1 – 7 A: Expiration

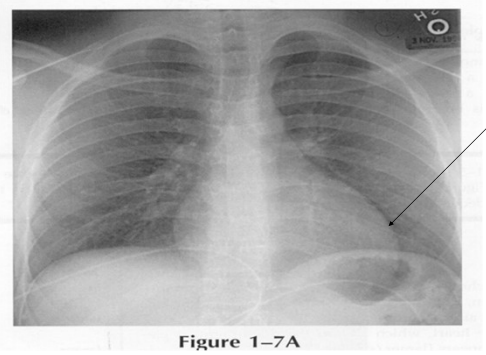

Figure 1–7A

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Figure 1-7B: 2 hours Later: Inspiration

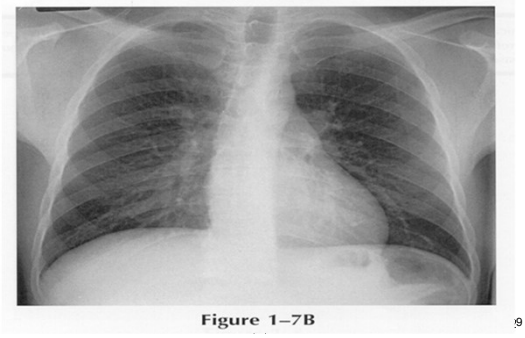

Figure 1–7B

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Systematic Approach is Essential

- PA or AP film is hung on the view box like you are facing the patient from the front
- Start reading the x-ray by looking at the least important areas first
  - Then move to the most important areas; the reason you ordered the x-ray in the first place

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Figure 1-2A: PA View

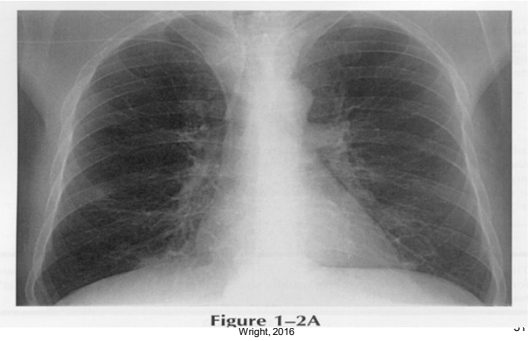

Figure 1–2A

Systematic Approach

- Verify name, age, and date of birth
- There have been a number of occasions when the wrong name has been applied to a film or the wrong patient's film has been hung on the box

Step 2

- Assess:
  - Technique utilized
    - PA, AP, lateral
      - PA and lateral preferred (PA clearer)
  - Position of the patient
    - Upright, supine, decubitus, lordotic
      - Upright preferred
  - Inspiratory Effort
    - Normal, hyperinflated, hypoinflated
  - Rotation

Adapted from Mettler, et. Al. Primary Care Radiology. 2000; WB Saunders.

Let's Review Anatomy

Figure 3 – 1 A

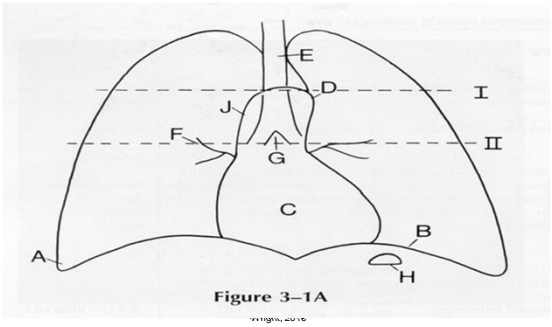

Figure 3 – 1 A

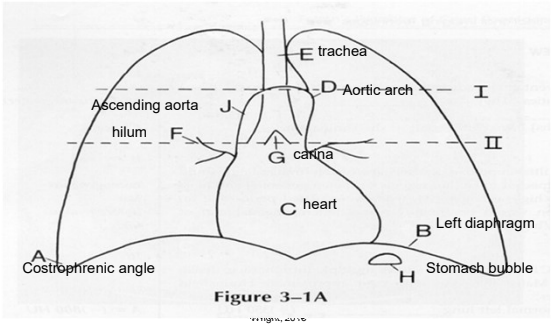

Figure 3-1B

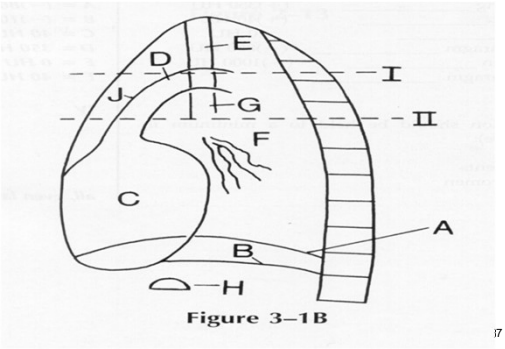

Figure 3–1B

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Figure 3-1B

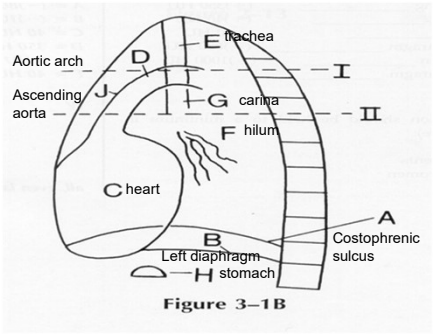

Figure 3–1B

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Posterior-Anterior View

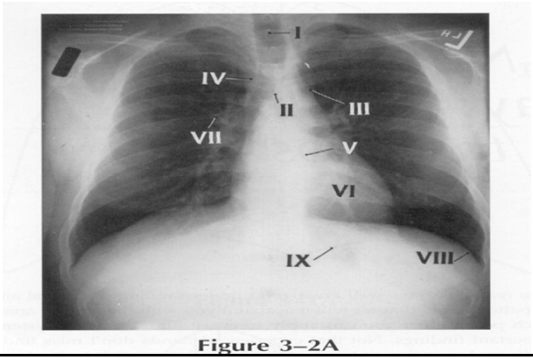

Figure 3–2A

Left Lateral View

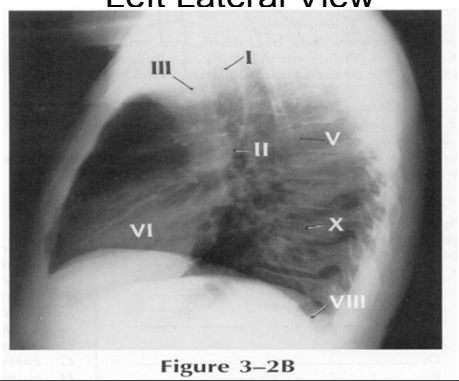

Figure 3–2B

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Pneumonic

- Helpful when trying to remember your systematic approach to chest x-ray interpretation
  - **A**re **T**here **M**any **L**ung **L**esions?
  - Abdomen
  - Thorax (soft tissues and bones)
  - Mediastinum
  - Lung (unilateral)
  - Lungs (bilateral)

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Goodman, L. R. Felson's Principles of Chest Roentgenology; 2nd ed. 1999.

Start With The Abdomen

- Start in the right upper quadrant
- Scan across the abdomen
- Normally, you will see the following:
  - Liver
  - Stomach bubble
  - Splenic flexure of the colon
  - Diaghragm (right diaphragm is higher than left)
  - Spleen may or may not be visible

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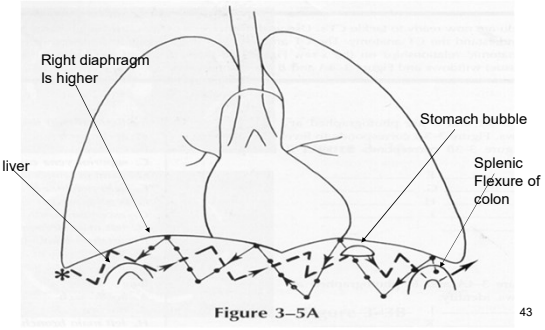
Figure 3-5A



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Diaphragms

- Usually dome shaped although some individuals have “polyarcuate” diaphragms
  - These look like numerous domes together instead of 1 dome
    - This is a normal variant that is often mistaken for a diaphragmatic tumor
  - Right diaphragm is higher than the left
  - The diaphragms form acute angles with the chest wall (costophrenic angles)
    - If these angles become blunted, consider pleural fluid

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Polyarcuate diaphragm

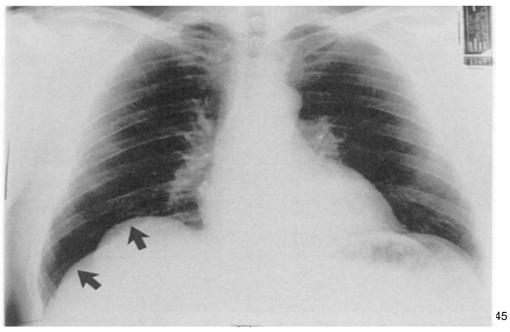

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Figure 3-5B

Identify the 4 structures
In the abdomen

Liver
Stomach bubble
Splenic flexure of colon
Diaphragm

Figure 3–5B

Move to the Right Lung Base

- Start with the right base, looking at:
  - Soft tissues (Muscles, breasts)
  - Chest wall
  - Ribs
    - Anterior ribs descend from lateral to medial
    - Posterior ribs descend from medial to lateral
    - Only the upper ribs are completely seen on x-ray
  - Shoulder girdle (scapula)
- Scan up to the clavicle
- Then work down the left lung to the base
- Compare right to left

So….

- Look for:
  - Right breast
  - Anterior ribs
  - Posterior ribs
  - Scapula
  - Clavicle
  - Left breast

Figure 3-6A

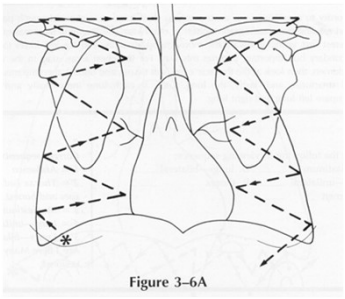

Figure 3–6A

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Soft Tissues, Ribs, Shoulder Girdle

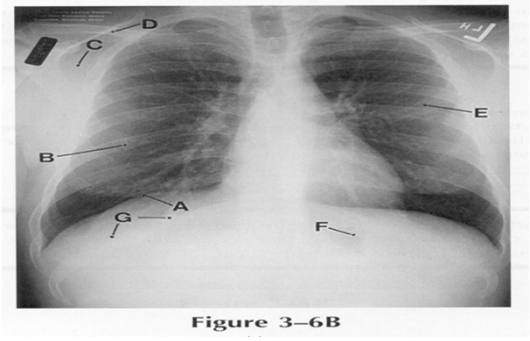

Figure 3–6B

Soft Tissues, Ribs, Shoulder Girdle

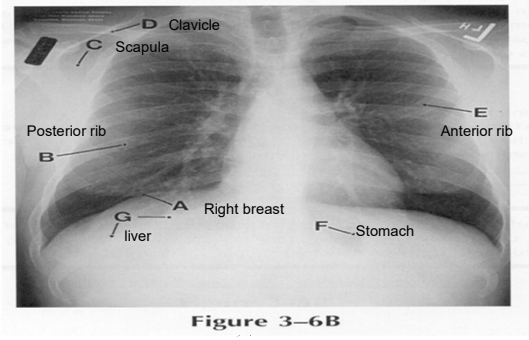

Figure 3–6B

What's Wrong?

Right
Mastectomy

Can be mistaken
For a left lower
Lobe infiltrate

Mediastinum

- This is probably the toughest part
  - Little differentiation between various structures
- Start with an overall look at the area for any abnormalities with contour
  - Such as widening
- Start with the trachea and work downward
  - Trachea
  - Carina
  - Aortic knob (arch)
  - Ascending aorta
  - Descending aorta
  - Heart
  - Hilum

Figure 3 -7A

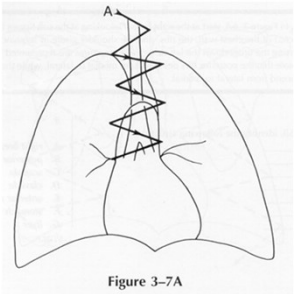

Figure 3–7A

Mediastinum

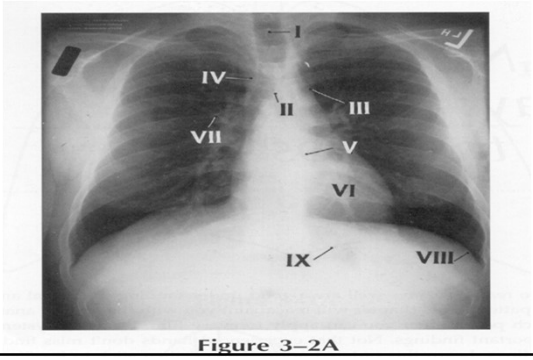

Figure 3–2A

Mediastinum

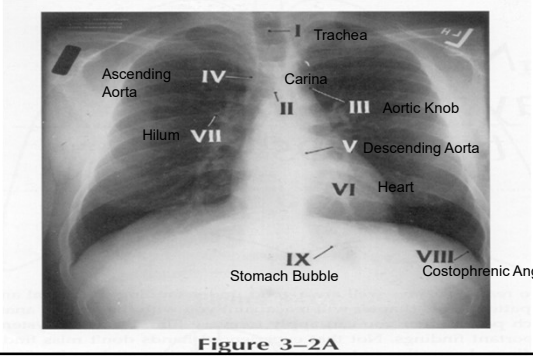

Figure 3–2A

Now, Look at the Lungs

- Since most chest x-rays are ordered to look at the lungs, these are saved for last
- We always need to look at the lungs twice when examining the x-ray
  - First examination is looking at each lung individually
  - Second examination is a comparison between the right and left lung
  - Also…use this as an opportunity to look again at the costophrenic angles and the hilum

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Figure 3-8A

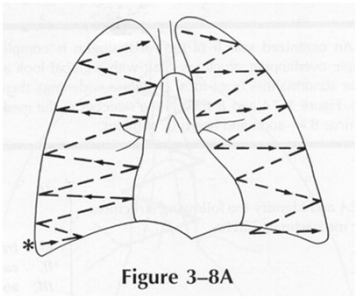

Figure 3–8A

What's the Abnormality?

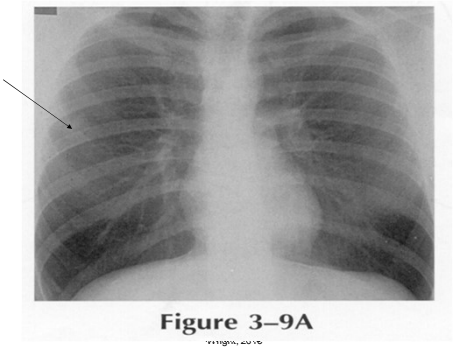

Figure 3–9A

Figure 3-9B: 1 year prior

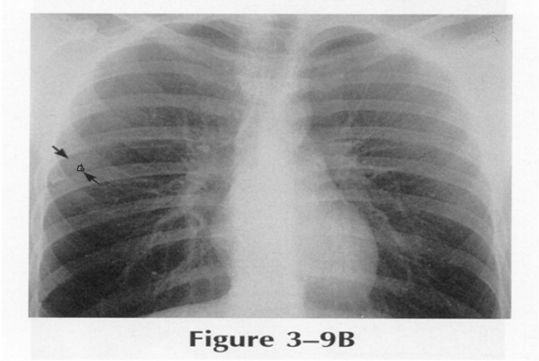

Figure 3–9B

Lateral Films

- Use the same approach to lateral films
  - Abdomen
  - Thorax
  - Mediastinum
  - Lung
  - Lungs

Figure 3-10A

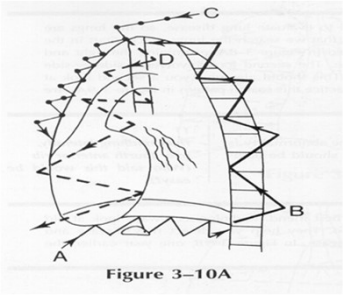

Figure 3–10A

Figure 3-10B Lateral Film

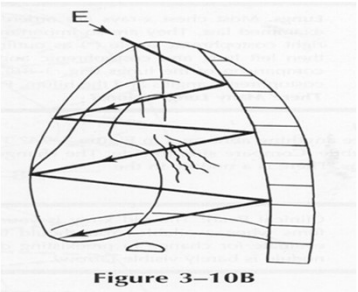

Figure 3–10B

What's Wrong??

Patient presents
To ER with severe
Back pain.

Any ideas?

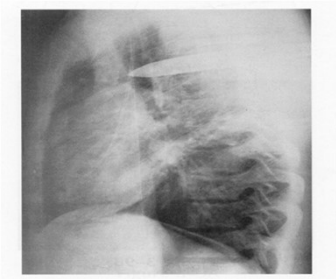

Figure 3–11

Before We Talk About Specific Diseases

- We must discuss more terminology
  - Lung contains alveoli (air sacs)
  - Air sacs are supported by structures such as the vessels, lymphatics, bronchi and connective tissue
  - The alveoli and the supporting structures are called the interstitium
  - On the chest x-ray, the pulmonary vessels are our only look at the interstitium as everything else is radiolucent or black (invisible)

Pulmonary Vessels

- Branch and taper as they progress out to the periphery
- Therefore, they are not visible in the outer 1/3 of the lung
- If a disease affects the interstitium (alveoli, vessels, bronchi, lymphatics), the tissue around the pulmonary vessels will thicken and become more visible in the periphery of the lung

Figure 1-1A: PA View

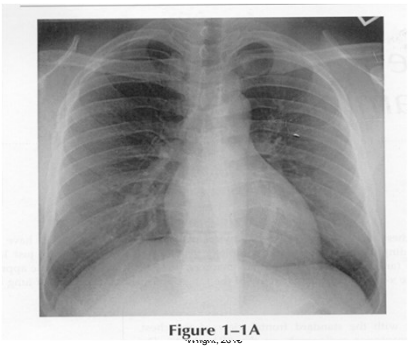

Figure 1–1A

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Fluid or Tissue

- If fluid or tissue (blood, edema, tumor, mucus) fills the alveoli, the lungs will become radiodense and the interstitial markings will become less visible

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Silhouette Sign

- Probably, one of the most important things to look at with a chest x-ray
  - Helps to determine the location of an abnormality in relation to the normal structures (helps us to diagnose and localize lung disease)
  - Two substances of the same density can not be differentiated from each other on x-ray
  - This phenomenon, the loss of the normal radiographic silhouette (contour) is called the silhouette sign

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Here is Some Additional Anatomy

- Right middle lobe: lies in contact with the right heart border
- Therefore, if there is a consolidation of the RML-the right heart border will be obscured

Right Lower Lobe

- This lobe sits on the diaphragm
  - So…if an individual has a right lower lobe pneumonia, the right diaphragm will be obscured
  - What would it mean if the right heart border and the right diaphragm are obscured???

Silhouette Sign

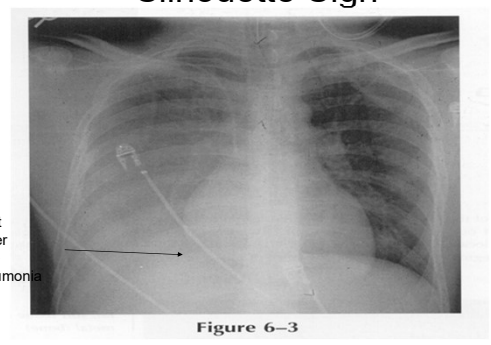


Figure 6–3

Left Lower Lobe

- This lobe sits on the left diaphragm and is direct contact with the descending aorta
- So…if an individual has a left lower lobe pneumonia, the left diaphragm and descending aorta will not be visible

What About the Upper Lobes?

- Right upper lobe consolidation will cause a silhouette sign of the right heart border and the right trachea/lung
- Left upper lobe consolidation will obscure the left atrium, aortic knob and the anterior and middle mediastinum
  - It can also obscure the proximal descending aorta

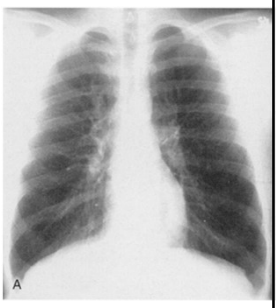
Let's Look At Disease Processes

Asthma

- Normally, a chest x-ray with an asthma flare is not necessary, unless you are concerned regarding pneumonia or an aspiration
- If an individual is having an acute asthma flare, you may see the following abnormalities on chest x-ray
  - Hyperinflation
  - Flat diaphragms
  - Prominent Interstitial Markings (scarring)
  - Occasionally, you will see thickened bronchial walls

Asthma

- Hyperinflation
- Diaphragm is down to the 11th ribs
- Most patients with asthma have normal x-rays



COPD

- Chest x-ray: only detects moderate-severe COPD
  - Hyperinflation
  - Superior aspect of the hemidiaphragm is often depressed down to the level of the posterior 12th rib
  - Flattening of the diaphragms
  - Blunting of the costophrenic angles
  - Increased AP diameter (seen best on the lateral view)
  - May also see bullae due to the destruction of the alveoli

COPD

Hyperinflation
Flat diaphragms
Blunting of angles

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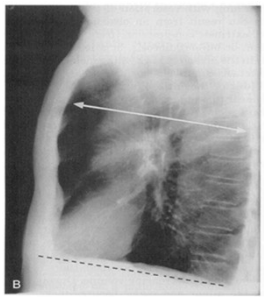
COPD: Lateral View

- Increased AP Lateral diameter
- The way you know that AP/Lat diameter is increased is by this clear space between the sternum and the ascending aorta
- Flat diaphragms; can invert
- May also see bullae



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Pneumonia

- Diagnosis of pneumonia is usually made clinically
  - Fever, cough, myalgias, pleuritic pain, anorexia
  - Physical examination findings: crackles, dullness to percussion, egophony, bronchophony or whispered pectoriloquy
- Clinician uses the x-ray to confirm suspicions

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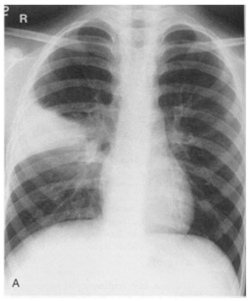
Pneumonia

- Most pneumonias produce lobar, segmental or patchy alveolar infiltrates
  - To identify location, PA and lateral chest x-rays are often necessary

Right and Left Upper Lobe Pneumonias

- Increased density in the upper portions of the lung on PA or AP view
- Notice: right cardiac border is seen but infiltrate is encroaching

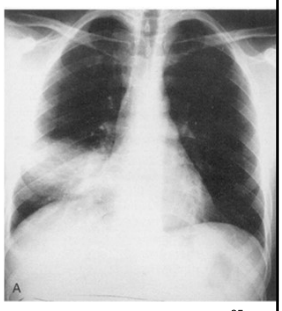


Right Middle Lobe Pneumonias

- Medial or lateral segments or both
- Right medial segment – may obscure the right heart border on the frontal view
  - On lateral view: triangular density radiating from the hilum toward the anterior and inferior aspect of the chest

Right middle lobe pneumonia

- Right middle lobe pneumonia
- Obscures the right cardiac border



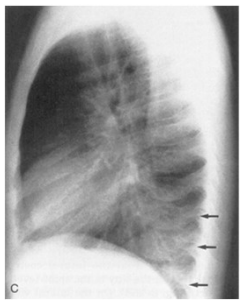
Right and Left Lower Lobes

- Often visualized with one of the following 3 methods
  - May obscure right or left hemidiaphragm on frontal view
  - Lateral view: looks as if it is behind major fissure OR
    - You can utilize the spine sign: normally: vertebral bodies of thoracic spine get darker as you proceed lower in the chest
    - If the vertebral bodies get darker then start to lighten, consider lower lobe infiltrate (to determine left or right lobe-you then need a frontal view)

Spine Sign

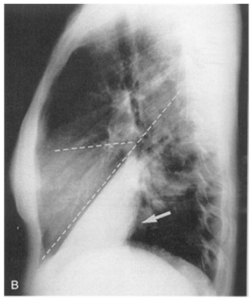
You can utilize the spine sign: normally: vertebral bodies of thoracic spine get darker as you proceed lower in the chest

- If the vertebral bodies get darker then start to lighten, consider lower lobe infiltrate (to determine left or right lobe-you then need a frontal view)



Right lower lobe pneumonia

- Lateral view of a right lower lobe pneumonia
- Notice that the diaphragm is obscured on lateral view



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Atelectasis

- Mild or localized volume loss of the lung
- Not always real easy to see
- On some occasions, a “line” will be visible and will mark the lung
- Other times, we must use other findings to confirm our suspicions

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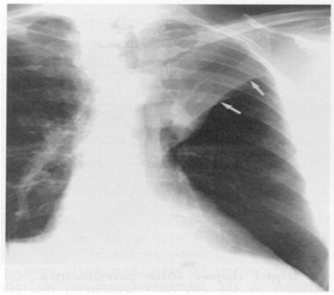
Atelectasis (LUL)

Arrows indicate elevated hilum
Notice diffuse increased density
In left upper lobe



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Pneumothorax

- Air in the pleural space
- Usually the result of trauma but can be spontaneous
- Remember, the pleural space should not be seen normally
- When air enters the pleural space, because the person is upright with the chest x-ray, the most common place for a pneumothorax is the right and left upper lobes

Pneumothorax

- Appears as a thin white line, adjacent to the ribs where normally no lung vascularity should be seen
- Represents the visceral pleura that has been separated from the parietal pleura by air
- Remember…if you are concerned about a pneumo, an expiration chest film will help to identify a small pneumo
  - Expiration view causes the lung to become more dense and smaller, whereas the pneumo size doesn't change. This makes the pneumo appear larger

Figure 1 – 5: Pneumothorax

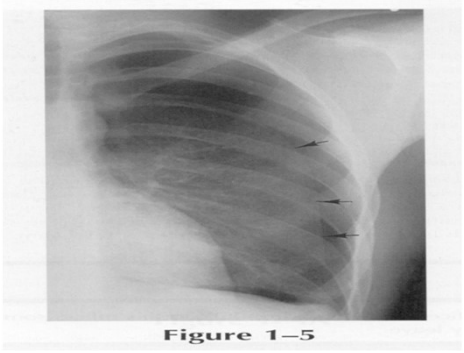

Figure 1–5

Other Direct Findings of a Pneumothorax

- Crowded bronchovascular markings
- Shift of adjacent structures
- I.e. nodules may move

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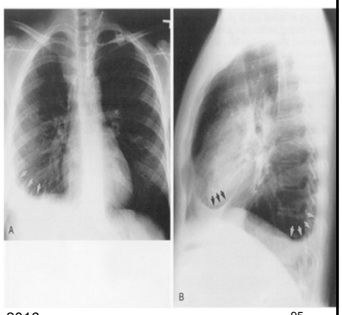
Pleural Effusion

- Fluid in the lung
- Blunting of the right costophrenic angle
- Fluid seen on lateral view



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Nodule

- Solitary nodule is often 1 of 2 things:
  - Granuloma
  - Lung cancer

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Steps to Determining Etiology

- First, is the nodule within the lung
  - Or, is it a shadow from a nipple or skin lesion?
- Locate the nodule
  - What level is it at?
- Look at the lateral film and see if you see it there and at the same level

Characteristics of the Nodule

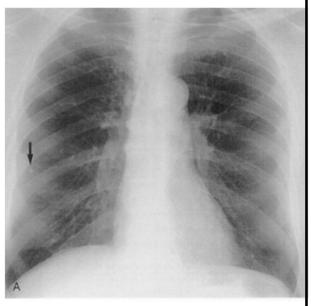
- Nodule characteristics
  - Round (likely to be a granuloma)
  - Regular or irregular (irregular – cancer)
  - Calcification within the nodule (central – granuloma)
- Compare it with old films
  - Nodule that has remained unchanged x 2 years is considered benign

Granuloma

- Usually < 0.5 cm
- Easily seen
- Quite dense
- Solitary
- Often found in an individual who is < 40 years of age

Granuloma

- Definite nodule seen



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Lung Cancer

- Usually picked up with a chest x-ray that is done for other reasons i.e. pneumonia, shortness of breath
- Characteristics
  - Irregular
  - 0.5 cm or larger
  - Poorly defined borders
  - Asymmetric lesion
  - Cavitated

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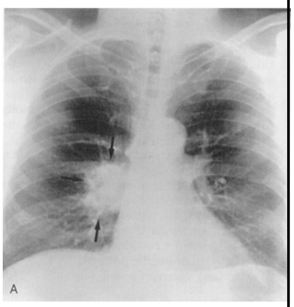
Cancer

- Poorly defined nodule
- Localized near the right hilum
- Shaggy appearance (carcinoma)
- Needs a CT



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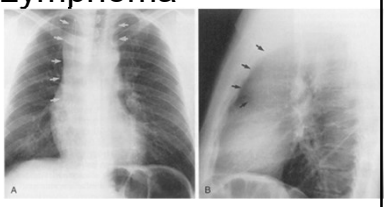
Lymphoma

- Usually seen on x-ray as a large mediastinal mass or hilar adenopathy

Lymphoma

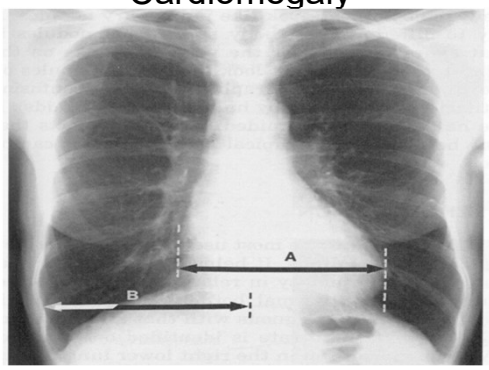
- 20 year old male
- SOB
- Cough
- Widening of the mediastinum
- Lateral view: anterior mediastinal mass



Cardiomegaly

- This is detected by looking at the width of the heart at its widest point
- It should be less than ½ of the thorax at its widest point from the middle of the spine to the inner ribs

Cardiomegaly



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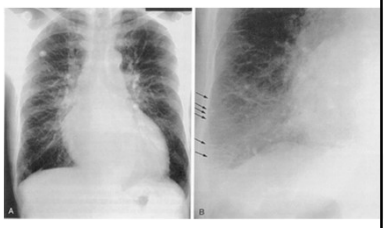
Congestive Heart Failure

- Usual findings
  - Cardiomegaly
  - Redistribution of the pulmonary vascularity
    - Normally, vessels in the lower lobe are more prominent than in the upper lobe
    - With CHF, they are equally prominent
  - Kerley B lines
    - Small, horizontal lines are seen in the periphery of the lung
    - Represent fluid in the interlobular septa

CHF

- As CHF progresses,
  - The hilum becomes indistinct
    - It is usually symmetric
    - Called “Bat Wing” Infiltrate
  - Pleural effusions may become present
    - This is seen on x-ray by a blunting or an obscuring of the costophrenic angles

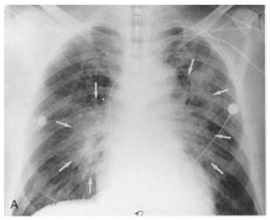
Congestive Heart Failure



- Cardiomegaly
- Increased vascularity
- Small horizontal lines called Kerley B

“Bat Wing”

- Notice the bat wing
- Symmetric thickening



Abdominal X-rays

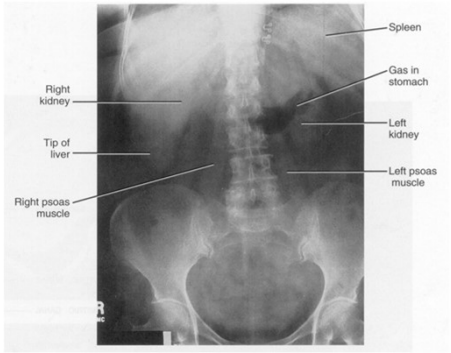
Why Would You Order Abdominal Films?

- Acute abdominal pain
  - Sudden onset of abdominal pain: bowel perforation, ruptured ectopic pregnancy, ovarian cyst, aneurysm, or ischemic bowel
  - Gradual onset: appendicitis, cholecystitis, bowel obstruction
  - Films: Chest x-ray and Abdominal film (upright and supine)
    - Ultrasound: if considering ectopic, cholecystitis, ovarian pathology

KUB

- Kidneys, ureter, bladder: most common abdominal imaging study
- This film will allow you to see the bony structures (hips, vertebrae); lung bases, soft tissues (psoas muscles, liver, kidneys) and gas patterns

Normal Anatomy of Supine View



Calcifications

- Quite common
- RUQ: Single or multiple calcifications are often gallstones or kidney stones
  - Posterior view helps to differentiate between the two (gallstone – anterior)
- LUQ: almost always splenic in nature
  - However, appearance can provide clues as to the etiology
    - Multiple, small: histoplasmosis
    - Serpiginous: splenic artery calcification
    - Rounded: splenic artery aneurysm

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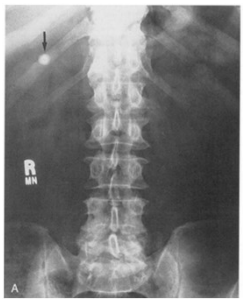
Right Upper Quadrant Calcification

- Gallstone
- Impossible to tell from one view whether it is a gallstone or a kidney stone
- US-differentiates



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Calcifications

- LUQ
  - Pancreas: pancreatitis
    - Lie in close proximity to the L1 – L2 vertebrae and extend to the left
    - Do not always count on them being present
    - CT is a better test for pancreatitis

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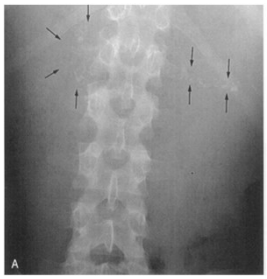
Pancreatitis

- Rarely seen but when present, is fascinating
- Horizontal band of calcifications going across the upper abdomen
- CT is needed



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RMQ

- Mesenteric lymph nodes: (infection)
  - Popcorn-shaped calcifications
  - Right mid-abdomen
  - On an upright view, these calcifications drop substantially

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Mesenteric lymph nodes

Upright; notice how it dropped

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Appendicolith

- Calcification in the appendix
- Use history to make diagnosis in combination with this film and a helical CT

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Appendicitis

- Supine film
- Dilated small bowel loops
- No definite gas in the colon
- Consider appendicitis vs. bowel obstruction

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Small Bowel

- Plain films can be very useful when looking for abnormalities of the small bowel
  - Small bowel: central location and thin mucosal markings that extend like stripes across the entire lumen make identification easy
    - These stripes (valvulae) look like a set of thick, stacked coins
  - Small bowel is < 3 cm in diameter
  - Gas pattern plain film is helpful

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Small Bowel Obstruction

- Large amount of dilated small bowel
- Recognized as small bowel by regular mucosal pattern of the valvulae extending across the lumen
- Looks like a set of thickly stacked coins

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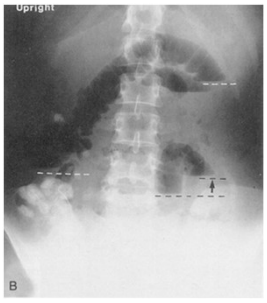
Small Bowel Obstruction

- Upright film
- Air-fluid levels of the abdomen
- Air-fluid levels in the same loop of bowel are at different heights



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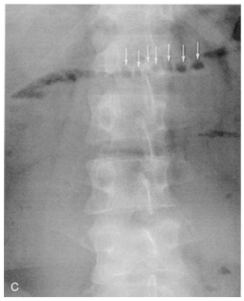
Small Bowel Obstruction

- Notice the string of pearls
- These are air bubbles
- Seen with an obstructed small bowel



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Kidney Stone

- Normal kidney: 13 cm in size on x-ray (smaller on ultrasound)
- Plain film is not your choice of diagnostic tests (either IVP or spiral / helical CT)

Let's Do Some Case Studies!

Case 1

- Young man
- Any abnormalities?
- What surgery did he have?
- Are you worried about anything?
- Any idea regarding diagnosis?

Figure Q–1

Case 2

- 11 year old child with asthma and fever x 3 days
- Increasing shortness of breath
- What do you see?
- Any idea regarding a diagnosis?

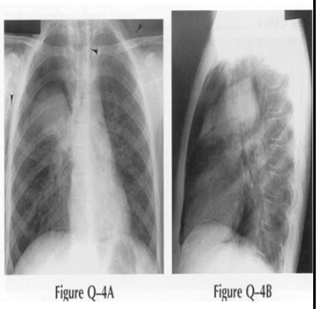

Figure Q–4A Figure Q–4B

Case 3

- 50 year old woman
- 5-a: 1 year ago
- 5-b: now: shortness of breath and pain on inspiration

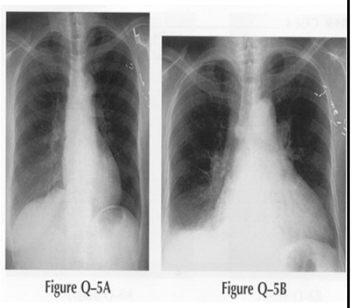

Figure Q–5A Figure Q–5B

Case 4

- Young man with shortness of breath and chest pain
- Any ideas?

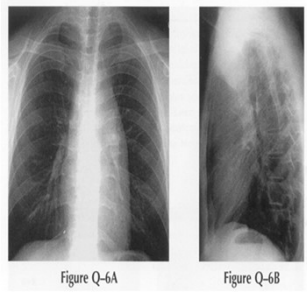

Figure Q–6A Figure Q–6B

Thank You!!

I Would Be Happy to Answer Any Questions You May Have

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