Interpretation of Chest Radiographs

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X-Rays

When x-rays are produced and directed toward the patient, they may act in three basic ways:

They may be…	***Which means…***
unabsorbed	they pass through the patient unchanged and strike the x-ray film
completely absorbed	the energy of the x-ray is totally deposited within the patient
scattered	they are deflected within the patient but may still strike the x-ray film

X-ray Absorption

- **Factors that contribute to X-ray absorption include the:**
  - Density of the tissue the beam strikes
  - Energy of the X-ray beam (the energy of the X-ray beam is usually fairly constant in posterior/anterior and lateral radiography)

Tissue Density

Whitest / Most Dense

Metal

Contrast material (*i.e.*, x-ray dye)

Bone

Calcium

Soft tissue

Fat

Air or gas

Blackest/Least Dense

Posterior/Anterior (PA) Radiograph

- **Posterior/anterior (PA) refers to the direction of the X-ray beam which in this case traverses the patient from posterior (back) to anterior (front)**
- **PA view is taken at a distance of 6 feet to reduce magnification and enhance sharpness**

Normal Frontal (PA) Chest Radiograph

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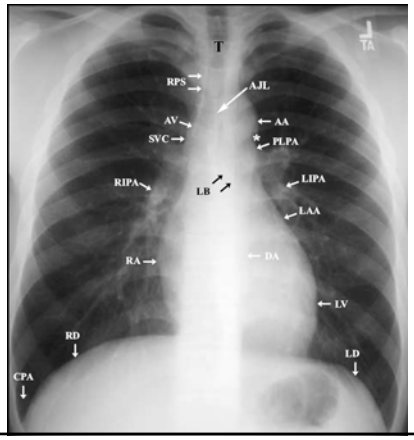
Normal Frontal (PA) Chest Radiograph



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PA & AP Chest X-rays

PA View

AP View

Lateral Radiograph

- **Lateral radiograph is the other routine view**
- **By convention it is taken at a distance of 6 feet and the left side of the chest is held against the X-ray cassette**
- **Lateral view generally shows lesions located behind the heart, near the mediastinum, or near the diaphragm on the PA view**
  - These lesions are otherwise difficult to detect

Normal Lateral Chest Radiograph

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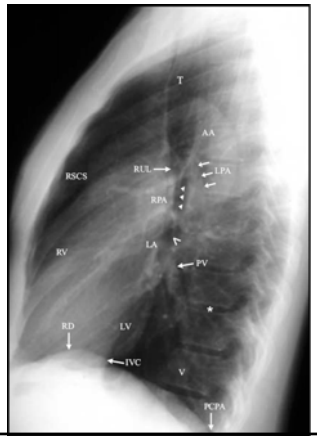
Normal Lateral Chest Radiograph



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Assessing Technical Quality of Radiographic Studies

- Before interpreting, the reader should ***always*** assess the quality of the study
- These technical parameters should be assessed:
  - Exposure
  - Proper positioning
  - Inspiratory effort

Exposure

- **Properly exposed:**
  - Thoracic intervertebral disc space just visible
  - Branching vessels through heart clearly visible
- **Underexposed:**
  - Difficult to "see through" mediastinal contours & heart
  - Lung parenchyma not clearly visible
- **Overexposed:**
  - Film appears "too black"
  - Small lung nodules or other faint pulmonary parenchymal opacities difficult to see
  - May be compensated by use of bright or "hot" light

Exposure

Overexposure Proper Exposure

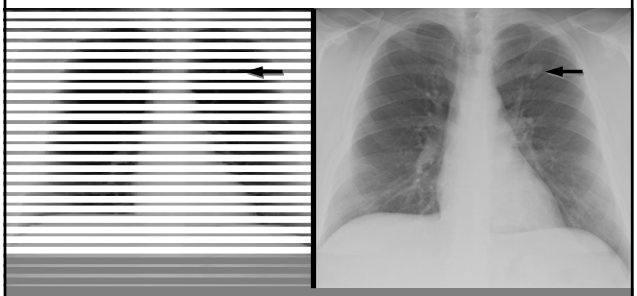


Image credit: Curry International Tuberculosis Center, University of California, San Francisco

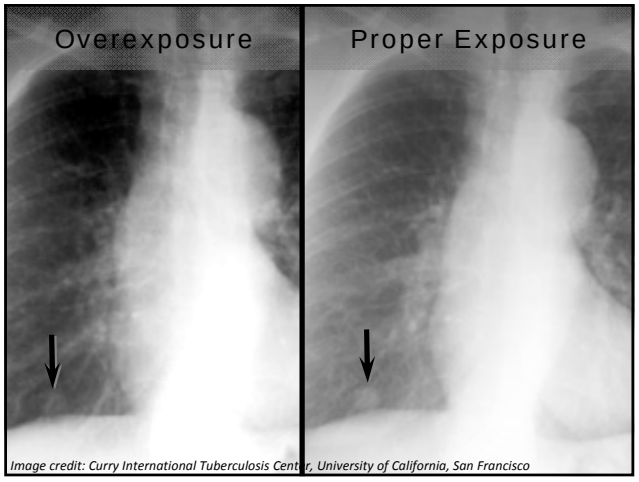
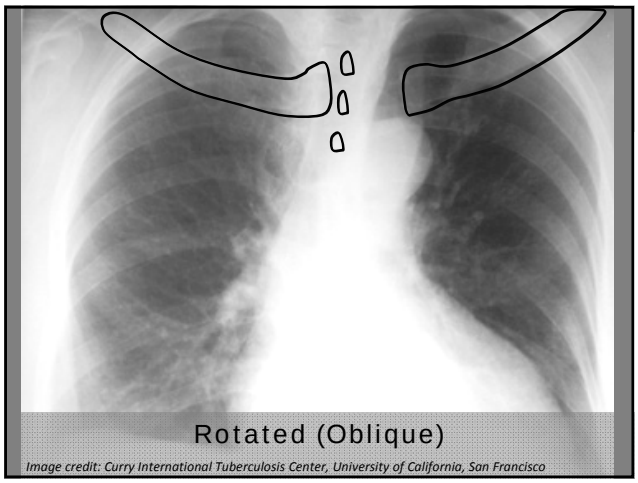


Image credit: Curry International Tuberculosis Center, University of California, San Francisco

Proper Positioning

- **No patient rotation**
- **Medial clavicle heads equidistant from spinous processes**
- **Medial clavicle ends overlie the junction of 1st anterior ribs or manubrium**
- **Lordotic projection: clavicles projected cranial to 1st ribs**
  - Useful for viewing pulmonary apices
  - Undesirable for routine frontal radiographs



Rotated (Oblique)

Image credit: Curry International Tuberculosis Center, University of California, San Francisco

Inspiratory Effort

- **Full inspiration results in diaphragm projected to 9-10th posterior ribs in normal patients**
  - Below 11th ribs, lung volumes are abnormally large
    - Air trapping or obstructive pulmonary disease
  - Above 8th ribs, lung volumes are abnormally low
    - Poor inspiratory effort or restrictive lung disease
- **Low lung volumes can:**
  - Result in basilar vascular crowding and atelectasis
  - Create appearance of interstitial lung disease or pneumonia in lung bases, or cardiac enlargement

Inspiratory Effort

Low Lung Volumes | Full Inspiration

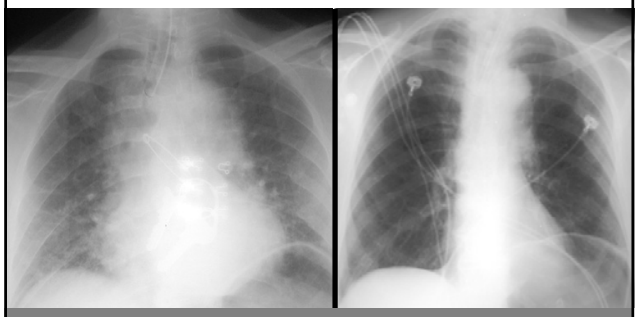


Image credit: Curry International Tuberculosis Center, University of California, San Francisco

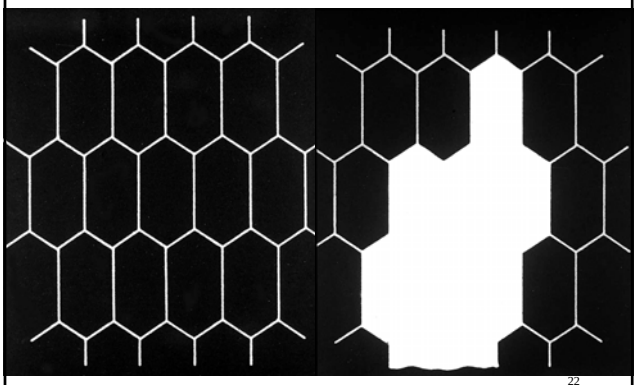
Basic Patterns of Disease

- **Consolidation** (or airspace filling)
- **Interstitial** (including linear and reticular opacities, small well-defined nodules, miliary patterns, and peribronchovascular thickening)
- **Solitary nodule**
- **Mass**
- **Lymphadenopathy**
- **Cyst/cavity**
- **Pleural abnormalities**

Consolidation

- **Also known as air space disease (ASD), alveolar filling disease, or acinar disease**
- **Appearance and findings**
  - Increased opacity
  - Ill defined, hazy, patchy, fluffy, or cloud-like
  - Silhouette sign
  - Air bronchograms
  - Butterfly or bat-wing pattern
  - Lobar or segmental distribution

Normal Consolidation



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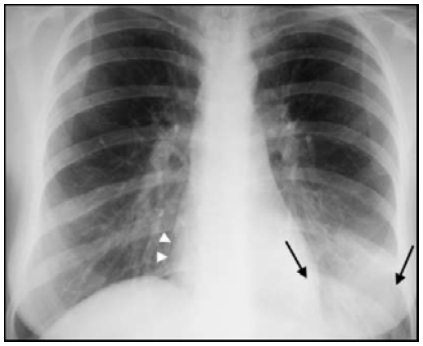
PA Chest Radiograph
(LLL pneumonia consolidation)



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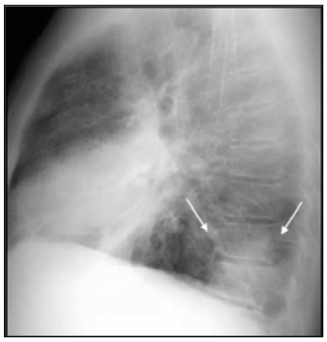
Lateral Chest Radiograph
(LLL pneumonia consolidation)



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Silhouette Sign: RLL Pneumonia

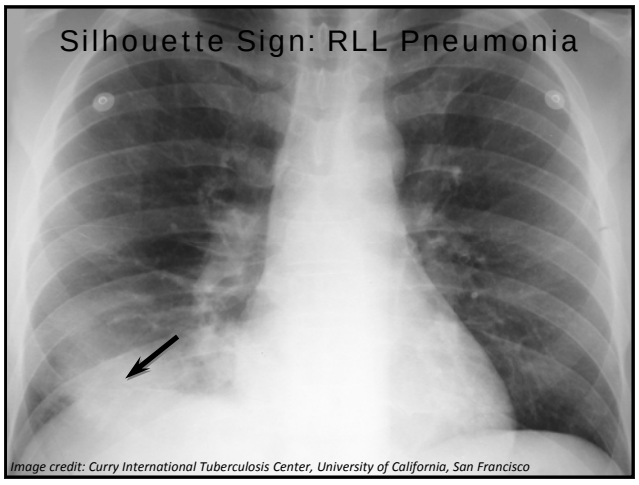
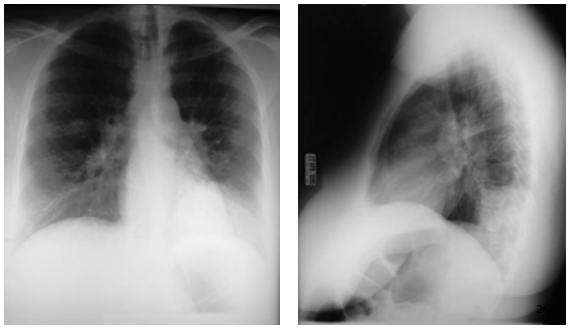
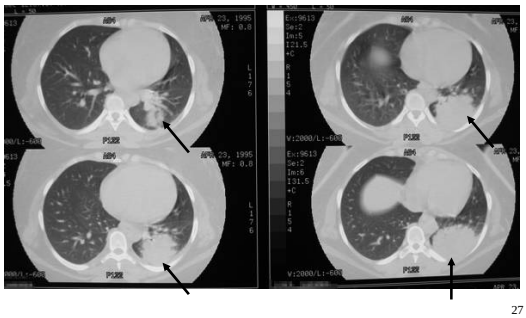


Image credit: Curry International Tuberculosis Center, University of California, San Francisco

Self Check



Chest CT



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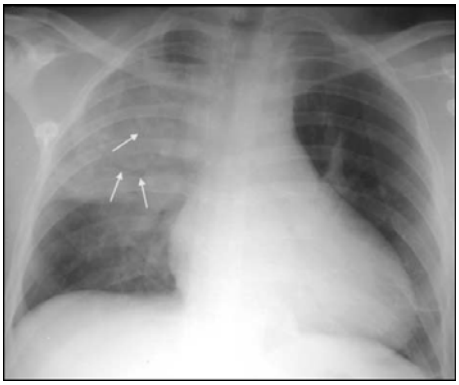
Consolidation (Airspace Opacity) (RUL pneumonia)



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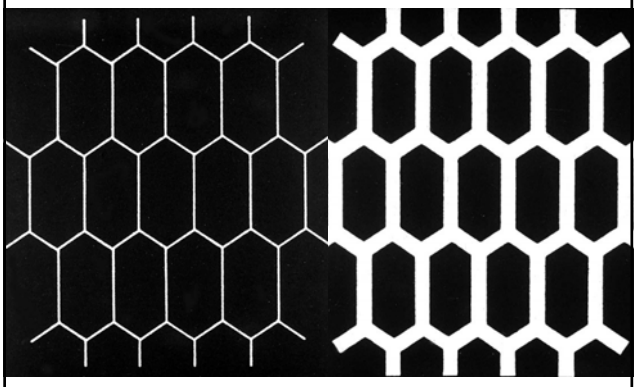
Interstitial Lung Disease (ILD)

- **Appearance and findings**
  - Reticular pattern, increased linear opacities
  - Interlobular septal thickening (Kerley B lines)
  - Peribronchial thickening (cuffing or tram tracking)
  - Honeycombing
  - Discrete miliary nodules
  - Reticulonodular pattern

Normal | Interstitial disease



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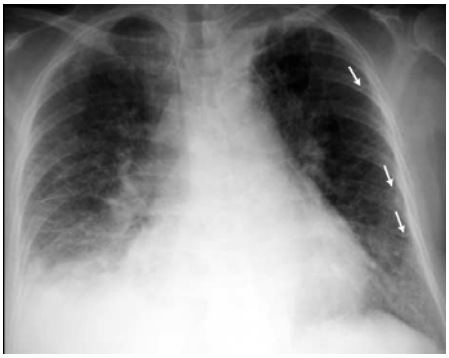
Linear Opacities



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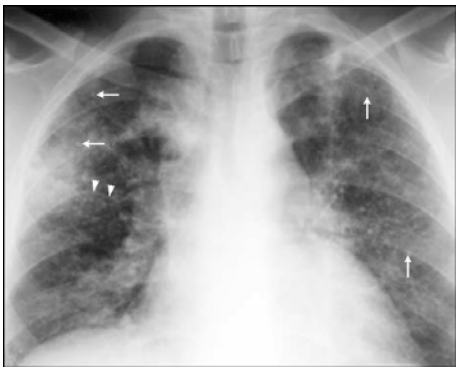
Nodules



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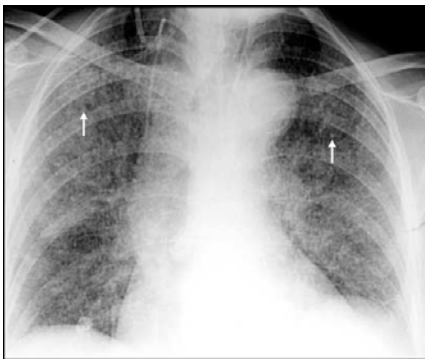
Miliary Pattern



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Nodules and Masses

- **Nodules and masses: discrete areas of increased lung opacity whose borders do not conform to anatomic divisions (such as a fissure)**
- **Masses: similar to nodules but larger, >30mm in diameter**
- **Nodules and masses are described by:**
  - Size
  - Number, single or multiple
  - Sharpness of their borders
  - Location
  - Presence or absence of calcification

Lung Mass

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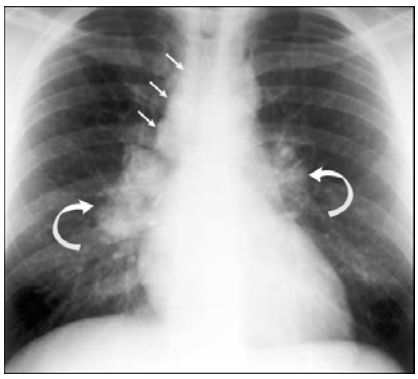
Lymphadenopathy

- **Enlarged lymph nodes appear as soft tissue densities in characteristic locations, including:**
  - Right paratracheal area
  - Hila
  - Aorticopulmonary window
  - Subcarinal mediastinum
  - Superior mediastinum
  - Supraclavicular area
  - Paraspinous region
  - Retrosternal area on the lateral radiograph
- **One or more regions may be involved, and in certain conditions, nodes may calcify**

Lymphadenopathy

- **Hilar enlargement due to adenopathy is frequently lobular**
- **Thickening of the posterior wall of the bronchus intermedius may be due to lymphadenopathy, tumor or edema**
- **Lymphadenopathy is best visualized on the lateral radiograph**
  - It fills the normally clear infrahilar window with an unexpected contour

Lymphadenopathy



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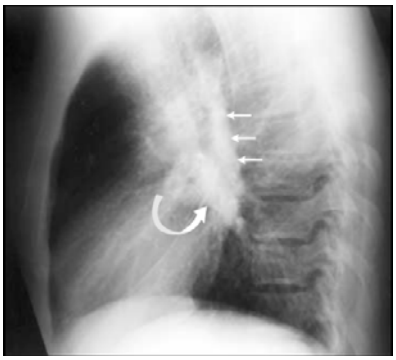
Lymphadenopathy



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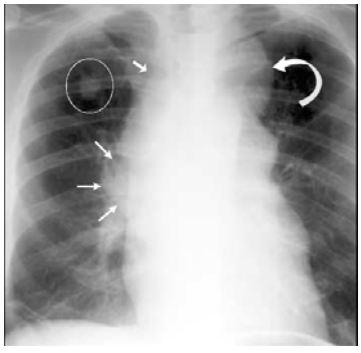
Mediastinal Lymphadenopathy



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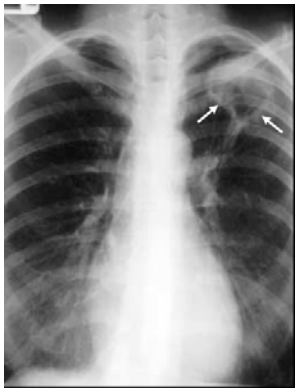
Cysts and Cavities

- **Focal lucent areas within the lung may result from cavities, cysts, emphysema, and bronchiectasis**
- **Pulmonary cysts:**
  - Commonly result from infections, trauma, or toxic ingestion, as well as other rare etiologies
- **Pulmonary cavities:**
  - Created by necrosis of lung parenchyma
  - May result from infection, neoplasm, and infarction

Cysts and Cavities

- **Pulmonary cysts and cavities are characterized by:**
  - Number and location
  - Character of the inner lining
  - Thickness of the wall (at the thickest portion, not including air-fluid levels)
  - Nature of the contents of the lesion

Cavity



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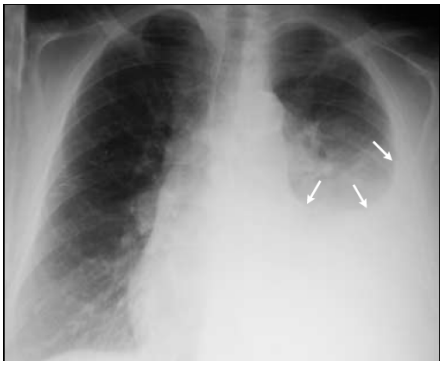
Pleural Disease

- **Since pleural abnormalities are outside the lung parenchyma, an air bronchogram cannot be seen**
- **Pleural abnormalities are usually homogeneous opacities**
- **In the upright patient, a pleural effusion will form a curvilinear interface with aerated lung that resembles a meniscus**
  - The pleural fluid settles dependently within the pleural space
- **In the supine patient, a pleural effusion may layer posteriorly in a dependent fashion, creating a hazy opacity over the entire hemithorax**

Pleural Effusion



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Self Check

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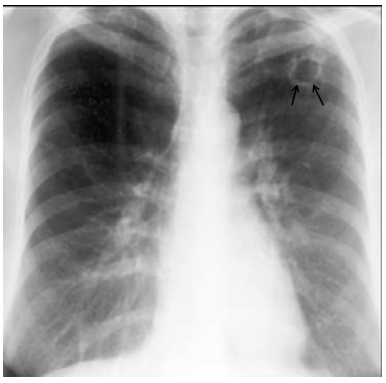
Answer



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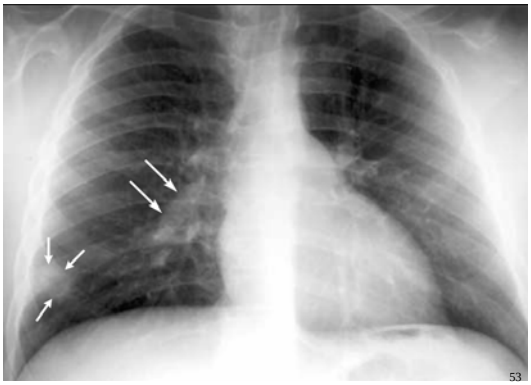
Primary TB in a Child



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Primary TB in a Child

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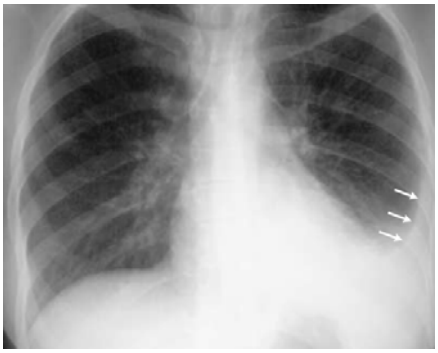
Primary TB in an Adult



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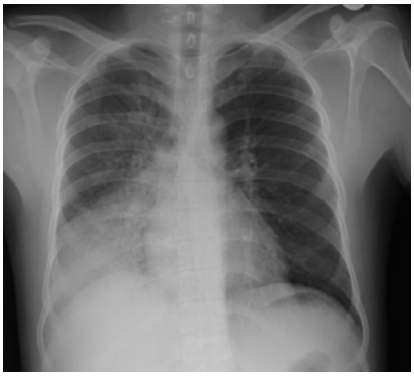
Primary TB in an adult (RLL consolidation)



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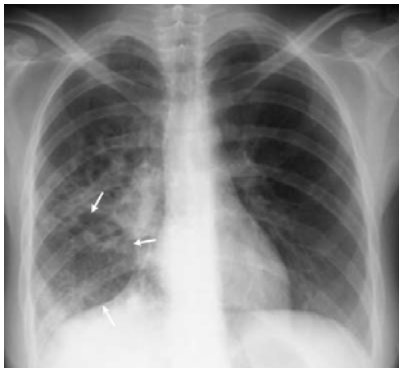
Primary TB with Cavitation



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Tuberculosis…

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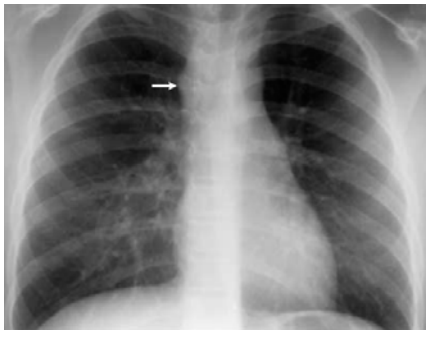
TB in a 10 year old



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Post-Primary (Reactivation) TB
(PA View)

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Post-Primary (Reactivation) TB (Lateral View)

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Tuberculoma

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Airspace Consolidation with Cavitation

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Volume Loss (Atelectasis)

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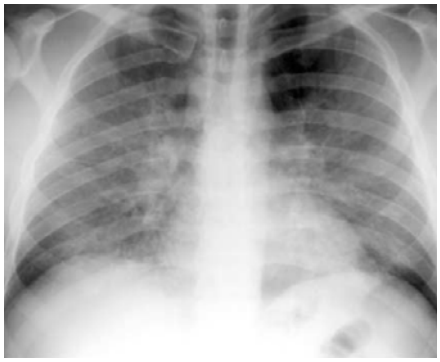
Self Check



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Paratracheal Adenopathy in HIV

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Fibrotic Scarring

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Self Check

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Self Check

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Answer

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Summary: Chest Radiographs

- **Tuberculosis has a myriad of radiographic appearances**
- **Chest X-rays are snapshots and cannot determine if the disease is active or infectious**
- **Tuberculosis may present atypically when patients are immunocompromised**
- **Direct comparison to old films is critically important to follow disease progression**

Acknowledgements

Daley, C.L., Gotway, M.B., Jasmer, R.M. (2006). *Radiographic Manifestations of Tuberculosis* (2nd ed.). Curry International Tuberculosis Center (www.currytbcenter.ucsf.edu)

Goodman, L.R. (2007) *Felson's Principles of Chest Roentgenology: A Programmed Text* (3rd ed.). Philadelphia: Saunders.