Interpretation of Chest Radiographs

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Slides courtesy of Alfred Lardizabal, MD
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Basic Radiology for the TB Clinician

Overview:
- Technical aspects of chest radiography
- Systematic approach to reading CXR
- Basic CXR anatomy
- Patterns of disease
- Radiographic manifestations of tuberculosis (TB)

Chest Radiography: Basic Principles

- X-ray photon: Absorbed / scattered / transmitted
- X-ray absorption depends on:
  - Beam energy (constant)
  - Tissue density

Maximum X-Ray Transmission
(least dense tissue)

Blackest
air
fat
soft tissue
calcium
bone
X-ray contrast
metal
Whitest

Maximum X-Ray Absorption
(densest tissue)
Differential X-Ray Absorption

Why we see what we see:

• Structures are visible on a radiograph because of the juxtaposition of two different densities
  ➔ Creating an interface

• Silhouette Sign
  Loss of an expected interface
  ➔ No boundary can be seen between two structures because they now are similar in density

Image credit: Curry International Tuberculosis Center, UCSF

Silhouette Sign: RLL Pneumonia

Image credit: Curry International Tuberculosis Center, UCSF
Silhouette Sign: RLL Pneumonia

Assess CXR Technical Quality

- Inspiratory effort
  - 9-10 posterior ribs
- Penetration
  - Thoracic intervertebral disc space just visible
- Positioning / rotation
  - Medial clavicle heads equidistant from spinous process
Inspiratory Effort

Low Lung Volumes  Full Inspiration

Image credit: Curry International Tuberculosis Center, UCSF

Exposure

Overexposure  Proper Exposure

Image credit: Curry International Tuberculosis Center, UCSF
Overexposure

Proper Exposure

Rotated (Oblique)

Image credit: Curry International Tuberculosis Center, UCSF
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A Systematic Approach to Reading a CXR

Image Credit: Lung Health Image Library/Gary Hampton

Approach to Reading a CXR

Be Systematic
- Lungs
- Pleural surfaces
- Cardiomedastinal contours
- Bones and soft tissues
- Abdomen

Image credit: Curry International Tuberculosis Center, UCSF
Interpretation: A-B-C-D-E

A=Air
B=Bones
C=Cardiovascular
D=Diaphragm
E=Everything else

Worth a Second Look

- Apices
- Retrocardiac areas (left and right)
- Hilar regions
- Below diaphragm
Apical TB

Image credit: Curry International Tuberculosis Center, UCSF

Apical TB (2)

Image credit: Curry International Tuberculosis Center, UCSF
Left Retrocardiac Opacity

Nodule Behind Diaphragm

Image credit: Curry International Tuberculosis Center, UCSF
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Basic CXR Anatomy

Frontal and Lateral Views

- Heart
- Aorta
- Pulmonary arteries
- Airways

Image credit: Curry International Tuberculosis Center, UCSF

Image Credit: Lung Health Image Library/Pierre Virot
- Aortic arch
- Right pulmonary artery
- Left pulmonary artery
- Trachea & bronchi
• Aortic arch

• Aortic arch
  • Right pulmonary artery

Image credit: Curry International Tuberculosis Center, UCSF
• Aortic arch
• Right pulmonary artery
• Left pulmonary artery

Image credit: Curry International Tuberculosis Center, UCSF

• Aortic arch
• Right pulmonary artery
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Image credit: Curry International Tuberculosis Center, UCSF
Patterns of Disease

Chest Radiographic Patterns of Disease

• Consolidation / air-space opacity
• Interstitial opacity
• Nodules and masses
• Lymphadenopathy
• Cysts and cavities
• Pleural abnormalities
Consolidation / Air-Space Opacity

- Caused by filling of alveoli with fluid, pus, blood, cells (tumor), etc.
- May be diffuse, or isolated to segments or lobes of the lung
- May be associated with air bronchograms (air-filled bronchus surrounded by opacified lung)

Pneumonia

Image credit: Curry International Tuberculosis Center, UCSF
Interstitial Opacity

• Disease localized to pulmonary interstitium, i.e., the alveolar septae and connective tissues that support the alveoli

• Hallmarks:
  – Lines and/or reticulation
  – Small, well-defined nodules
    ▪ Miliary pattern

• DDX: Pulmonary edema, interstitial lung diseases (e.g., idiopathic pulmonary fibrosis), sarcoidosis, infection, tumor (lymphangitic spread), etc.
Nodules and Masses

- Nodule: Discrete pulmonary lesion, sharply defined, nearly circular opacity 0.2 - 3 cm
- Mass: Larger than 3 cm
- Describe with qualifiers:
  - Single or multiple
  - Size
  - Border characteristics
  - Presence or absence of calcification
  - Location

Image credit: Curry International Tuberculosis Center, UCSF
Lymphadenopathy (LAN)

- **Non-specific terms:**
  - Mediastinal widening
  - Hilar prominence

- **Specific patterns:**
  - Particular station enlargement (location)

> Important to know what “normal” should look like in order to recognize “abnormal”
Lymphadenopathy

- Infrahilar window (right hilar and/or subcarinal)
- Left hilar
- Subcarinal

Image credit: Curry International Tuberculosis Center, UCSF
Lymphadenopathy

- Left hilar

Image credit: Curry International Tuberculosis Center, UCSF

Lymphadenopathy

- Subcarinal

Image credit: Curry International Tuberculosis Center, UCSF
Right Paratracheal & Bilateral LAN

Right Hilar LAN

Image credit: Curry International Tuberculosis Center, UCSF
Cysts & Cavities

- Abnormal pulmonary parenchymal spaces ("holes"), filled with air and/or fluid, with a definable wall (>1 mm)
  - Cyst: Congenital or acquired
  - Cavity: Caused by tissue necrosis, (inflammatory and/or neoplastic)

- Characterize:
  - Wall thickness at thickest portion
  - Inner lining
  - Presence / absence of air / fluid level
  - Number and location
TB or Not TB? Cysts and Cavities

Are there radiographic features that suggest benign vs. malignant diagnoses?

“45 year old man from China with cough, weight loss”

Image credit: Curry International Tuberculosis Center, UCSF

TB or Not TB? Cysts and Cavities (2)

Are there radiographic features that suggest benign vs. malignant diagnoses?

- **Benign cysts**: Uniform wall thickness, 1mm, smooth inner lining (e.g., PCP)
- **Benign cavities**: Max. wall thickness \( \leq 4 \text{ mm} \), minimally irregular inner lining (e.g., TB)
- **Malignant cavities**: Max. wall thickness \( \geq 16 \text{ mm} \), irregular inner lining
Pleural Disease: Basic Patterns

- Effusion
  - Angle blunting to massive
- Thickening
- Mass
- Air
- Calcification
Post-TB Pleural Calcification

Plombage with Lucite balls
Can this be TB?

“Typical Pattern”: Post-Primary TB

- Distribution
  - Apical / posterior segments of upper lobes
  - Superior segments of lower lobes
  - Isolated anterior segment involvement unusual for *M.tb* (think *M. avium* complex)
“Typical Pattern”: Post-Primary TB

Patterns of disease
- Air-space consolidation
- Cavitation, cavitary nodule
- Endobronchial spread
- Miliary
- Bronchostenosis
- Tuberculoma
- Pleural effusions (empyema most likely in post-primary disease)

Can this be TB?

“Atypical Pattern”: Primary TB
- Distribution: Any lobe involved (slight lower lobe predominance)
- Air-space consolidation
- Cavitation is uncommon (<10%)
- Adenopathy is common (esp. children and HIV), predilection for right side
- Miliary pattern
- Pleural effusions
Can this be TB? Miliary TB

Radiographic Patterns: Pulmonary TB

<table>
<thead>
<tr>
<th>TB Pattern</th>
<th>“Typical” (Post-Primary)</th>
<th>“Atypical” (Primary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltrate</td>
<td>85% upper</td>
<td>Upper: Lower 60: 40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Usually upper in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>children</td>
</tr>
<tr>
<td>Cavitation</td>
<td>Common</td>
<td>Uncommon</td>
</tr>
<tr>
<td>Adenopathy</td>
<td>Uncommon</td>
<td>Children common</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adults ~30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unilateral &gt; bilateral</td>
</tr>
<tr>
<td>Effusion</td>
<td>May be present</td>
<td>May be present</td>
</tr>
</tbody>
</table>
### CXR Pattern: Early vs. Advanced HIV

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Early HIV (CD4&gt;200)</th>
<th>Advanced HIV (CD4&lt;200)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“Typical” (Post-Primary)</td>
<td>“Atypical” (Primary)</td>
</tr>
<tr>
<td>Infiltrate</td>
<td>Upper lobes</td>
<td>Lower lobes, multiple sites, or miliary</td>
</tr>
<tr>
<td>Cavitation</td>
<td>Common</td>
<td>Uncommon</td>
</tr>
<tr>
<td>Adenopathy</td>
<td>Uncommon</td>
<td>Common</td>
</tr>
<tr>
<td>Effusion</td>
<td>Uncommon</td>
<td>More common</td>
</tr>
</tbody>
</table>

### Can this be TB?

**“Old / Healed” TB**
- Ca++ granuloma–Ghon lesion
- Ca++ granuloma and hilar node calcification–Ranke complex
- Apical pleural thickening
- Fibrosis and volume loss
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Summary:
• Remember: Technical quality can significantly impact your CXR interpretation
• Develop a systematic approach (and use it every time!)
• Practice identifying normal CXR anatomy
• Important to characterize and describe lesions—this can help with your differential diagnosis
• Whether typical or atypical
  ➔ TB can always fool you!

Questions?