Basic Radiology: Chest X-Ray Fundamentals

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Learning Objectives

This workshop is geared toward the Primary Care PA. Upon completion of this workshop, the participant should be able to:

• List image & quality considerations of the chest x-ray study
• Recognize basic normal thoracic radiographic anatomy
• Perform a systematic review of the chest x-ray using an: “A, B, C, D, E” approach
• Identify & interpret common radiographic presentation of pathology
• Identify areas where pathology is commonly missed
• Describe useful signs & hints

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Image Quality

Exposure

Underpenetrated

Exposure

Overpenetrated
Bronchovascular structures seen thru heart
T-spine disc spaces barely visible thru heart
Diaphragm: 8th-10th posterior or 5th-6th anterior rib

Sternum should be seen edge on.
Posteriorly, you should see 2 sets of ribs.
Spine & lungs darken as you move caudally.

Regionstrauma.org/blogs/ribtestlat.jpg
ultimatexray.blogspot.com
radiologypics.com
CXR Interpretation

• **One** approach to reading a CXR:
  - **A**: Airways
  - **B**: Bones
  - **C**: Cardi mediastinal silhouette
  - **D**: Diaphragm
  - **E**: Everything else (plus lungs!)

**Normal**

- **A**: Airways
- **B**: Bones
- **C**: Cardi mediastinal silhouette
- **D**: Diaphragm
- **E**: Everything else (+lungs)

**Selected Pathology & CXR Findings**
Inflammatory "infiltrate" (pus) in alveoli → consolidation of airspaces

Consolidation

- "Infiltrate"
- Airspaces filled with pus (pneumonia) or other fluid (inflammation, CA, blood)
- Usually no loss of lung volume

Silhouette Sign

- Loss of the silhouette or lung/soft tissue interface caused by a mass or fluid in the normally air-filled lung
A 35-year-old man comes to the emergency department for evaluation of fever, and productive cough for the past 4 days. Temperature is 39.4°C (103°F). Physical examination shows rales over the right lower anterior chest. Chest x-ray study is shown.
Case 1

- silhouette sign
- Focal area of consolidation by right heart
- Sharp horizontal fissure
- Dx: Right middle lobe pneumonia

Case 2

- A 58-year-old man is being evaluated in the intensive care unit. Two days ago, he was in a high speed car accident, and was treated for a closed right tibia and fibula fracture. Earlier today, he was intubated because of increasing dyspnea, tachypnea, and confusion. Chest x-ray study is shown.

Case 2

- Diffuse bilateral infiltrates
- Appropriate positioning of ET tube (5 cm above carina or midway between clavicles & carina)
- Dx: ARDS
LVH & Pulmonary Edema

Alveolar Edema

Left ventricular hypertrophy (LVH) can lead to pulmonary edema. In pulmonary edema, there is an accumulation of fluid in the alveoli, which can cause difficulty breathing.

Pulmonary Edema

- ↑ prominence of interstitial lines
- Kerley B (septal) lines
- Cephalization of the pulmonary vasculature
- Peribronchial cuffing

Radiographic features of pulmonary edema include:

- "Bat wing" pattern
- Air bronchograms

Normal: < 50% of thoracic diameter

Bilateral perihilar infiltrates
A 58-year-old man is seen in the emergency department because of increasing dyspnea and orthopnea for the past 2 days. Pulse rate is 98/min, blood pressure is 132/84 mmHg, respirations are 22/min. Physical examination shows bilateral scattered rales, intermittent wheezes, and a S3. Chest x-ray study is shown.

Case 3

Cardiomegaly
Prominent bilateral pulmonary vasculature
Cephalization of vessels
Kerley B lines
Dx:
- Heart failure
- Pulmonary edema

Emphysema
Dilated Airways
Emphysema

- Bilateral diffuse hyperinflation, flattening of diaphragms, ± bullae
- Narrowing of the cardiac silhouette

Case 4

- A 66-year-old woman is seen in the office for progressive shortness of breath for the past 2 months. She smokes 2 packs of cigarettes per day for the past 40 years. Physical examination shows pursed lip breathing, and mild curvature of the thoracic spine. Heart sounds are distant, but without murmur or gallop. Lung sounds are normal. Chest x-ray study is shown.
Pulmonary Nodules & Masses

- Most common nodule: granuloma

Solitary Pulmonary Nodule

- Discrete, well-marginated round opacity < 3 cm diameter
- Surrounded by lung parenchyma
- Does not touch hilum or mediastinum
- Ø adenopathy, atelectasis or pleural effusion

Solitary Pulmonary Nodule

- Calcification pattern (if present):

  - Diffuse
  - Central
  - Stippled
  - Eccentric
  - Popcorn
  - Laminar, Concentric

  Most likely benign

Other possibilities:
- Cysts, hemangiomas, lipomas + many more
Mediastinal Lines

- Paratracheal line
- Aortopulmonic window
- Paraspinal line
- Paraortic line
- Azygoesophageal line or recess

Mediastinum

- Mediastinum: ≥ 8 cm (supine)

Mediastinum & Hila

- Hodgkin Disease: Mass in aortopulmonary window
- Mass in retrosternal space

Sarcoidosis

Mediastinum & Hila

- Mediastinum - lines?
- Hila - dilated vessels or nodes?

Nodes - there are round densities where you don't expect to see blood vessels
A 68-year-old man is seen in the emergency department because of sharp tearing chest pain radiating to the upper back that began 1 hour ago. He is lightheaded, and has nausea. Pulse rate is 80/min, blood pressure is 200/110 mmHg, respirations are 18/min. Physical examination shows grade II/VI diastolic murmur over the aortic area, and diminished pulses in both lower extremities. Chest x-ray study is shown.

- Widened mediastinum
  - > 8 cm
- Tracheal shift (right)
- Dx: aortic dissection

Hemopneumothorax
A 27-year-old woman is evaluated in the emergency department for left-sided chest pain, and shortness of breath. During the primary survey, decreased breath sounds are heard over the left chest wall. Chest x-ray study is shown.

- Visceral pleura edge is seen
- No vascular markings on outer lung field
- Air-fluid level behind left diaphragm
- Scoliosis!
- Dx: Pneumothorax
**Pneumothorax: Size or %.?**

- "Small" < 3 cm
- "Large" > 3 cm

- "Small" < 2 cm
- "Large" > 2 cm

\[ \approx 50\% \] pneumo

- **Small** < 3 cm
- **Large** > 3 cm

- **Small** < 2 cm
- **Large** > 2 cm

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**Pleural Effusion**

- Fluid accumulation in the pleural cavity:
  - serous fluid (transudate or exudate)
  - pus (empyema)
  - blood (hemothorax)
  - lymph (chylothorax)

- Fluid collection in pleural space → blunting of costophrenic angle

- Minimum volume on XR:
  - \( \approx 250 \) mL on PA view
  - \( \approx 75 \) mL on lateral view

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**Pleural Effusion**

- Lateral decubitus view → fluid "layering"
A 28-year-old man is seen in the office because of fever, chills, and productive cough for the past week. Over the past 2 days, he has developed left-sided chest pain, and progressive shortness of breath. Pulse rate is 110/min, blood pressure is 108/72 mmHg, respirations are 28/min, and temperature is 39.4°C (103°F). Physical examination shows decreased breath sounds over the lower ⅔’s of the left chest. Chest x-ray study is shown.

- Opacification (white out) of lower ⅔ of left hemithorax
- Meniscus
- Deviation of trachea & heart to right
- Elevation of right horizontal fissure
- Dx: Pleural effusion (empyema)
**Atelectasis**

- Collapse or incomplete expansion of lung or lung segment

**Characteristics:**
- ↑ opacity of airless lobe (+ volume loss)
- displacement of fissures, hilar & cardiomiadiastinal structures **toward** side of collapse
- elevation of ipsilateral hemidiaphragm
- ↑ lucency of aerated lung
- ± silhouette sign

**Atelectasis Patterns**

- **RUL atelectasis**
  - “Δ” density
  - Right tracheal shift
  - ⊙ retrosternal clear space on lateral view

- **RML atelectasis**
  - Silhouette sign right heart
  - “Δ” density on lateral view
- **RLL atelectasis**
  - “Δ” density right heart
  - Right tracheal shift
  - Elevation right diaphragm
  - “Δ” density posterior CP on lateral view

- **LUL atelectasis**
  - General haze over left lung
  - ± left hilar mass
  - Left tracheal shift & elevated left diaphragm
  - ø retrosternal clear space

- **LLL atelectasis**
  - “Δ” density left heart
  - Elevation left diaphragm
  - “Δ” density posterior CP on lateral view