Chest X-ray Interpretation for the Clinician

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Chest X-ray Interpretation

✧ **Objectives:**

1) To review basic anatomy seen on the plain chest x-ray.

2) Discuss an approach to common chest x-ray presentations seen in common lung diseases.

3) Discuss uncommon chest x-ray presentations in lung diseases (common and uncommon).

4) Discuss an approach to chest x-ray interpretation in the critically ill patient.
CXR Interpretation for the Clinician
Pearls of Wisdom

✶ Previous/prior CXRs are invaluable in aiding the interpretation, if possible have them available when looking at the current CXR.

✶ The knowledge of the patient’s history and physical findings by the reader is very helpful.

✶ The hardest CXR to read? *Normal CXR!*

✶ Read 100s of CXRs. Read the CXR of every patient you see! Never accept the reading of “Normal” CXR without viewing it yourself!

✶ Don’t read the radiologist’s report before looking at the CXR. Look at each one as a test.

✶ Describe to yourself what you see before thinking of the differential diagnosis.
Reading a CXR

❖ Begin ~ 6’ away and then move closer
❖ Don’t stop with the first abnormality you see
❖ Directed systematic visual approach
❖ Non-mnemonic way to review whole CXR:
  ❖ Lung parenchyma and airways
  ❖ Mediastinum
  ❖ Chest wall including; ribs, diaphragms, pleura, vertebrae, all extrathoracic structures.
  ❖ If ICU/CCU patient, lines and tubes first.
Approach to the CXR: Technical Aspects

- Name of patient, date
- Type of film and position markers: PA vs AP/ Right vs Left
- Patients position: Upright or erect/ semi erect/ supine/ lateral etc.
- Technical Quality: Penetration/exposure
- Lung volumes
- Foreign objects: lines, tubes, drains, ECG leads. Non-medical objects; bullets, glass, etc.
Approach to the CXR: Technical Aspects

- Positioning/Rotation:
  - medial clavicle heads equidistant to the spinous process
- Lung volumes: 6 ribs anteriorly (5 to 7), 9 to 10 posteriorly
- Penetration/Exposure:
  - thoracic intervertebral disc space just visible (looking through the heart)
Chest Xray Technical Aspects

- PA film minimizes magnification of the cardiac silhouette/shadow.
- AP view magnifies the clavicles, sternum and mediastinal structures (heart, aorta, pulmonary vessels).
- Supine position widens the heart and mediastinum and changes the normal physiology of the pulmonary blood flow.
Penetration
Thoracic Imaging Strategies

✧ Approach to image interpretation
  ✧ What is the expected normal and variant anatomy?
    ✧ Is something absent?
    ✧ Is there some additional structure present?
  ✧ Look at the bones and soft tissues
  ✧ Look at the heart and mediastinum
  ✧ Look at the lungs and pleura
  ✧ Look at the airways
  ✧ Look at the diaphragms and upper abdomen
Normal PA and Lateral Film
Look at the bones ...

Examine scapulae, humeri, shoulder joints, clavicles, ribs and spine for symmetry.

Identify the 1st rib by its anterior junction with the manubrium then count down the posterior ribs.

The location of an abnormal shadow can be described by its proximity to a particular rib or interspace.
Survey the soft tissues

- Breast tissues (if applicable)
- Skin
- Supraclavicular areas
- Axillae
- Subcutaneous fat
- Muscles

Which film is that of a woman?
What happened to this patient?

Notice the asymmetry of the left breast shadow relative to the right and the surgical clips in the left axilla.

Diagnosis: Left breast cancer treated with lumpectomy and axillary node dissection.
Subcutaneous emphysema and pneumomediastinum

Notice the air within the right lateral soft tissues and in the supraclavicular region. There are also linear streaks of air outlining the mediastinal structures.
What’s wrong with this radiograph?
What’s wrong with this radiograph?

Notice the absence of both clavicles. The heart and aortic arch are also on the right side (situs inversus), a congenital variant.
Normal Anatomy: Frontal CXR

- Heart
- Aorta
- Pulmonary arteries
- Airways
- Diaphragm/costophrenic sulci
- Junction lines
Normal Anatomy: Lateral

- Heart
- Aorta
- Pulmonary arteries
- Airways
- Spine
Heart and Mediastinum

- Three ‘bumps’ on left side (PA view): aorta, main pulmonary artery and LV
  - if more think of adenopathy or LA enlargement

- Superior mediastinum (at level of aortic knob) < 8 cm

- Right paratracheal stripe < 0.5 cm

- The width of the adult heart should be < half the greatest thoracic diameter measured from inside the rib cage at its widest point near the level of the diaphragm.
Signs of congestive heart failure include indistinct pulmonary vessels, peribronchiolar cuffing, and interstitial Kerley lines; often accompanied by cardiac enlargement and pleural effusions.
Hilar Enlargement

- Due to either enlarged vessels, lymph nodes, or presence of abnormal mass
  - Enlarged vessel $\rightarrow$ pulmonary hypertension
  - Enlarged lymph node $\rightarrow$ infection, inflammation, malignancy
  - Abnormal mass $\rightarrow$ usually mediastinal pathology
Lymphadenopathy

- Non-specific presentations:
  - mediastinal widening
  - hilar prominence

- Specific patterns:
  - particular station enlargement
Pulmonary Hypertension
Vasculature

- Well-defined branching structures in the lung parenchyma
- Taper to the periphery, but are only faintly visible in this location
- On upright PA films upper zone vessels are smaller than lower zone vessels.
  - this finding cannot be used in supine portable films where vessels are the same size.
Chest Radiographic Patterns of Disease

- Air space opacity
- Interstitial opacity
- Nodules and masses
- Lymphadenopathy
- Cysts and cavities
- Lung volumes
- Pleural diseases
Chest Radiographic Patterns of Disease

- Cardiomedastinal contour abnormalities
- Bone and soft tissue abnormalities
- Below the diaphragm: abdominal and retroperitoneal disease
Review areas:

- Apices
- Behind the heart
- CP angles
- Below the diaphragm
- Soft tissues (breast, surgical emphysema)
- Ribs & clavicle
- Vertebrae
Pathology - Pattern Recognition

- Many radiographic findings are not specific for a disease process
- Several findings in combination are usually more helpful
- In most cases a differential will still exist, but can be aided by the clinical examination.
Air Space Opacity

Components:
- air bronchogram: air-filled bronchus surrounded by airless lung
- confluent opacity extending to pleural surfaces
- segmental distribution
Air Space Opacity: DDX

- Blood (hemorrhage)
- Pus (pneumonia)
- Water (edema)
  - hydrostatic or non-cardiogenic
- Cells (tumor)
- Protein/fat: alveolar proteinosis and lipoid pneumonia
Silhouette Sign

- Loss of the expected interface normally created by juxtaposition of two structures of different density
- No boundary can be seen between two structures of similar density
RML pneumonia
Interstitial Opacity

- Hallmarks:
  - small, well-defined nodules
  - lines
  - interlobular septal thickening
  - fibrosis
  - Reticulation
  - Reticulonodular pattern
Interstitial Opacity: DDX

- Idiopathic interstitial pneumonias
- Infections (TB, viruses)
- Edema
- Hemorrhage
- Non-infectious inflammatory lesions
  - sarcoidosis
- Tumor
Interstitial Pattern
Nodules and Masses

✧ Nodule: any pulmonary lesion represented in a radiograph by a sharply defined, discrete, nearly circular opacity 2-30 mm in diameter

✧ Mass: larger than 3 cm

✧ Miliary: < 3 mm
Lung Nodules and Masses

- Assumed malignant until proven otherwise
- Important features
  - Patient’s age
  - Smoking status
  - Size of lesion
  - Stability of lesion
  - Presence of calcification
  - Border features
- Other causes include benign tumors, inflammatory granulomas, AVMs, hamartomas, sequestration, septic emboli
Nodules and Masses

- Definition: sharply defined, intermediate, poorly defined
- Shape: round, ovoid, lobular, irregular
- Contour: smooth, intermediate, spiculated
- Density: ground glass opacity, mixed, solid
- Size
- Location: central vs peripheral, subpleural/perifissural, perivascular, peribronchial, apical, diaphragmatic
- Calcification: present/absent, distribution (bullseye, popcorn, laminated diffuse (solid) vs eccentric
Pleural Disease: Basic Patterns

- Effusion
  - angle blunting to massive
  - mobility

- Thickening
  - distortion, no mobility

- Mass

- Air

- Calcification
Pleural Effusion

- If free will localize to the dependant portions
- Cannot differentiate transudate, exudate, malignancy, empyema, etc. unless associated findings
- Unless shown to move, usually cannot differentiate from pleural thickening/masses on radiographs
Pleural Effusion

- Lateral:
  - May see > 100 cc
  - Homogeneous opacification of the posterior costophrenic angle
  - Superior concave meniscus
  - If lateral normal, a clinically significant effusion is excluded
Pleural Effusion

- PA film
  - May see > 175 cc, usually 200 – 400 cc
  - Obliteration of costophrenic/cardiophrenic angles
  - Meniscus convex toward the lung
Pleural Effusion

✧ Supine:
  ✧ Seen when > 500 cc
  ✧ Opacification of lateral costophrenic angles
  ✧ Generalized density/haziness to hemithorax
  ✧ Obscured diaphragm contour
  ✧ Will still see well-defined vessels if mild-moderate in size (not in consolidation or atelectasis)
Lines and Tubes

- Endotracheal tube should sit a minimum of 2 cm above the carina.
- Mid-trachea, T4 – 6, below the clavicles.
- With flexion and extension the ETT can move 2 to 3 cm.
Diffuse Parenchymal Lung Disease Or Interstitial Lung Diseases

- Idiopathic Interstitial pneumonias
- Connective Tissue Diseases
- Occupational and Environmental Exposures
- Drug-Induced Lung Injury
- Other “Systemic” Disorders
Diffuse Lung Disease

- Infection: > than 40 causes
- Drugs: > 50 causes
- Air space/edema: cardiogenic or non-cardiogenic: > 30 or more causes
- Inflammatory: Sarcoidosis, Hypereosinophilic Syndromes, vasculitides
- CTD: ~ 10 causes
- Occupational/hypersensitivity pneumonitis: > 50 causes
- Pulmonary hemorrhage: Good Pasture’s, idiopathic hemosiderosis, others
- Interstitial pneumonias: DIP/RB-ILD, NSIP, AIP, LIP, UIP, IIP, COP
- Malignancy/lymphoproliferative disorders
- Miscellaneous: Pulmonary alveolar proteinosis, LAM, LCH (Histiocytosis X), CF, alveolar microlithiasis, tuberous sclerosis, etc.
CXR Interpretation Summary

- Practice and repetition. Speak with your Radiologist.
- Prior CXRs are very useful!
- Plain CXR is the starting point, findings on the CXR will direct you towards further imaging.
- Some diseases have certain CXR patterns, but this is not written in stone!
- Always keep the patient clinical presenting features in mind when coming up with your differential diagnosis.