RADY Resident Symposium:
CXR #1 in the World

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Module objectives

By the end of this activity, participants will be able to:

1. Describe the utility of chest radiography
2. State chest radiography anatomy
3. Describe a suggested approach to reviewing CXR
4. Understand the CXR basics of pneumonia, pulmonary edema, CHF, cardiomegaly, atelectasis, aortic aneurysm, lymphadenopathy

(NB: in our Critical Values and Radiographic Aunt Minnie sim labs, we will discuss ‘don’t miss’ and iatrogenic CXR findings)
Module outline

I. Chest radiography facts and figures
II. Anatomy on CXR
III. Approach to chest film interpretation
IV. Cardiopulmonary diseases
Chest Radiography Facts

• Chest film is the most commonly performed radiographic examination in the world, but it is also very difficult to interpret expertly

• Low radiation dose (PA film = 0.01-0.02 mSv) inexpensive examination

• First line imaging for cardiopulmonary diseases
  
  PA and lateral series always preferred over single AP/portable

• Limitations do exist
  
  Not for nodules < 1 cm, subtle rib fx, lung CA screening. Chest radiography is not recommended for rib fx in uncomplicated setting, or for asymptomatic preop patient
Chest Radiography Facts

- Routine and emergent diagnoses in critical settings around the world
  - WHO recommendations for CXR make it the primary means of diagnosis, triage, as well as screening of TB in resource-poor settings
  - In patients receiving mechanical ventilation in the ICU, utilized by about 3/5ths of patients on a daily basis

- In 2019, ongoing research in JAMA about recommendations for CXR utilization in different clinical settings

- Prudent use is important as routine CXR can lead to delays of care, incidental findings, unnecessary radiation, and increased healthcare costs
Chest Radiography Technique

- **PA** = Posterior to anterior, pt is standing, xray beam comes from back and pt chest is against the film
- **AP** = Anterior to posterior, pt is supine or seated, xray beam comes from front and pt back is against the film
- **Lat** = Lateral, pt is standing or seated, beam comes from right and film is on left against lateral chest wall
Chest Radiography Technique

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- **Lat =** Lateral, pt is standing or seated, beam comes from right and film is on left against t wall.
Always view films as if looking at patient!
Portable versus Lateral Erect CXR

Portable film post-op aortic dissection repair

Lateral film same patient
Portable CXR with large bilateral effusions
Chest Radiography: Two vs One

• PA and Lateral series ALWAYS preferred
  Two views provide more information
  Cardiac size is more accurate, pleural effusions are more readily seen, and lesion location can be triangulated

• Portable AP films are more limited but are the only option for critically ill patients
  Single view
  Magnified cardiac silhouette
  Unable to triangulate lesions
  Pleural effusions may not be detected if small
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Normal Anatomy CXR

- Bones
- Lungs
- Pleural space
- Diaphragm
- Heart
- Mediastinum
Q: How do you judge lung volumes, and what is normal?

A: Count POSTERIOR ribs: 9-10 posterior ribs seen above hemidiaphragm on frontal film is normal.
Normal Anatomy CXR: LUNG LOBES

RIGHT:
- Upper lobe
- Lower lobe
- Middle lobe

LEFT:
- Upper lobe
- Lower lobe
Normal Anatomy CXR: DIAPHRAGMS

DIAPHRAGMATIC HIATUS:
- IVC
- Aorta
- Esophagus
Normal Anatomy CXR: CARDIAC BORDERS

PA CXR

CARDIAC CT

RT ATRIUM  LT VENT
Normal Anatomy CXR: CARDIAC BORDERS
Normal Anatomy CXR: MEDIASTINAL LINES

FRONTAL PA or AP
CHECKLIST:
- Trachea
- Carina, RMB, LMB
- Hila/hilar vessels
  (right hilum lower than left, hila = density and size)
- RA border
- LV border
- Aortic arch & desc aorta
Normal Anatomy: MEDIASTINAL LINES

FRONTAL PA or AP CHECKLIST:
- Trachea
- Carina, RMB, LMB
- Hila/hilar vessels (right hilum lower than left, hila = density and size)
- Aortic arch & desc aorta
- RA border
- LV border
Normal Anatomy CXR: MEDIASTINAL LINES

LATERAL CHECKLIST:
- Trachea
- RV and RVOT
- Hila/hilar vessels
  (LMB and LPA, RPA confluence)
- LA contour
- IVC
Normal Anatomy CXR: MEDIASTINAL LINES

LATERAL
CHECKLIST:
- Trachea
- RV and RVOT
- Hila/hilar vessels (LMB and LPA, RPA confluence)
- LA contour
- IVC
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APPROACH TO CHEST FILM INTERPRETATION

CHECKLIST:
1 Technique
2 Rotation
3 Lung Volumes
4 Lung Parenchyma
5 CP Angles
6 Heart Size
7 Bones & Soft Tissues
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RECALL: Normal CXR Appearance
Pneumonia very common disease and one of the most common causes of death worldwide. Causative organisms may be bacterial, viral, or fungal. In pneumonia (particularly bacterial), alveolar spaces are filled with organisms, inflammatory cells, and pus. Lobar pattern of consolidation containing air bronchograms. Peripheral ground-glass opacities are present.
Lobar consolidation containing air bronchograms is the classic appearance seen in bacterial pneumonia. Interstitial disease seen as reticular (mesh-like or netlike), nodular (small round opacities), or reticulonodular (mixed reticular and nodular patterns) with infecting organisms ‘atypical’. These patterns may be found in viral, mycoplasma, or fungal pneumonias.
Case 3: COVID19 Pneumonia

Corona virus disease 19 (SARS, MERS also coronavirus)

Fever, chills, dyspnea, malaise, myalgia, dry cough

Acute: Normal imaging 15%, CXR underestimates disease. On CT: bilateral multifocal lower lobe vs diffuse peripheral airspace (ground glass) opacities and consolidation
Increased pulmonary venous pressure causes early dilation of superior zone veins.

Increased prominence of the vasculature superiorly is cephalization.

Typical for early CHF with approx 15-25 mm HG
Kerley lines are present, consistent with a wedge pressure of approx 25-30 mmHg

Due to thickened interlobular septa

Horizontal lines typically found in periphery
As pulmonary pressure progresses above 30 mm Hg or higher ‘Batwing’ edema appears.

Perihilar opacities

With a high enough wedge pressure, the fluid spills into the alveoli yielding air bronchograms and air alveolograms.
Case 6: Alveolar Pulmonary Edema

As pulmonary pressure progresses above 30 mm Hg or higher ‘Batwing’ edema appears.

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Case 7: Congestive Heart Failure

CHF
Cardiomegaly
Pulmonary edema
Pleural effusions are also common
Case 8: Pulmonary Artery Catheter

SG catheter monitors hemodynamic status

Aids in differentiating cardiogenic from noncardiogenic edema via use of a pressure balloon

Position 2 cm distal to hilum in proximal R or L pulm art

SG risks pulm hemorrhage & infarct if overwedged
Cardiomegaly defined as widest transverse heart diameter greater than half the transverse thoracic diameter on PA film in full inspiration.

False positives:
- Low lung vol
- Chest wall abnl
- Pericardial effusion
- AP view
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False positives
Low lung vol
Chest wall abnl
Pericardial effusion

Case 9: Cardiomegaly
Increased lung opacity with evidence of volume loss
Direct signs: Vascular crowding, displacement of fissures
Indirect signs: Elevation of the hemi diaphragm of the affected lung, mediastinal shift to side of volume loss, rib crowding, obscuration of heart or diaphragm border.

**Silhouette sign**: RUL (mediastinum), RML (rt heart), RLL LLL (hemidiaphragms), LUL (mediastinum)

Case 10: Atelectasis
Case 11 (Schematic): Atelectasis

Patterns of collapse

**Directly from Core Radiology textbook**
Case 12: Atelectasis RML

Can be difficult to detect on frontal radiograph
Silhouetting of R heart border by collapsed lobar segment
Lateral radiograph demonstrates wedge-shaped opacity
Case 13: Atelectasis LUL

Left upper lobe atelectasis demonstrates the ‘luftsichel’ or ‘air sickle’ sign

Abnormal air crescent present when aorta is illuminated against the backdrop of hyperexpanded superior segment of left lower lobe
Thoracic aorta can be dilated tortuous (ectatic) or aneurysmal. Aneurysm defined as maximal transverse diameter > 50% larger than normal vessel. Upper limit normal ascending aorta = 40 mm, and descending aorta = 30 mm.
Case 15: Aortic Injury

Deceleration injury of thoracic aorta aka aortic transection
High mortality
Widened mediastinum, >8cm level arch), obscured or irregular aortic arch, deviation of the trachea to the right of T4 spinous process, deviation of NGT to right of T4 spinous process, left apical cap
Deceleration injury of thoracic aorta aka aortic transection
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Case 15: Aortic Injury
Case 16: Lymphadenopathy

Bilateral hilar LAN: manifested as enlarged lobular hila
Mediastinal LAN: thickening of the right paratracheal stripe and the left paratracheal stripe.
DDx of thoracic lymphadenopathy includes granulomatous disease, HIV, other infection, metastatic disease.

Sarcoidosis
Case 17: Cystic Fibrosis

CXR findings are bronchial thickening, bronchiectasis, atelectasis, focal consolidation, hilar lymphadenopathy, enlarged pulmonary arteries, hyperinflation due to chronic airway obstruction. Severe disease can lead to mucus plugging, pneumothorax, pneumomediastinum, hemoptysis, and pulmonary hypertension.
Case 18: Sickle Cell Disease

SC Disease cardiopulmonary and bone changes namely CM, pulm opacities, atelectasis and peripheral pulmonary infarcts, pleural effusion, bone infarcts in humeral heads and spine (H shaped vertebra), upper abdominal findings (RUQ cholecystectomy clips and auto-splenectomy)
CXR RECAP

- Relatively cheap and widely used
- May demonstrate very subtle findings in a variety of settings and diseases
- May be better than cross sectional imaging depending on indication
- Adopt an organized approach to chest radiograph interpretation and stick with it!
References

• Mandell J. (2013). Core Radiology: A visual approach to diagnostic imaging.


