RADIOLOGIC ASSESSMENT OF THE CHEST

I. Radiation Physics
   A. Discovered by Wilhelm Roentgen in 1895
      1. German physicist
      2. first X-ray was of a hand
      3. named rays “X-rays”
      4. chest X-rays are often called roentgenograms, actual technical term is radiograph
   B. Origin of X-rays
      1. produced from the impact of high velocity electrons from a cathode onto a target anode (tungsten)
      2. rays can penetrate solids and expose a photograph plate
      3. X-rays are waves and are described by the formula
         a. \( v = f \times \lambda \)
         b. \( v \) = velocity (speed of light)
         c. \( f \) = cycles per unit of time
         d. \( \lambda \) = wavelength
         e. velocity is constant therefore, the wavelength of a given wave decreases if the frequency increases
      4. X-rays are part of the electromagnetic spectrum
         a. they have a shorter wavelength but higher frequency than visible or UV light and are much higher than radio or television waves
   C. Practical Use of X-rays
      1. interaction of X-rays and human tissue is based on the energy of the X-rays
      2. higher frequencies produce higher amounts of energy
      3. X-rays have enough energy to pass through less dense atoms -
         a. tissue
         b. skin
         c. air
      4. X-rays are absorbed in varying degrees by heavier atoms -
         a. bone
         c. metal
      5. Order of common densities
         a. gas DARKEST
         b. fat
         c. water (tissue)
         d. bone
         e. metal LIGHTEST
      6. The ability to distinguish densities on X-rays gives it its diagnostic value
   D. Danger of X-rays
      1. X-rays produce ionizing radiation
         a. excessive exposure causes necrosis of tissue
         b. X-rays are monitored by film badges

II. Standard Positions
   A. Posterioranterior (PA) Radiograph
      1. standard PA is performed with the patient standing -
         a. film is next to the anterior chest
         b. shoulders are rotated forward -
      2. film distance is 6 ft.
      3. radiograph is usually taken after the patient has fully inspired -
         a. diaphragm should descend to the 9th - 11th rib
      4. expiratory PA -
B. Anterior-posterior (AP) Radiograph
   1. AP's are used on patients who cannot tolerate or perform a PA -
   2. normally taken with a portable X-ray machine at bedside -
   3. film distance is usually 48 inches
   4. disadvantages of an AP radiograph
      a. magnification of heart and superior portion of mediastinum occurs
      b. less resolution than standard PA
      c. distortion may occur -
      d. extraneous shadows may be present -

C. Lateral Radiograph
   1. often complements a PA radiograph -
   2. the side of the patient's chest is placed against the film cassette
      a. right lateral -
      b. left lateral used most often -
   3. provides a view of structures behind the heart and diaphragmatic dome
   4. used with the PA the viewer can construct a 3-dimensional view -

D. Lateral Decubitis Radiograph
   1. patient lies on either the left or right side when radiograph is shot
      a. right lateral decubitis -
      b. left lateral decubitis -
   2. used to diagnose free fluid in chest -
      a. pleural effusion
      b. fluid in a cavity

III. Inspecting the Chest Radiograph
A. General premise for reading chest radiographs - "You must be able to recognize normal anatomical structures before you can effectively identify abnormal ones."

B. Technical Quality
   1. proper position
      a. rotation -
         1. PA -
         2. lateral -
      b. entire lung should be on film -
   2. evaluate exposure quality
      a. normal -
      b. compare relative densities of heart and lungs
      c. over exposed - everything appears burned out
      d. underexposed - everything appears denser or whiter
   3. assess level of inspiration
      a. full inspiration should show 10 ribs (minimum of 9)
   4. look for name, date, patient number and position markers

C. Sequence of Examination - should be performed in a systematic fashion
   1. mediastinum
      a. assess width, contour, and shifts from midline
      b. anatomy of mediastinum - trachea, carina, cardiac borders, aortic arch, superior vena cava
   2. trachea - (PA) appears as a translucent band overlying vertebral column
      a. carina - (T6)
      b. tracheal shift away from affected area -
      c. tracheal shift towards affected area -
   3. heart - PA, the ratio of the width of heart to thorax is normally less than 1:2
      a. two bulges are seen on the right border of heart -
         1. upper bulge is superior vena cava
         2. lower bulge is the right atrium
   4. hilar regions - right and left should be evaluated for change in size and position
      a. left hilum is normally 2 cm higher than the right
b. increased density may indicate engorgement of hilar vessels
c. vertical displacement may suggest loss of volume in upper lobes
d. lymph nodes may enlarge or calcify -
5. lung parenchyma - examine systematically, top to bottom in thirds
   a. tissue markings should be seen throughout the lung to with 2 mm of pleura
   b. absence of lung markings - pneumothorax or pneumonectomy, COPD, over
      exposure of film
   c. excessive tissue markings - fibrosis, interstitial or alveolar edema, lung compression,
      under exposed film
   d. periphery of lung fields should extend to the pleura, diaphragms, mediastinum
6. pleura should be examined for thickening, presence of fluid, or lesions
7. costophrenic angles should be distinct
   a. blunting of costophrenic angles indicate fluid
   b. diagnostic test - lateral decubitus
8. diaphragm
   a. both right and left hemidiaphragms should be in an upward convex, dome shaped
      contour
   b. right hemidiaphragm is about 2 cm higher than left –
   c. causes of flattening of the diaphragm –
   d. elevation of the diaphragm –
9. subdiaphragmatic air
   a. stomach bubble under left hemidiaphragm
   b. intestinal gas
   c. free air is sometimes seen after abdominal surgery or peritoneal abscess
10. bony thorax includes: ribs, vertebrae, sternum and scapulae
    a. intercostal spaces should be symmetrical and equal over each lung field
    b. intercostal spaces too close together -
    c. intercostal spaces too far apart -
    d. inspect ribs for deformities or fractures -
11. extrathoracic soft tissue
    a. identify breast tissue - note size, location, and observe boundaries
    b. observe for subcutaneous emphysema (air) in soft tissue

IV. Other Radiologic Techniques
A. Fluoroscopy
   1. technique produces X-ray motion pictures
   2. danger noted because of larger doses of radiation than standard radiograph
   3. used to assess diaphragmatic movement, localization of lesions during fiberoptic
      bronchoscopy, coronary and pulmonary angiograms

B. Bronchography
   1. requires the instillation of a radiopaque dye into the lumen of the tracheobronchial tree
   2. any radiograph showing the contrast media in the airway is labeled a bronchogram
   3. contrast media will clearly outline the trachea, carina, right and left main stem bronchi,
      and segmental bronchi
   4. used to diagnose - bronchogenic carcinoma, measure the extent of bronchiectasis
   5. computerized tomography (CT scans) has replaced this procedure

C. Computerized tomography (CT scans)
   1. produces a series of cross-sectional or transverse pictures or tomograms
   2. each image produces a "slice" through the body at a specific level
   3. light to dark images are similar to a standard PA, lateral when describing lung density
   4. CT scans can accurately determine the location, size, and shape of a lesion -
   5. ideal for confirming the presence of mediastinal masses, pulmonary nodules, small lesions
      of the bronchi, pulmonary cavities, small pneumothorax, pleural diseases and small
      tumors (0.3-0.5 cm)
   6. intravenous contrast media may be used with CT scans of the thorax -

D. Magnetic resonance imaging (MRI)
   1. MRI uses magnetic resonance as a source of energy to produce images of the body
2. MRI does not use ionizing radiation
3. MRI is superior to CT scan for identifying congenital heart problems, bone marrow disease, adenopathy, and lesions of the chest wall
4. MRI is used with CT scanning to study mediastinum and hilar region
5. negative aspects: costly, sensitive to motion, poor spatial resolution
6. MRI uses a strong magnetic to produce images - any ferromagnetic clips or appliances can shift under such a strong magnetic field and harm the patient -

E. Pulmonary angiograms
   1. radiopaque contrast medium is injected via right heart into the pulmonary artery
   2. injection is followed by rapid serial pulmonary angiograms
   3. pulmonary vessels will appear white and will be absent where vessel is blocked -

F. Ventilation/perfusion scans
   1. perfusion scan is obtained by injecting macroaggregates tagged with iodine 131 or technetium 99m
      a. injected into right side of heart, aggregates are carried into pulmonary vasculature where they become trapped in pulmonary capillaries
      b. lungs are scanned with a gamma camera, dark areas indicated good blood flow, light areas indicated poor flow
      c. obstruction of capillaries is not significant and macroaggregates break down and are eliminated
      d. useful in detecting: emboli, lung abscess, lung compression, loss of pulmonary vasculature, atelectasis, or alveolar consolidation
   2. ventilation scan is performed with patient inhaling xenon 133 from a closed system
      a. a gamma camera measures distribution of gas through airways, dark areas indicated well ventilated airways, light areas indicated poor or absent ventilation
      b. poor or absent ventilation indicates: airway obstruction, bronchospasm, loss of alveolar elasticity, consolidation, pulmonary edema