



Neonatal & Pediatric Chest Imaging

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Learning Objectives

- Review Related Terminology
- Describe Indications for Imaging
- Compare and Contrast Types of Imaging
 - X-Rays
 - CT Scan
 - MRI's
 - PET Scans
- Examine Normal Imaging
- Review Common Abnormalities
- Furnish Additional References

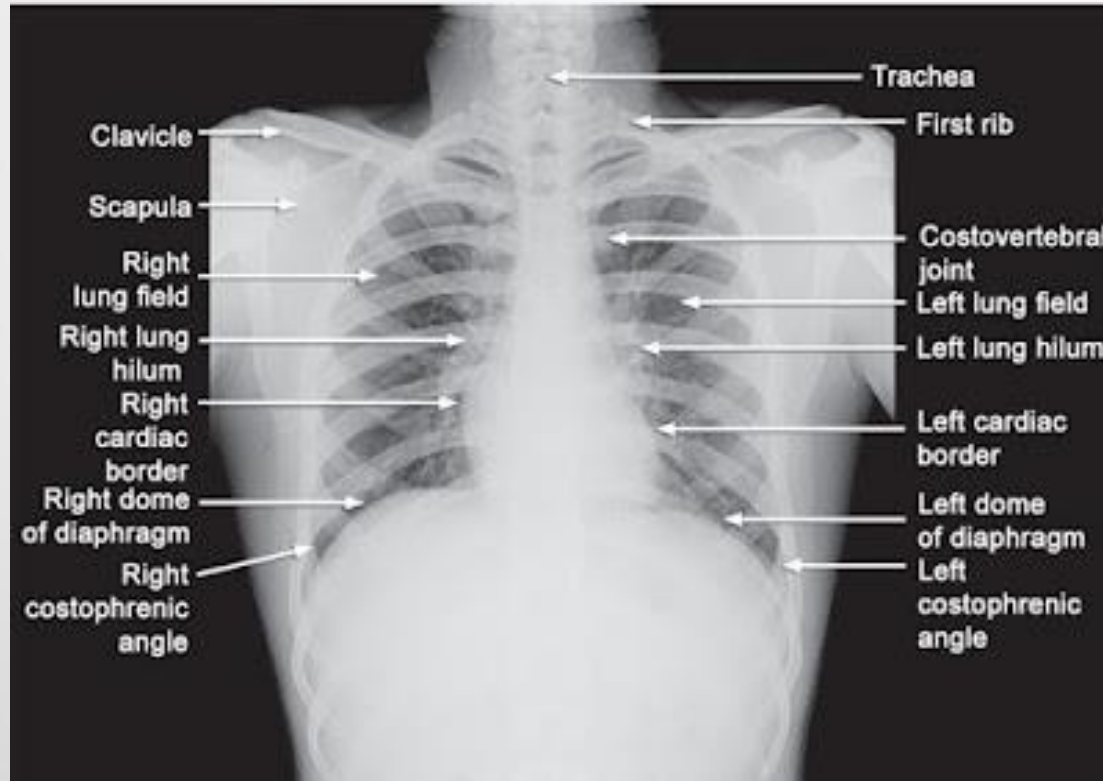
Common Terminology

- **X-Ray:** A penetrating form of high-energy electromagnetic radiation to view body structures
- **Anterio-Posterior:** Front-to-back
- **Posterior-Anterior:** Back-to-front
- **Radio-opaque:** Density which obstruct the passage of energy appearing light/white on X-Ray.
 - Infiltrates (consolidation, atelectasis); Tumor
- **Radio-lucent:** Less dense tissue or air appearing dark on x-ray.
- **CT Scan:** A series of X-rays to create cross sectional images.
- **MRI:** Uses a magnetic field and computer-generated radio waves to create detailed tissue images.
- **PET Scan:** Images of a radioactive drug (tracer) to show both normal and abnormal metabolic activity.

Major Indications

- To determine the positioning of lines, airways and drains.
 - Gold standard in assessing endotracheal (ET) tube placement
 - Mid-tracheal between inferior clavicular border and carina
 - Chest tubes
- To detect gross boney abnormalities.
- To examine for lung abnormalities including but not limited to
 - Hyperinflation
 - Tumors
 - Consolidation & Atelectasis
 - Pneumothoresis

Normal Chest X-Ray (CXR) Key Landmarks



Key Elements of CXR Interpretation



The initial assessment of the pediatric CXR should include:

- Technique of the exam, to include patient positioning, proper exposure and the degree of inspiration
- Position of all tubes and lines and evaluation for pneumothorax, pneumomediastinum, and pneumoperitoneum
- Mediastinal and cardiac silhouettes
- Airway and lungs
- Pulmonary vascular pattern

Airway Obstruction

- Foreign Body
 - Tooth
 - Small toy
- Croup (laryngotracheobronchitis)
 - Church steeple appearance
- Epiglottitis
 - Thumb sign
- Asthma
 - Hyperinflation

Foreign Body Aspiration

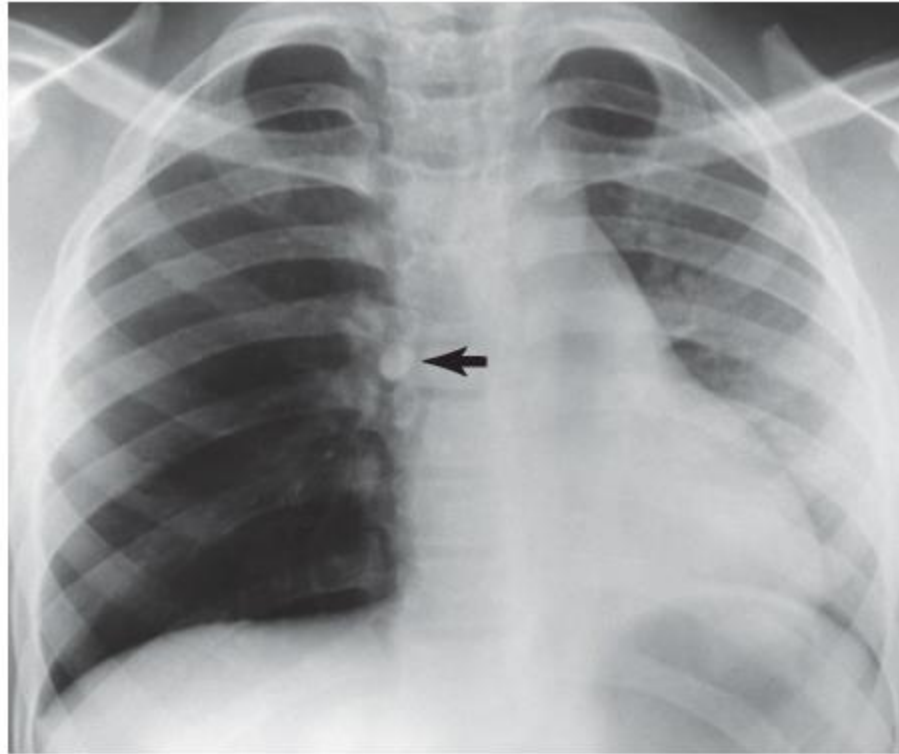
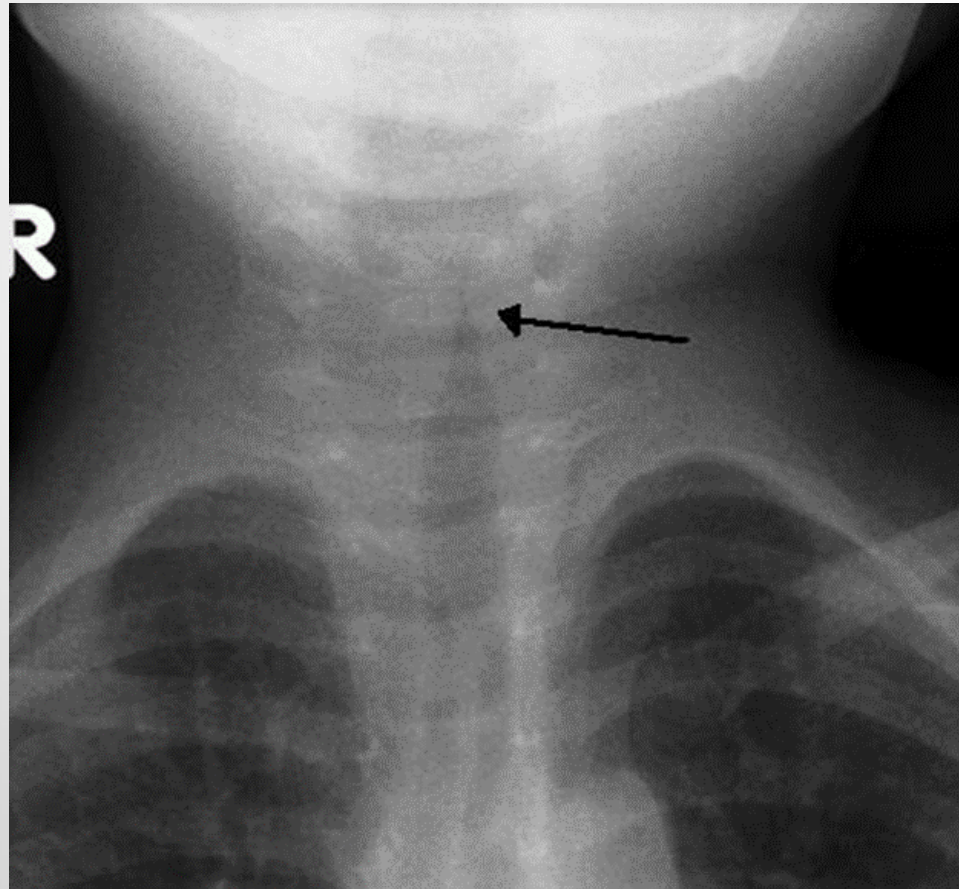
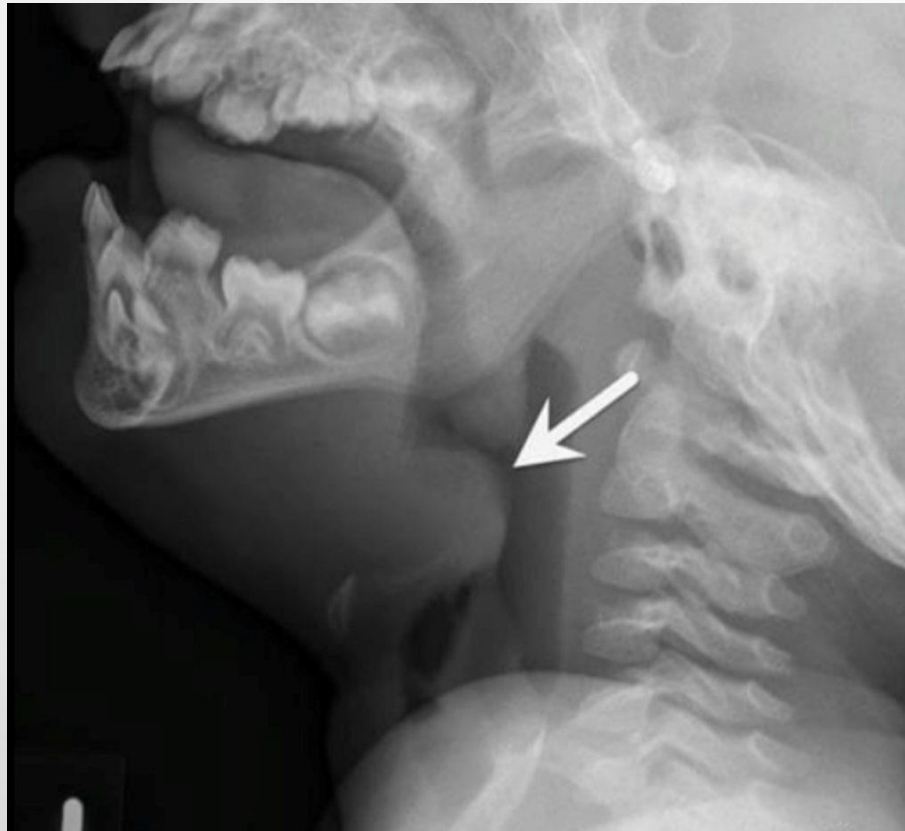


FIGURE 6-1 Expiratory frontal chest radiograph shows normal decrease in left lung volume. Tooth (*arrow*) obstructs the right mainstem bronchus and causes air trapping in the right lung.

Steeple Sign in Croup



Thumb Sign in Epiglottitis



Epiglottitis Vs. Croup

- **Epiglottitis**

- Bacterial-Antibiotics indicated
- Rapid On-set
- Profound illness
- Hospitalization common required.
- Pt. may be drooling and leaning forward with compromised speech
- May need emergent care and airway management.

- **Croup**

- Viral-Antibiotics are not indicated
- More gradual onset
- Mild to moderate illness
- Occasionally requires hospitalization
- Mainly supportive care

Infant Respiratory Distress Syndrome (IRDS)

- **Causes**

- Infants: Prematurity
- Pediatrics
 - Pneumonia
 - Near drowning
 - Inhalation injury
 - Aspiration
- Bronchopulmonary Displasia (BPD), pneumothoraces and pneumomediastinum are common complications, often associated with positive pressure ventilation and low lung compliance.

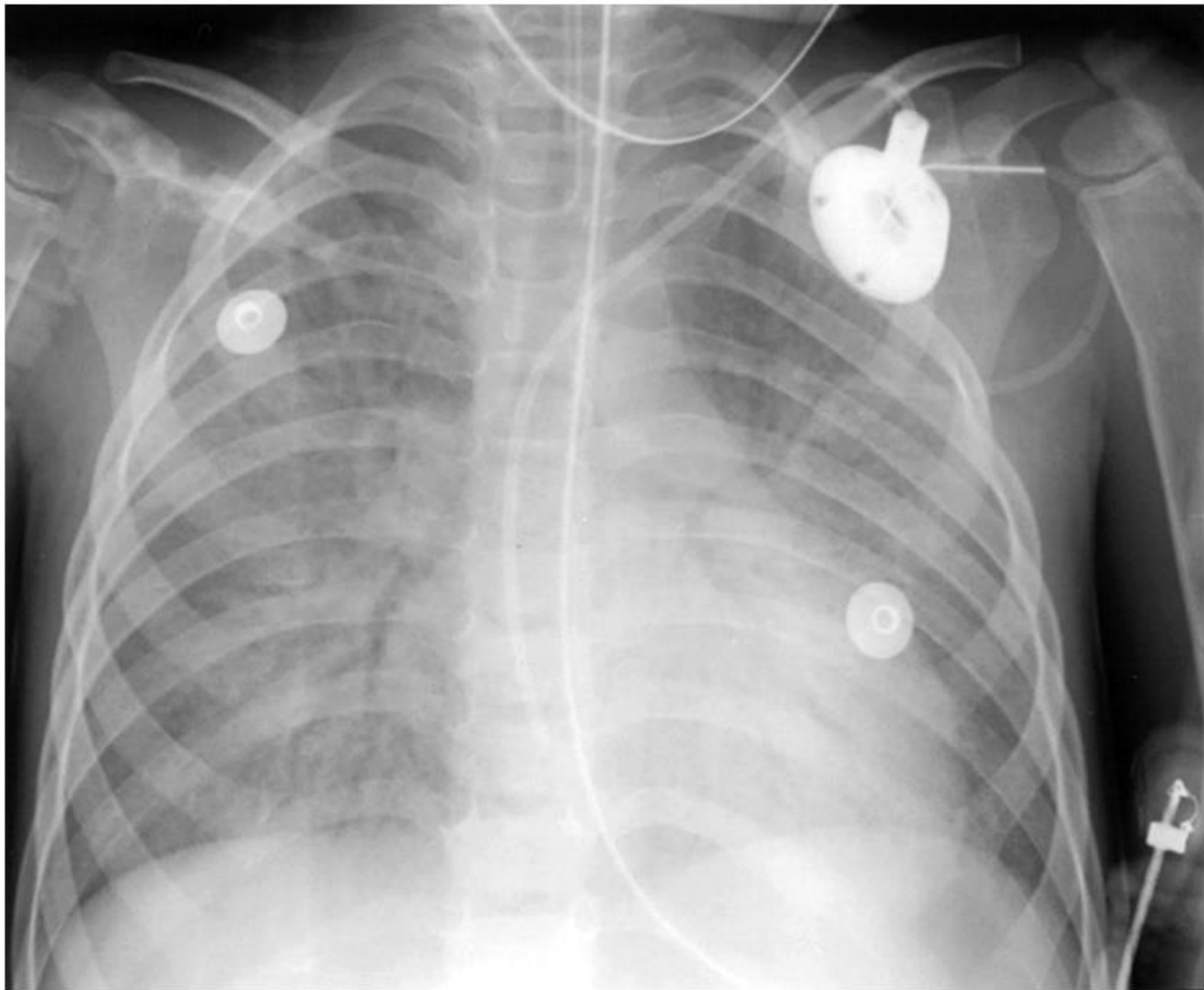


FIGURE 29-1 Chest radiograph of a patient with ARDS. Note the infiltrates in all five lobes, the air bronchograms that appear as a result of areas of consolidation, and the loss of lung volume.

Manifestations & Treatment

Clinical Manifestations

- Hypoxemia
- Hypercarbia
- Increased WOB
- Gradual Increase in A/W pressures/Low Compliance
- Retractions
- Decreased breath sounds

Treatment

- Mechanical Ventilation
 - High FIO₂ and PEEP
- Nasal CPAP
- Oscillatory Ventilation
- Surfactant Replacement
- ECMO

Bronchopulmonary Dysplasia (BPD)

- Premature infants treated with supplemental oxygen and prolonged mechanical ventilation have alveoli not mature enough to function normally.
 - Can be part of the recovery from IRDS.
- Treatments include:
 - Surfactant
 - Kinder, gentler mechanical ventilation
 - Antenatal glucocorticoid therapy.

Bronchopulmonary Dysplasia (BPD)

Bronchopulmonary Dysplasia

- **“Old BPD” (before surfactant and steroids)**
 - Cystic changes, heterogeneous aeration
- **“New BPD” (after surfactant and steroids)**
 - More uniform inflation and less fibrosis, absence of small and large airway epithelial metaplasia and smooth muscle hypertrophy
 - Some parenchymal opacities, but more homogenous aeration and less cystic areas
 - **PATHOLOGIC HALLMARKS:** larger simplified alveoli and dysmorphic pulmonary vasculature



Pneumothorax



FIGURE 22-10A A. Right-sided tension pneumothorax incompletely drained by the intercostal drain. There is flattening of the diaphragm and shift of the midline with compression of the left lung. **B.** Lateral view shows that the chest drain is angulated posteriorly and is not ideally sited to drain the anterior and subpulmonary collection of air leak (*asterisk*).

From Arthur R. The neonatal chest x-ray. *Paediatr Respir Rev* 2001;2:311.

Manifestations & Treatment

Clinical Manifestations

- Hypoxemia
- Increased WOB
- Abrupt Increase in A/W pressures/Low Compliance.
- Retractions
- Unilateral Chest Expansion
- Decreased breath sounds
- Tracheal deviation away from affected side.

Treatment

- If small, may be self resolving
- Chest Tube Insertion

Chest Tube Insertion in Pediatric Patients

DIAGRAM OF CHEST TUBE INSERTION TECHNIQUE

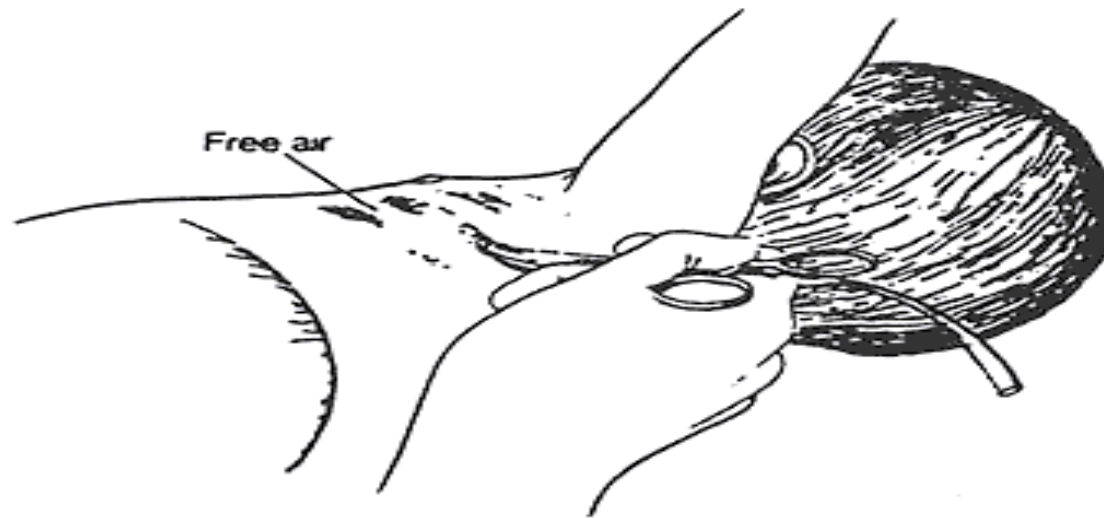



Fig. Hemostat is used as introducer for catheter, which is being inserted in midaxillary line. Because curve of hemostat is aiming anteriorly, when it is pushed off of hemostat (which is then withdrawn), catheter will proceed in that direction to location of free air.

Chest Tube Sizes for Younger Patients



Chest Tube Sizes for Age

		<i>Pneumothorax</i>	<i>Serous fluid</i>	<i>Empyema</i>	<i>Hemothorax</i>
Neonate/Newborn	< 5 kg	8-14 Fr	8-14 Fr	8-14 Fr	14-20 Fr
Infant/Child	5-10 kg	8-14 Fr	8-14 Fr	12-18 Fr	18-24 Fr
	10-15 kg	8-14 Fr	8-14 Fr	18-24 Fr	18-24 Fr
	15-20 kg	8-14 Fr	8-14 Fr	18-24 Fr	18-24 Fr
	20-30 kg	8-14 Fr	8-14 Fr	18-24 Fr	18-24 Fr
Preteen-Adult	> 30 kg	8-14 Fr (perc) 24 F (open)	8-14 Fr (perc) 24 F (open)	24-32 Fr	24-36 Fr

Calculating pediatric tube size for age: $3 \times (4 + \text{age}/4)$

Another Air-Leak: Pneumomediastinum

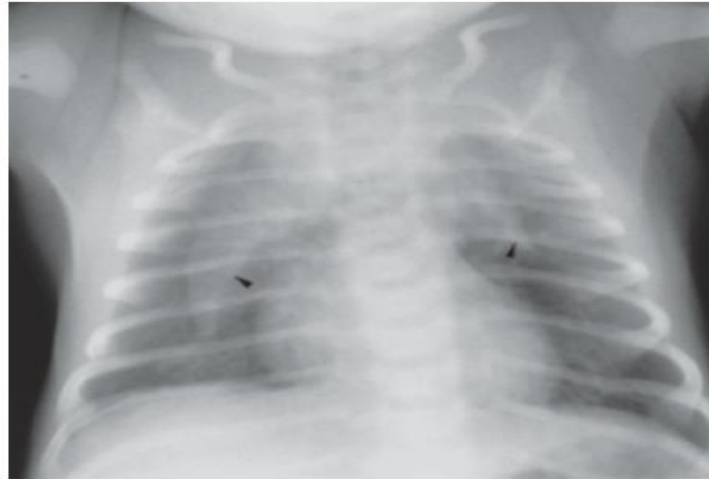


FIGURE 22-12 Neonatal pneumomediastinum. Note the thymus gland outlined by air giving an “angel’s wings” appearance (*arrow-heads*).

From Arthur R. The neonatal chest x-ray. *Paediatr Respir Rev* 2001;2:311.

- The gold standard for diagnosis is CT scan, as one-third of cases are not visualized on x-ray.
- **Treatment**
 - Surgery and washout if esophageal tear is present
 - Often, no significant interventions are required
 - Bedrest and pain management

Yikes! Yet Another Air Leak!- Pneumopericardium

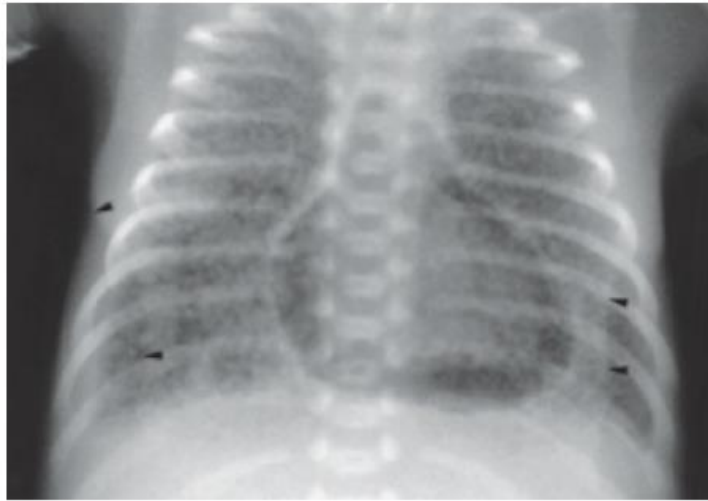


FIGURE 22-13 Pneumopericardium has developed in association with bilateral pulmonary interstitial emphysema. Note bilateral skinfolds at bases simulating a pneumothorax (*arrowheads*).

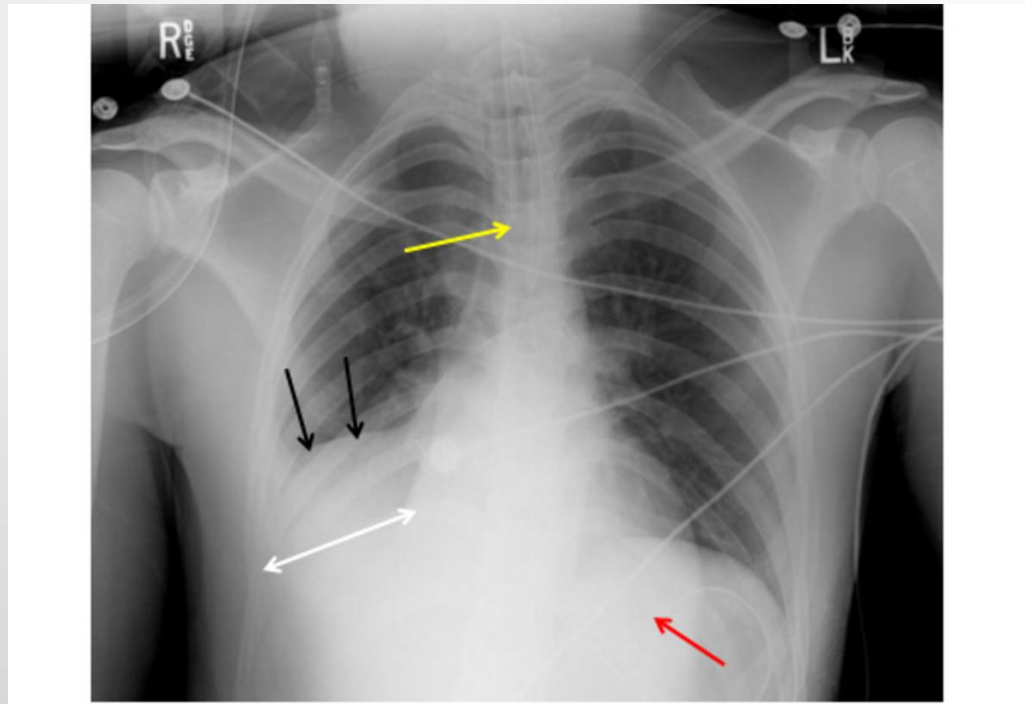
From Arthur R. The neonatal chest x-ray. *Paediatr Respir Rev* 2001;2:311.

- Predisposing Factors: Premature infants with a history of respiratory distress and mechanical ventilation with high pressure
- Treatment:
 - Pericardial aspiration
 - Pericardial tube placement

Atelectasis

- Most atelectasis is subsegmental
- Discoid—platelike opacities
- Ipsilateral mediastinal shift and diaphragm elevation
- Crowding of pulmonary vascular and interstitial markings
- Right upper lobe (RUL) atelectasis
 - Minor fissure shifts upward
 - Triangular wedge of opacity
- Right lower lobe (RLL) and left lower lobe (LLL)

Atelectasis



Manifestations & Treatment

Clinical Manifestations

- Fever
- Decreased breaths sounds.
- Tachypnea/tachycardia
- Hypoxemia
- Increased WOB
- Retractions
- If severe, tracheal deviation towards affected side.

Treatment

- CPT & suctioning
- Bronchodilators/mucolytics
- Pediatric: Hyperinflation or Percussive Ventilation
- Neonatal
 - Bubble CPAP
 - Surfactant Replacement

Pneumonia

RIGHT UPPER LOBE PNEUMONIA



Manifestations & Treatment

Clinical Manifestations

- Fever
- Increased WBCs
- Unilateral chest expansion
- Decreased breath sounds
- Tracheal deviation (toward affected side)
- Increased WOB
- Retractions

Treatment

- Antibiotics
- Fluids
- Antipyretics
- CPT & suctioning
- Bronchodilators/mucolytics
- Pediatric: Hyperinflation or Percussive Ventilation
- Neonatal
 - Bubble CPAP
 - Surfactant Replacement

Hyperinflation Associated with Pediatric Asthma



Manifestations & Treatment

Clinical Manifestations

- Wheezing or decreased breath sounds
- Hypoxemia/Hypercarbia
- Increased WOB
- High A/W pressures/High resistance (PIP-Plateau).
- Retractions

Treatment

- Continuous bronchodilators
 - Weaned to intermittent
- Heliox therapy
- Systemic Steroids
- If severe, intubation & mechanical ventilation

Cystic Fibrosis

- Early changes
 - Peribronchial thickening, atelectasis, air trapping
- Disease progression
 - Finger-like mucoid impaction
 - Bronchiectasis
 - Lobar atelectasis
 - Scarring
 - Pulmonary artery and right ventricular (RV) enlargement
 - Overinflation

Cystic Fibrosis CXR



Manifestations & Treatment

Clinical Manifestations

- Testing:
 - Positive sweat chloride
 - Genetic testing
- Repeated respiratory infections
- Increased WOB
- Retractions
- Digestive problems
- Fatty stools
- Declining PFTs

Treatment

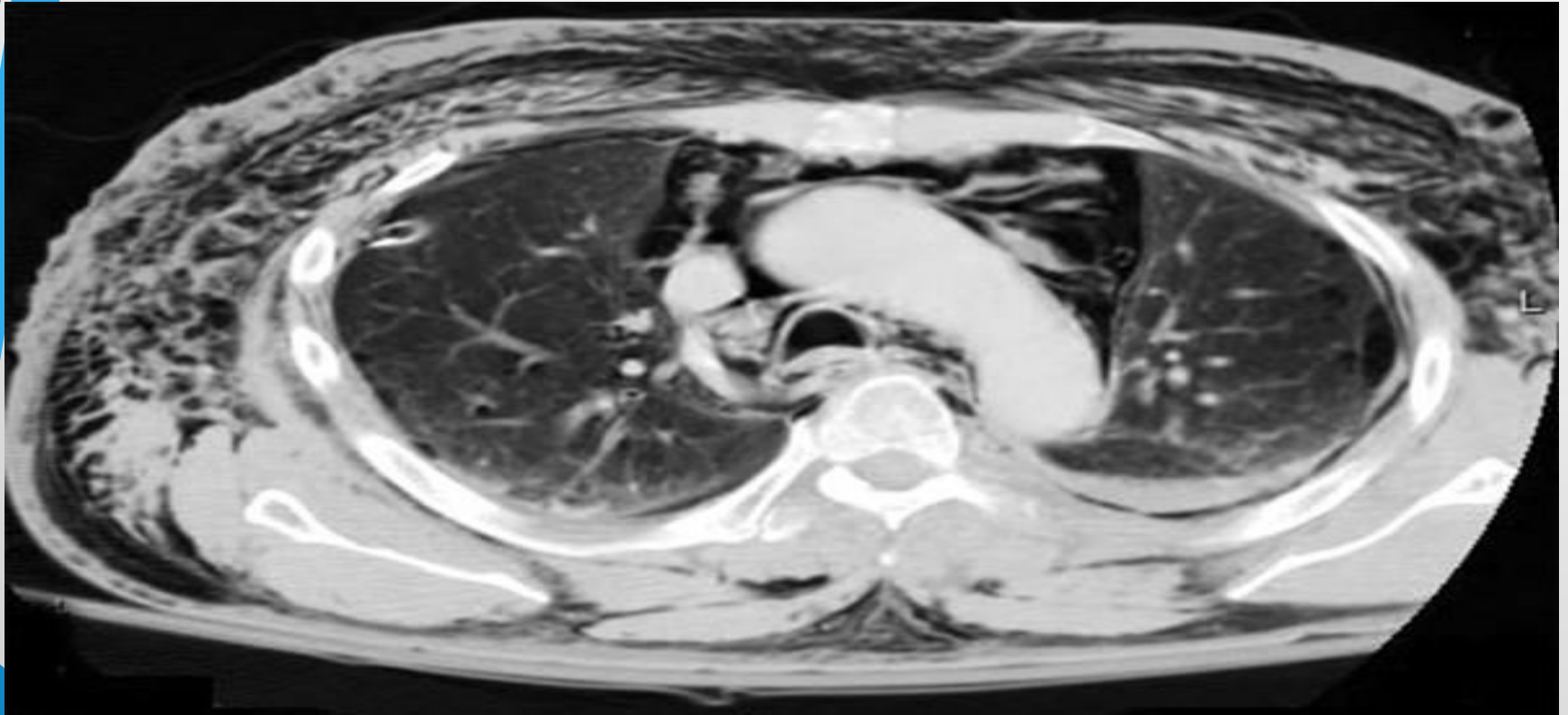
- Aggressive CPT pulmonary toileting
- Percussive ventilation/PEP therapy
- Bronchodilators
- Mucolytics
- Antibiotics for bacterial infections
- Digestive enzyme replacement.
- Lung Transplantation (if advanced)

Other Imaging

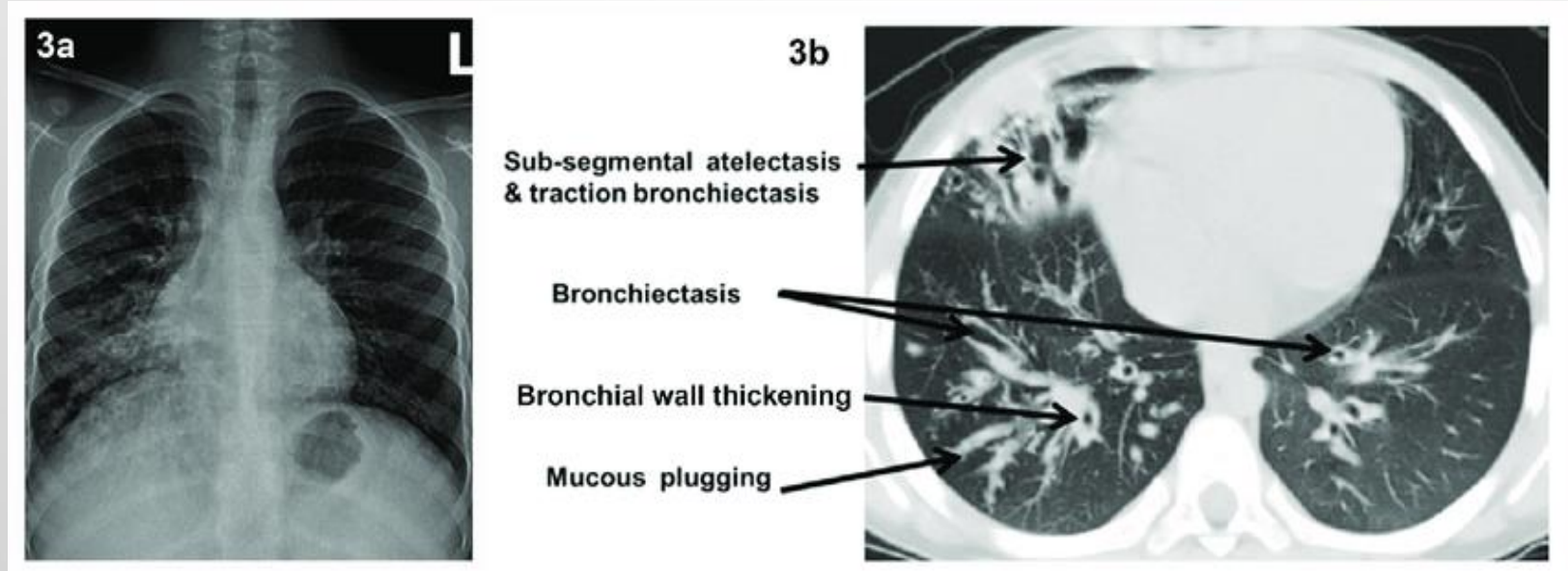


- CT Scan: A series of X-rays to create cross sectional images.
 - Reveals 3-dimensional needed for depth
- MRI: Uses a magnetic field and computer-generated radio waves to create detailed tissue images.
 - Much greater detail/resolution than X-Ray & CT.
- Ultrasound: Uses sound waves to create images.
 - Heart function.
 - Pleural effusion size and location.
- PET Scan: Images of a radioactive drug (tracer) to show both normal and abnormal metabolic activity.
 - Can detect biological changes, which often precede visual ones.
 - Often used to distinguish benign from malignant masses.
 - Identify potential sites of cancer metastasis.

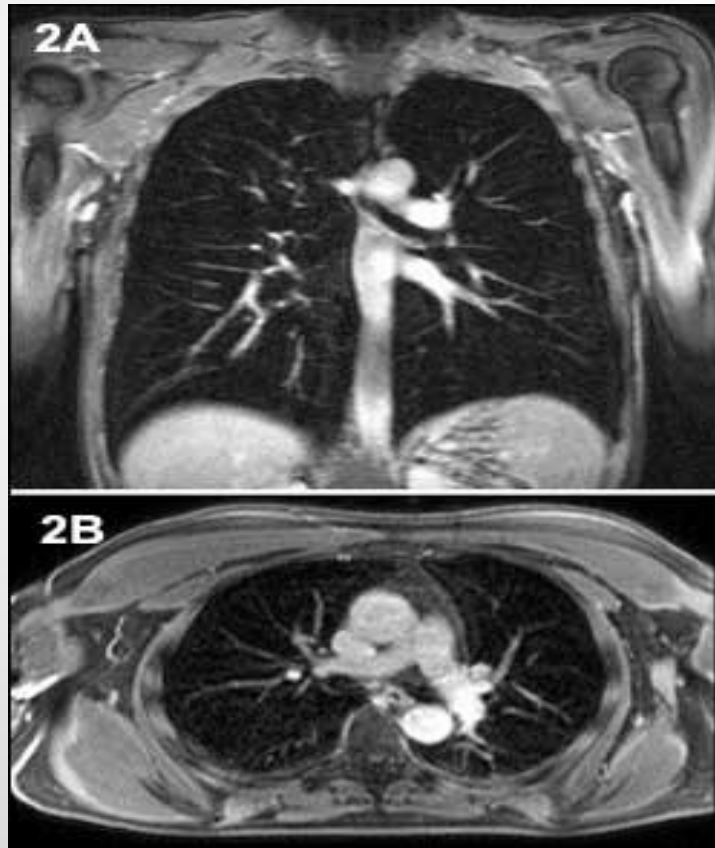
CT Scan of Pneummediastinum



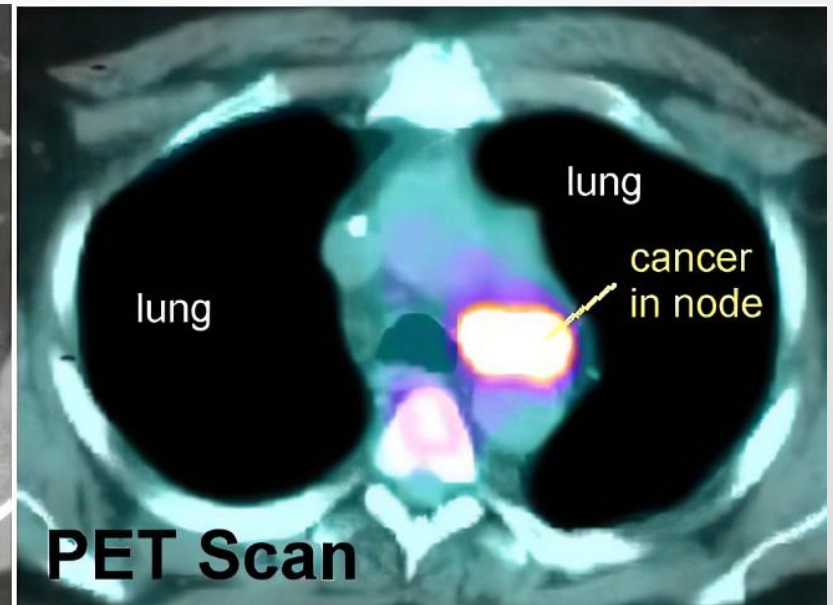
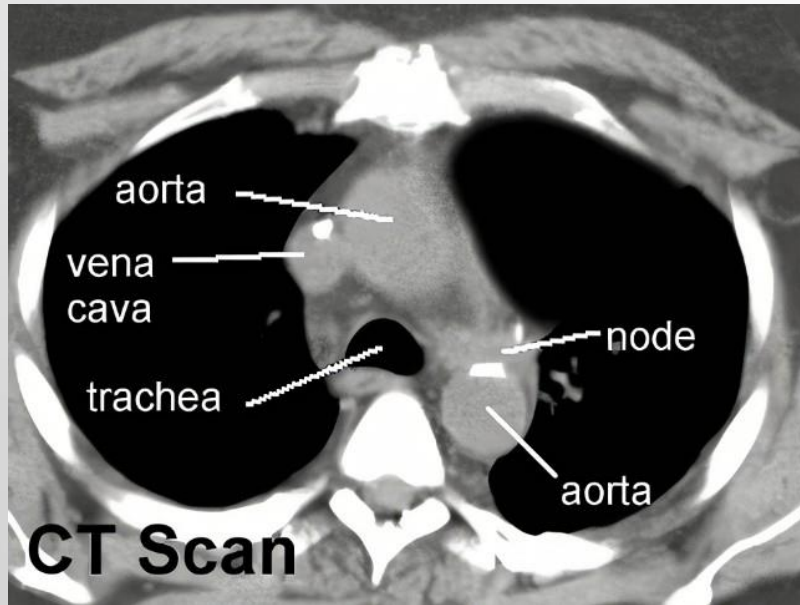
CXR & CT Scan of Cystic Fibrosis



Chest MRI example



CT Scans Vs Pet Scan



Selected Sources & References

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