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Approach to Pediatric Plain Films

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Approach to Pediatric Plain Films

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Pittsburgh, PA

Normal neonatal chest

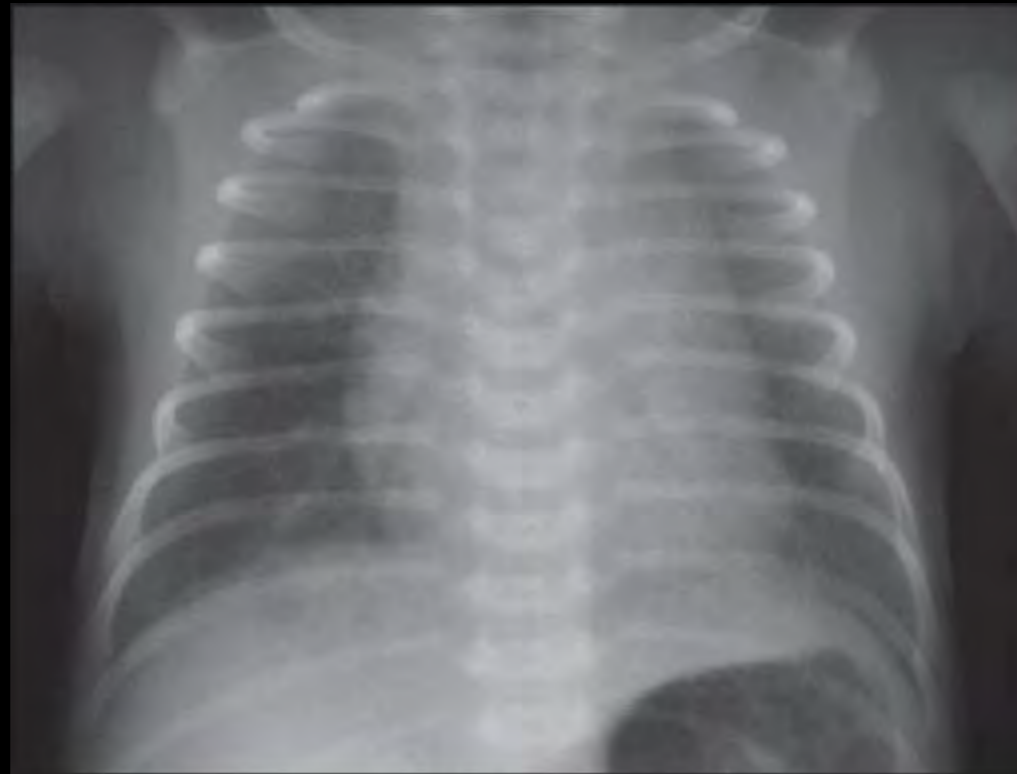
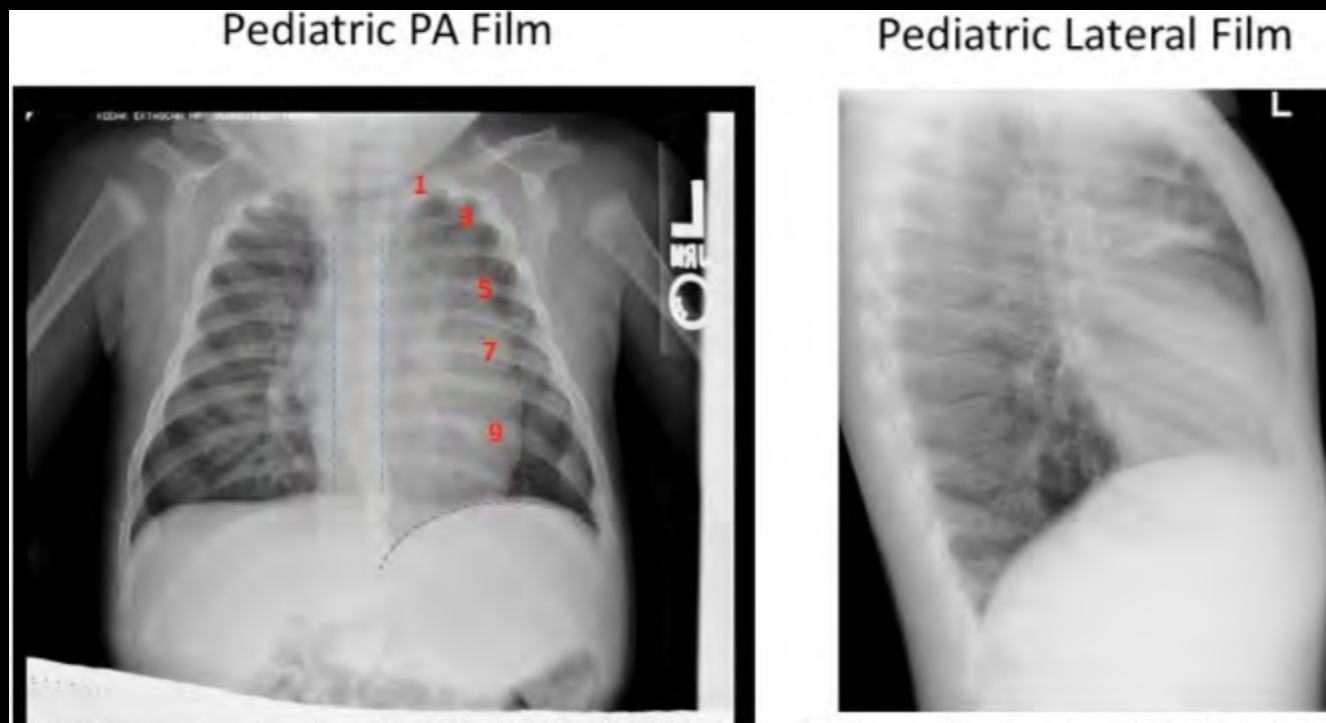


Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance

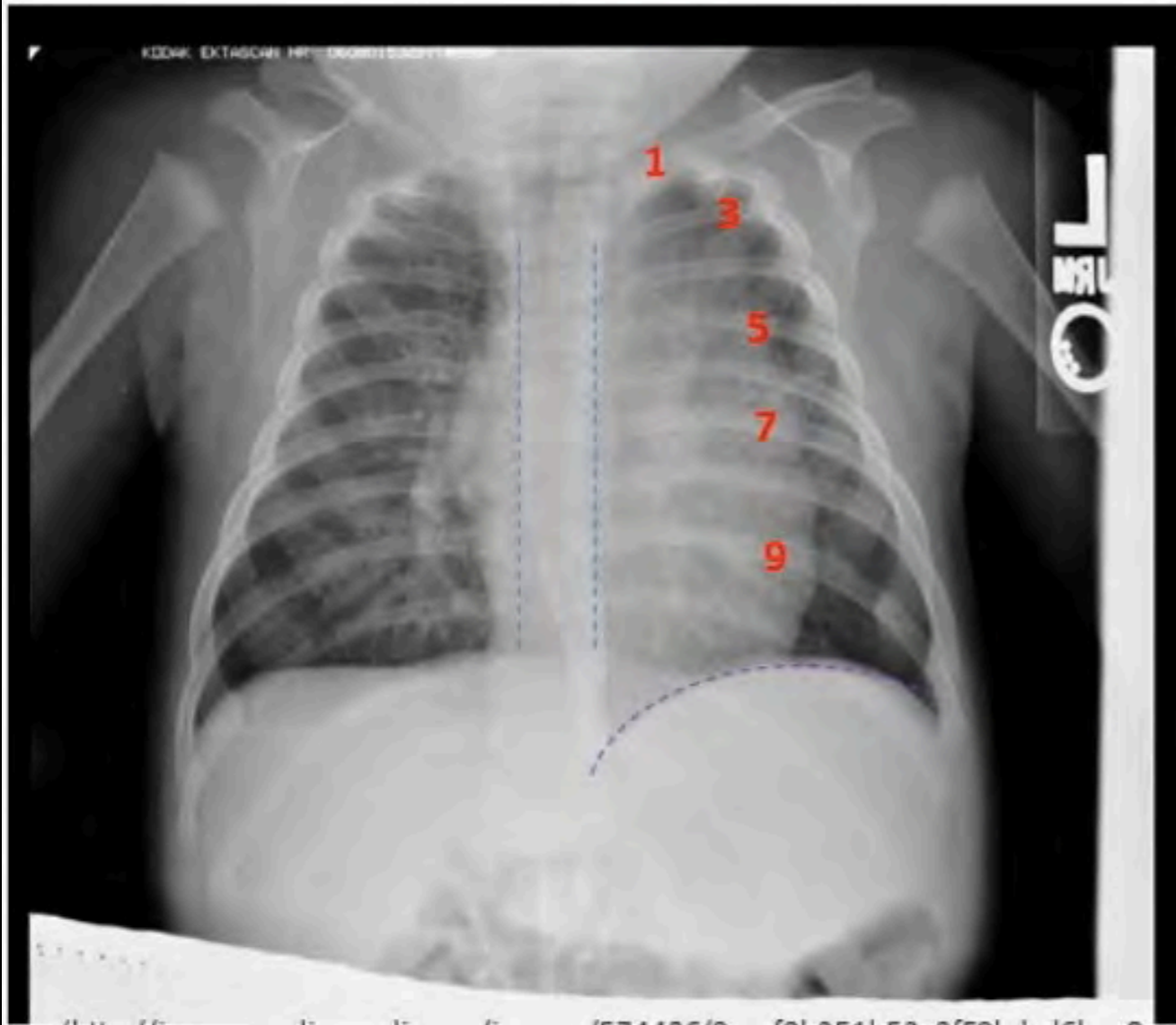
Inside-out or outside-in Approach

- Inside-out approach
 - Begin with mediastinum/heart
 - Lungs/diaphragm
 - Bones
 - Soft tissues



- Penetration: should be able to see thoracic spine through heart, and left hemidiaphragm traced to spine
- Inspiration: 9-10 posterior ribs
- Positioning: Clavicular heads should be equidistant from spinous process

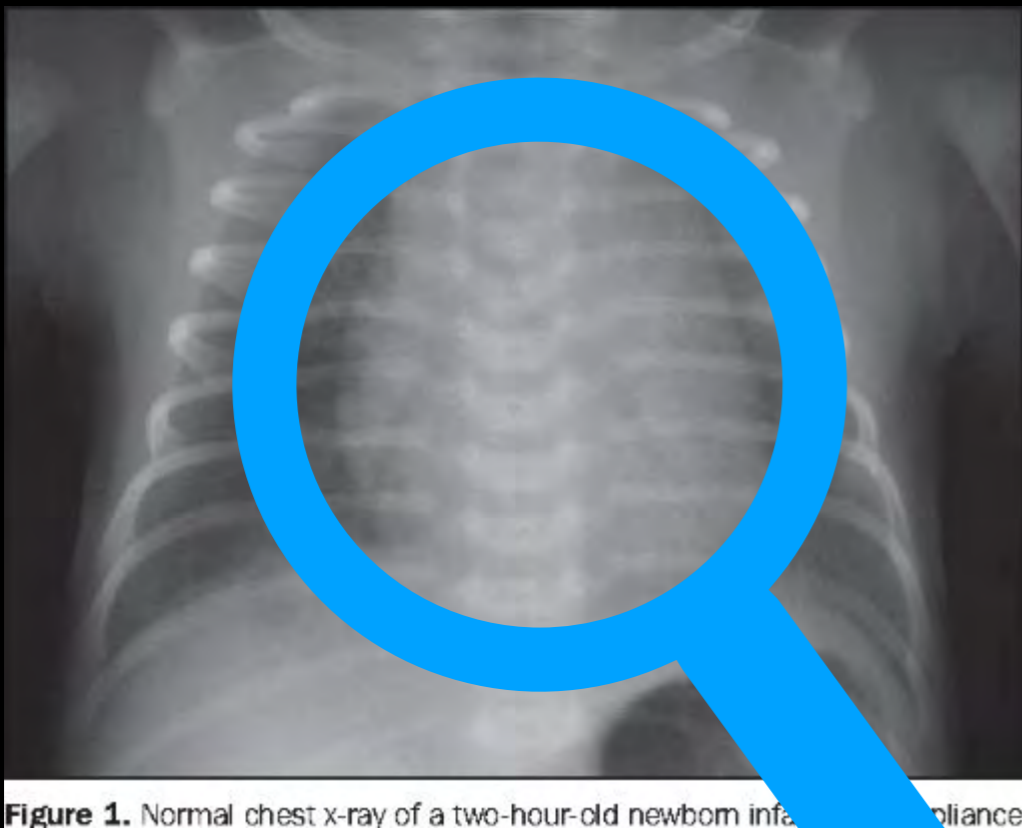
Pediatric PA Film



Pediatric Lateral Film



Inside-Out



- Trachea
- Aorta
- Thymus
- Heart

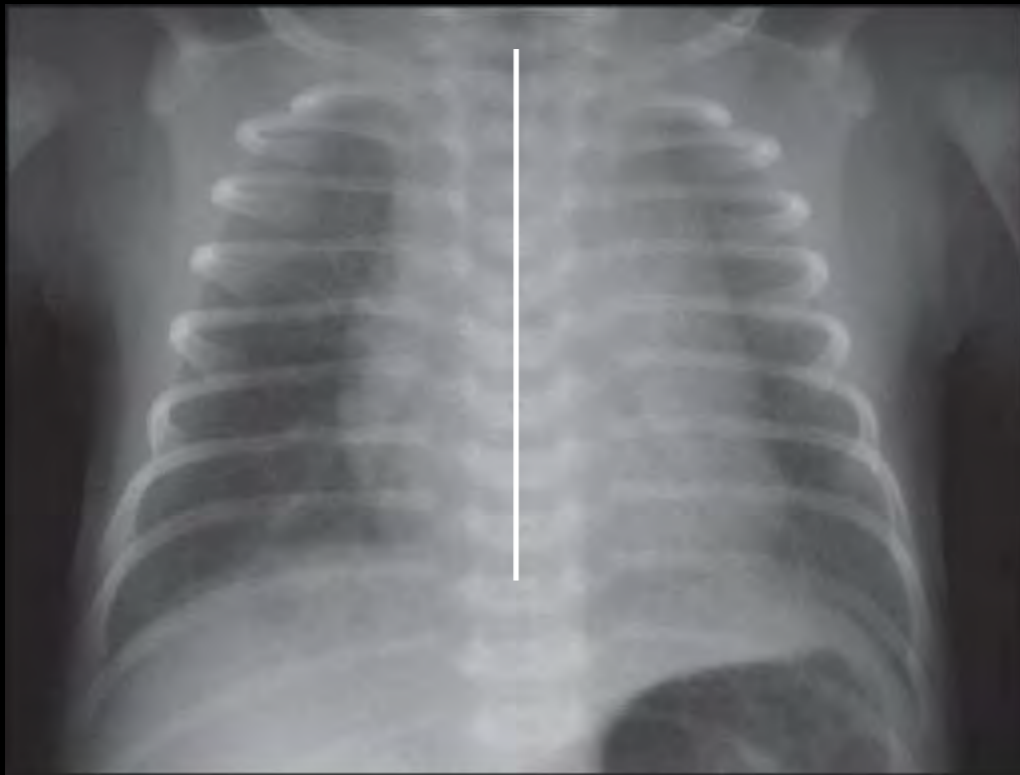
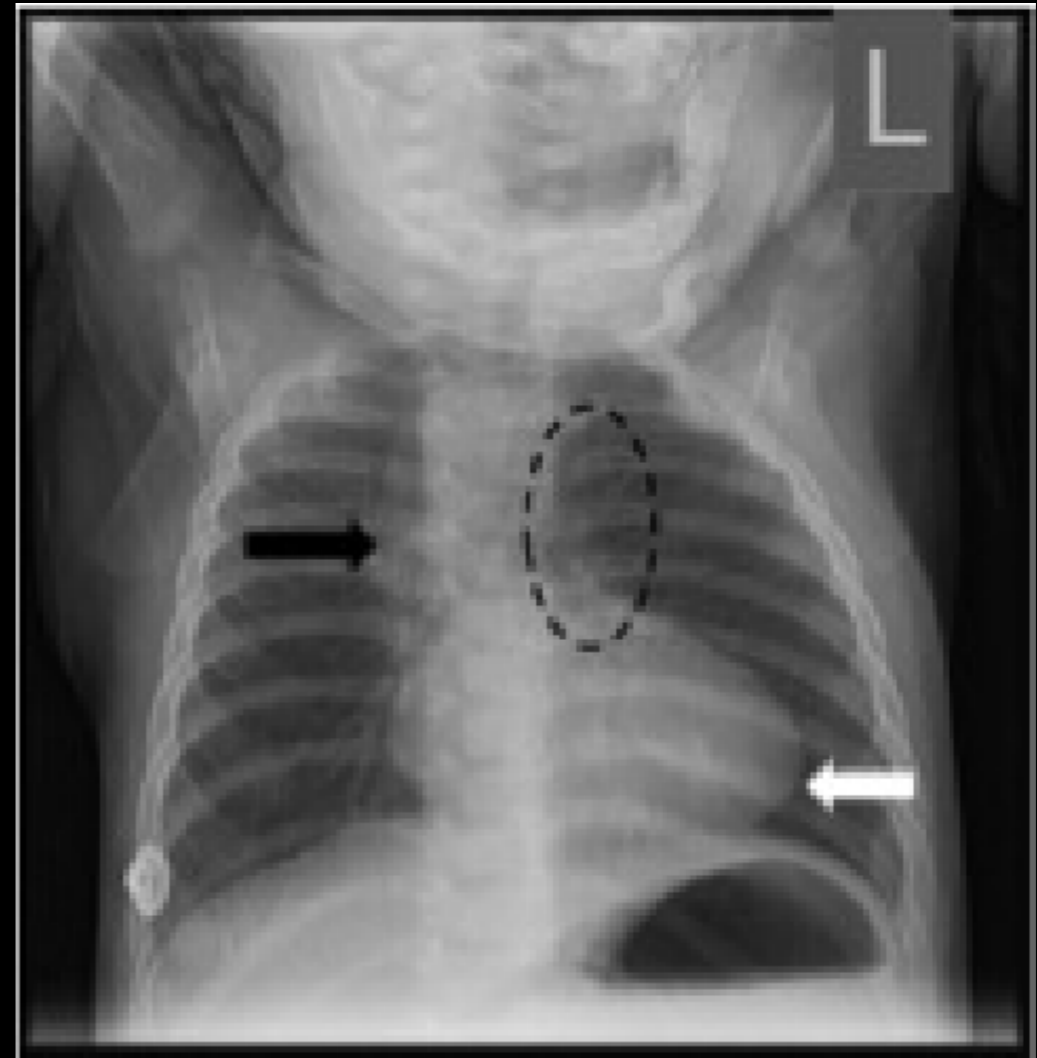


Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance

- “Normal anatomy”
 - Trachea is to the right of midline
 - Left aortic arch
 - Symmetry is your friend
 - —> Right | Left



Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance



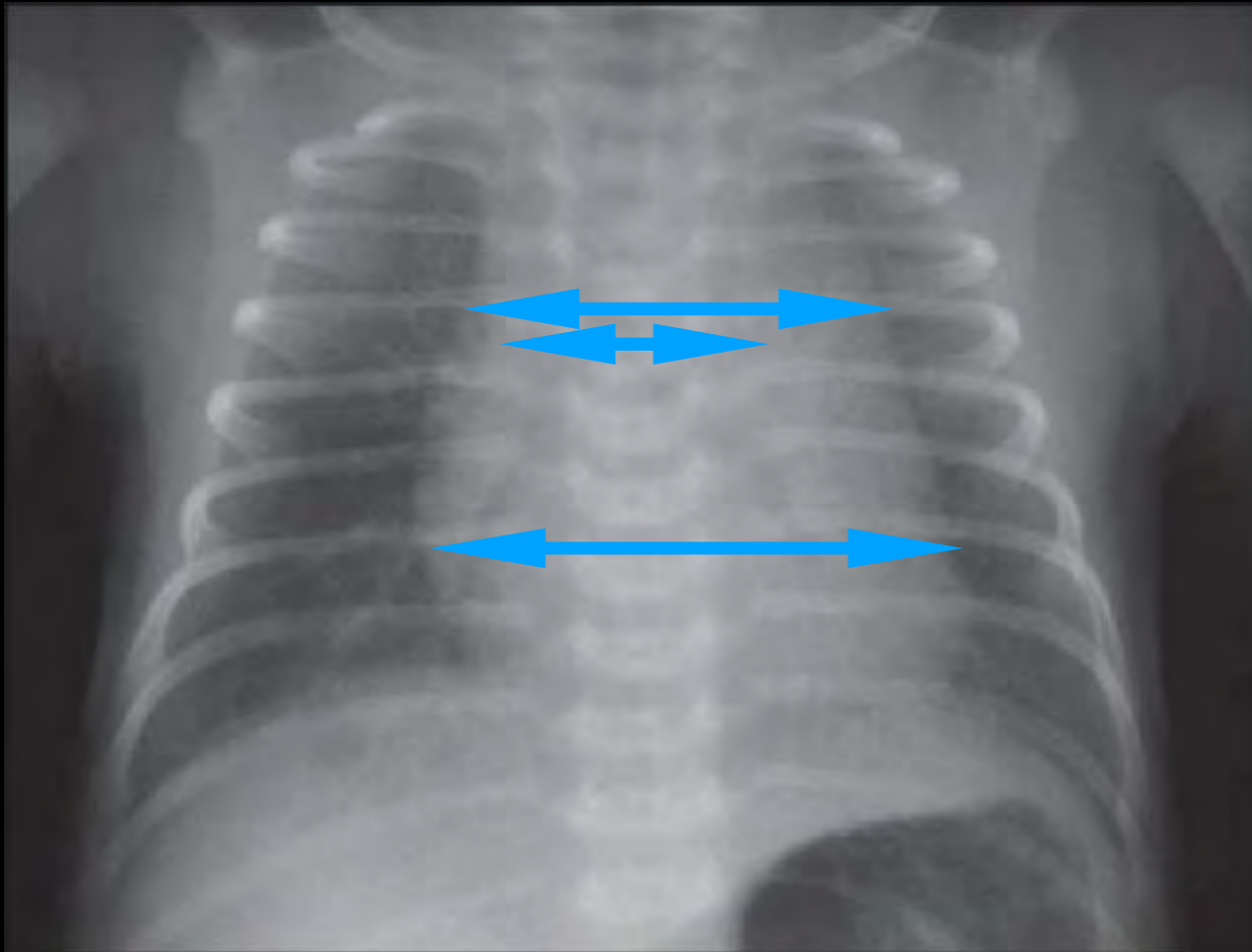


Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance

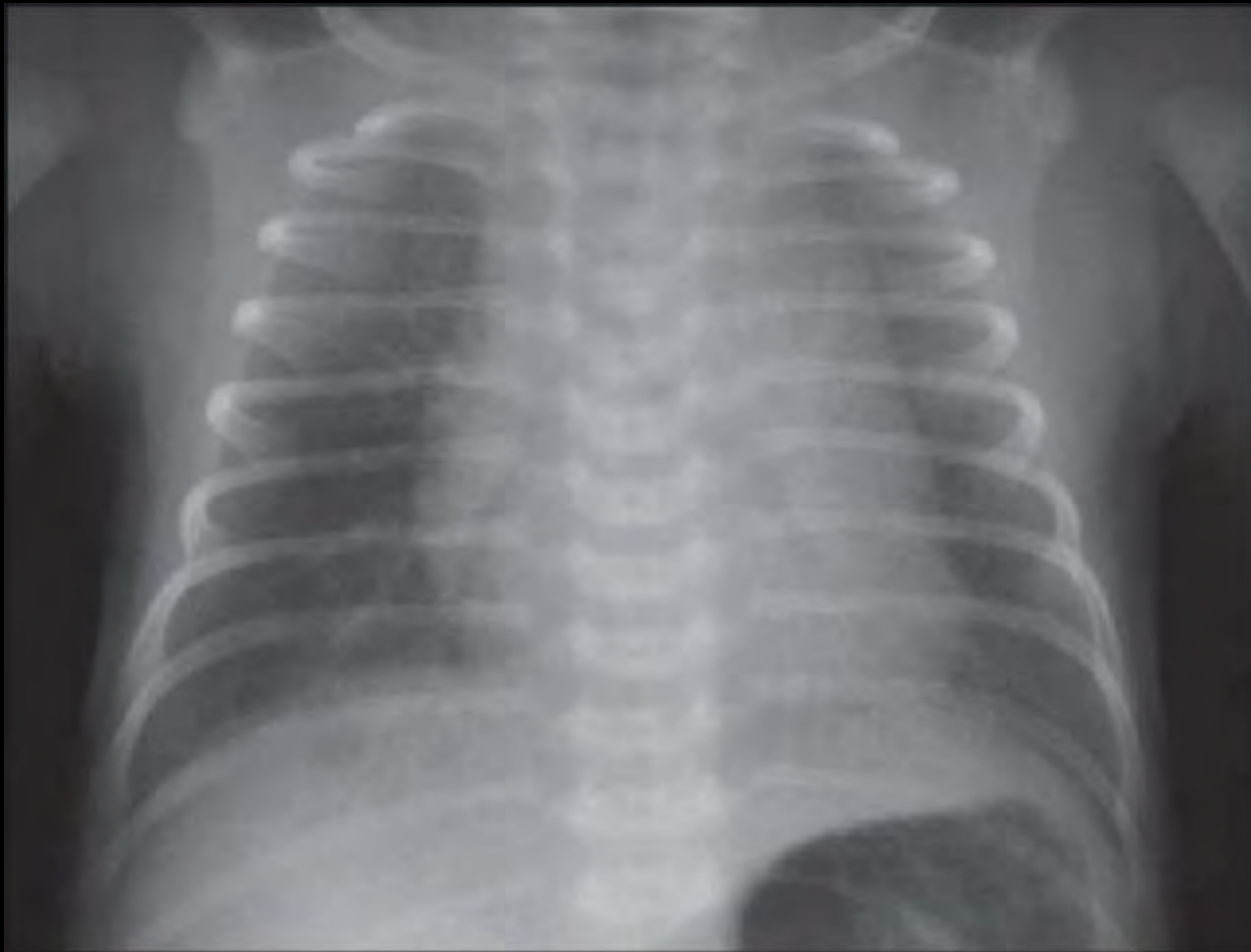


Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance

- Neonate
 - Normal thymic shadow on frontal radiograph should be more than twice width of 3rd thoracic vertebrae
 - Smaller dimensions
 - Involution
 - Hypoplasia

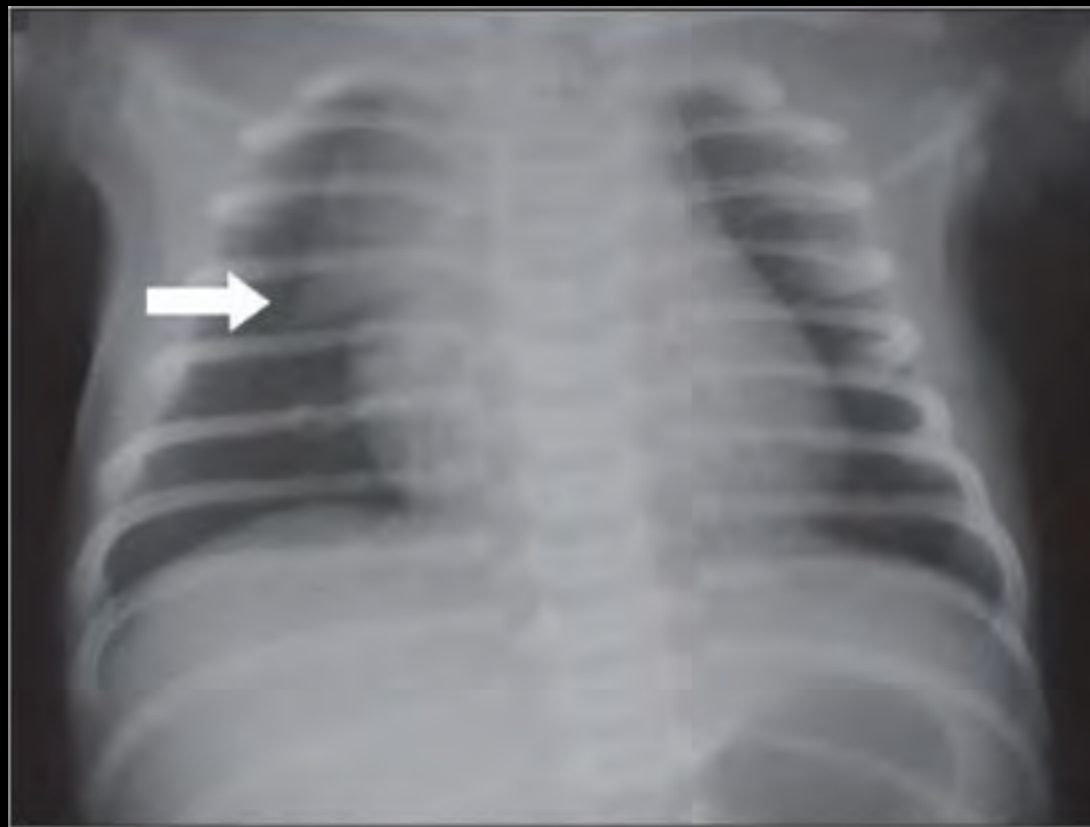
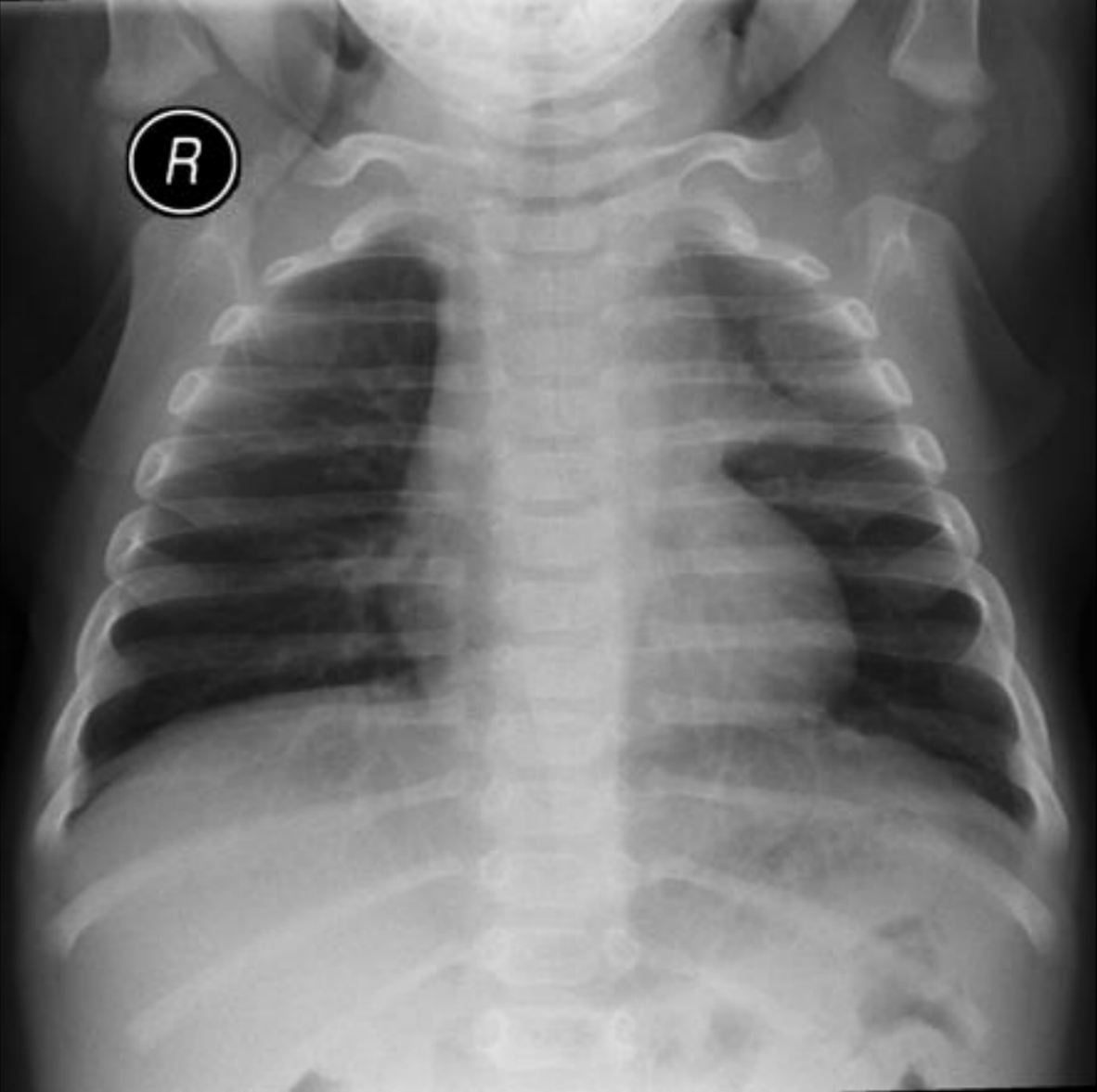


Figure 10. Three-hour-old newborn infant x-ray presenting the “sail sign” (arrow).

- Triangular-shaped inferior margin of normal thymus
- Commonly seen on right side
- Can also be bilateral
- Should not be confused with “Spinnaker sail sign” which indicates pneumomediastinum

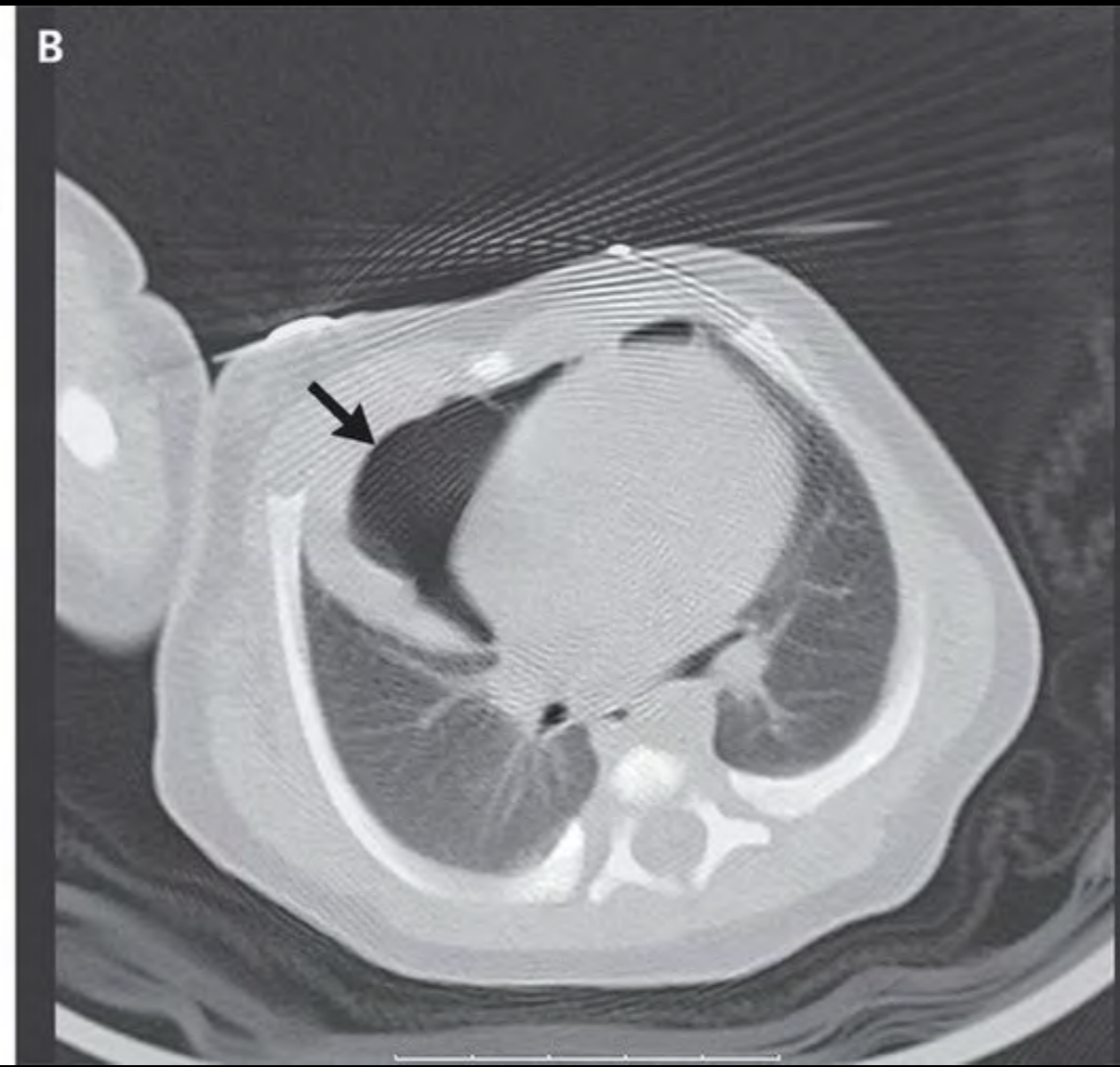
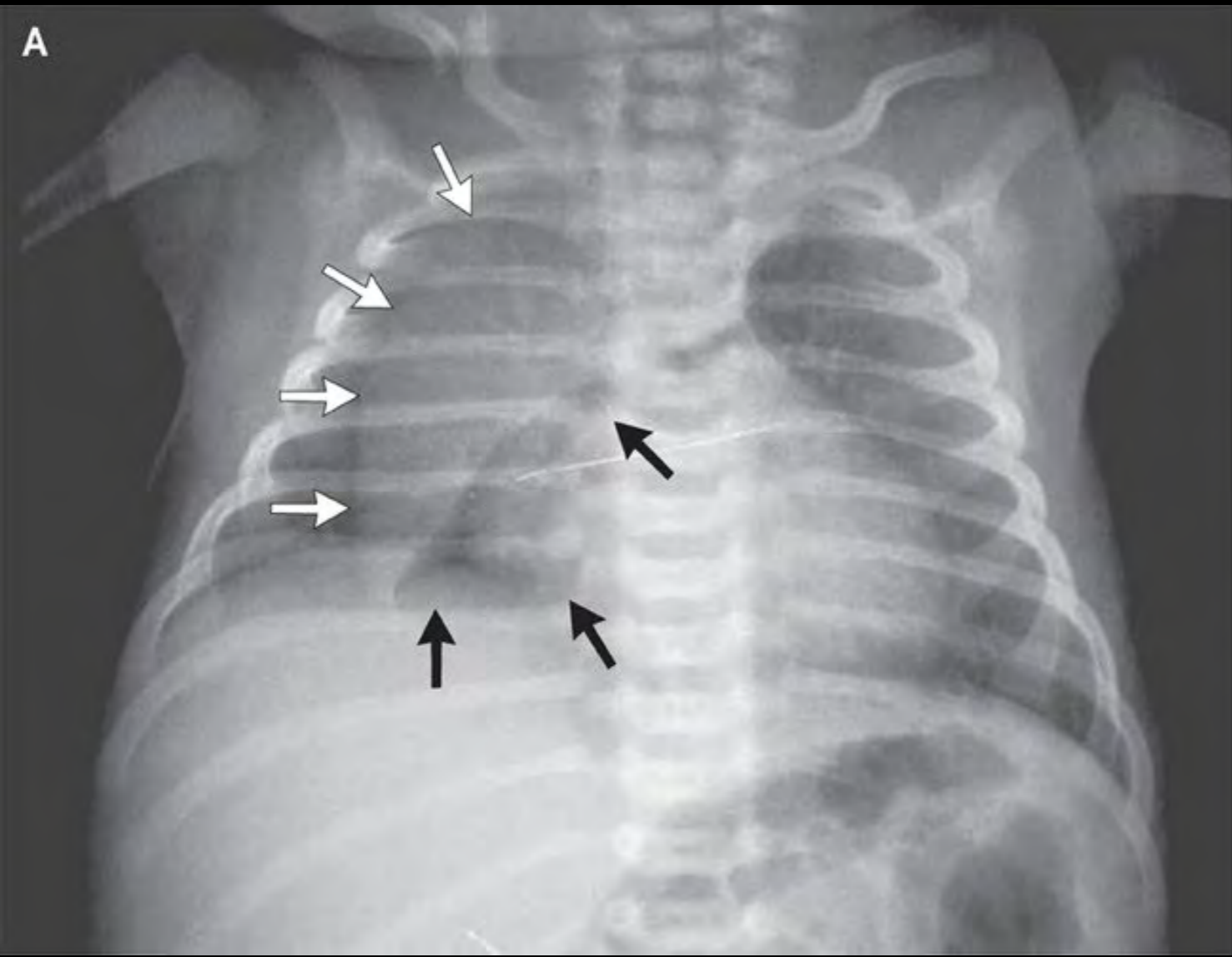


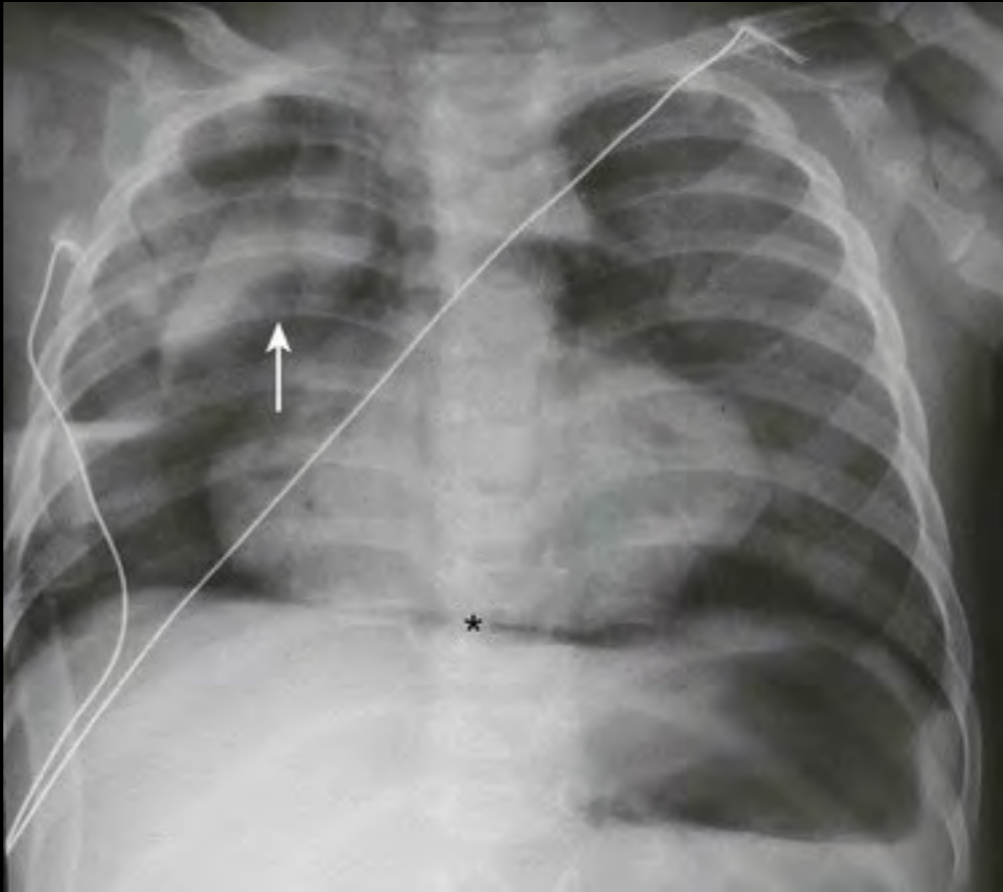




- Spinnaker Sail sign
- Thymus is made up of 2 lobes
- Pneumomediastinum displaces lobes off mediastinum







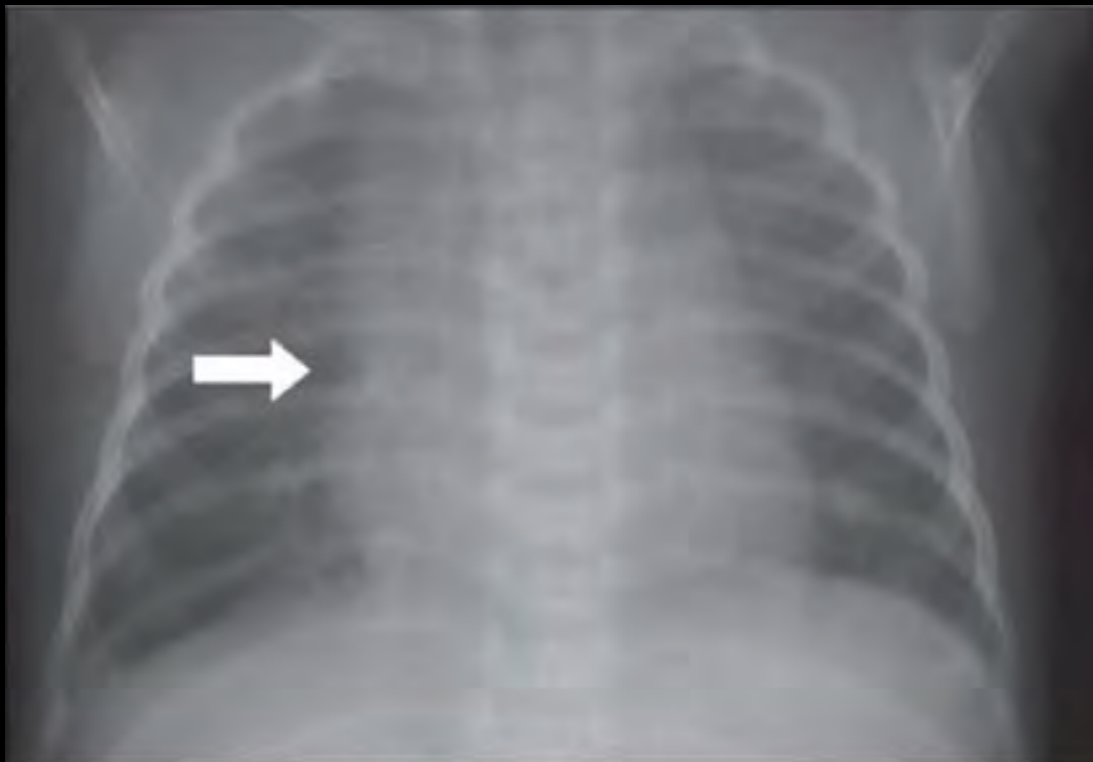


Figure 9. Twenty-two-day-old newborn infant x-ray demonstrating “notch-sign” (arrow).

- “Notch sign”
- Inferior border of thymus blends with border of cardiac silhouette



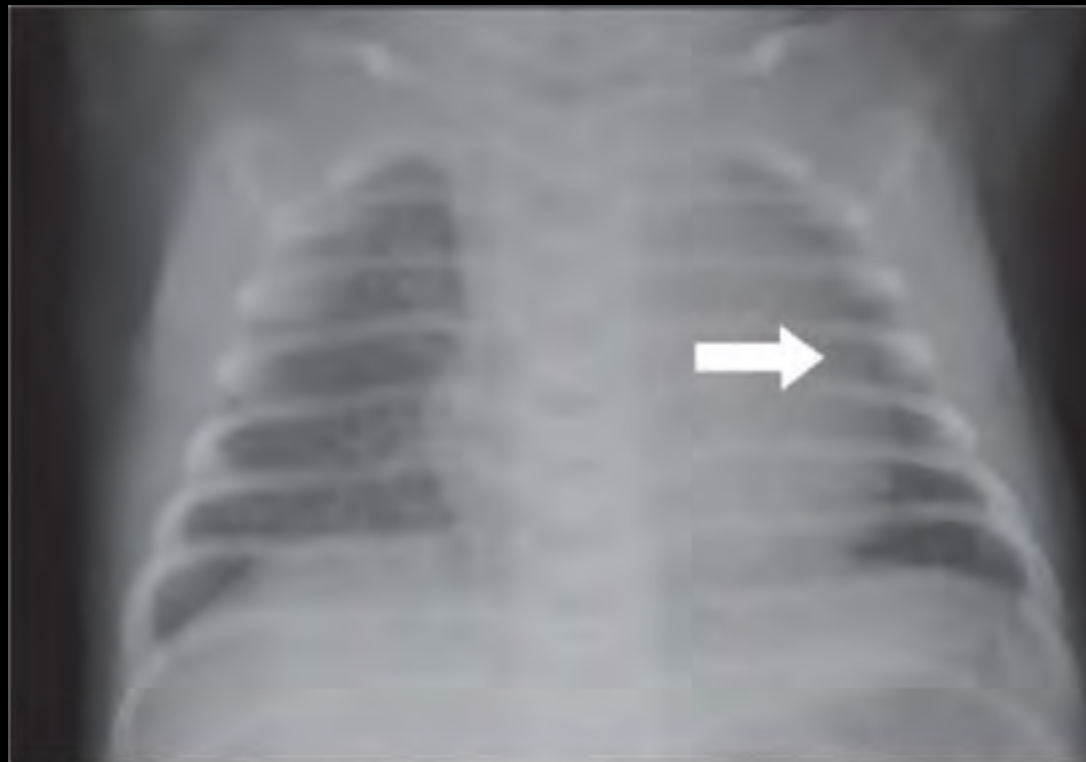
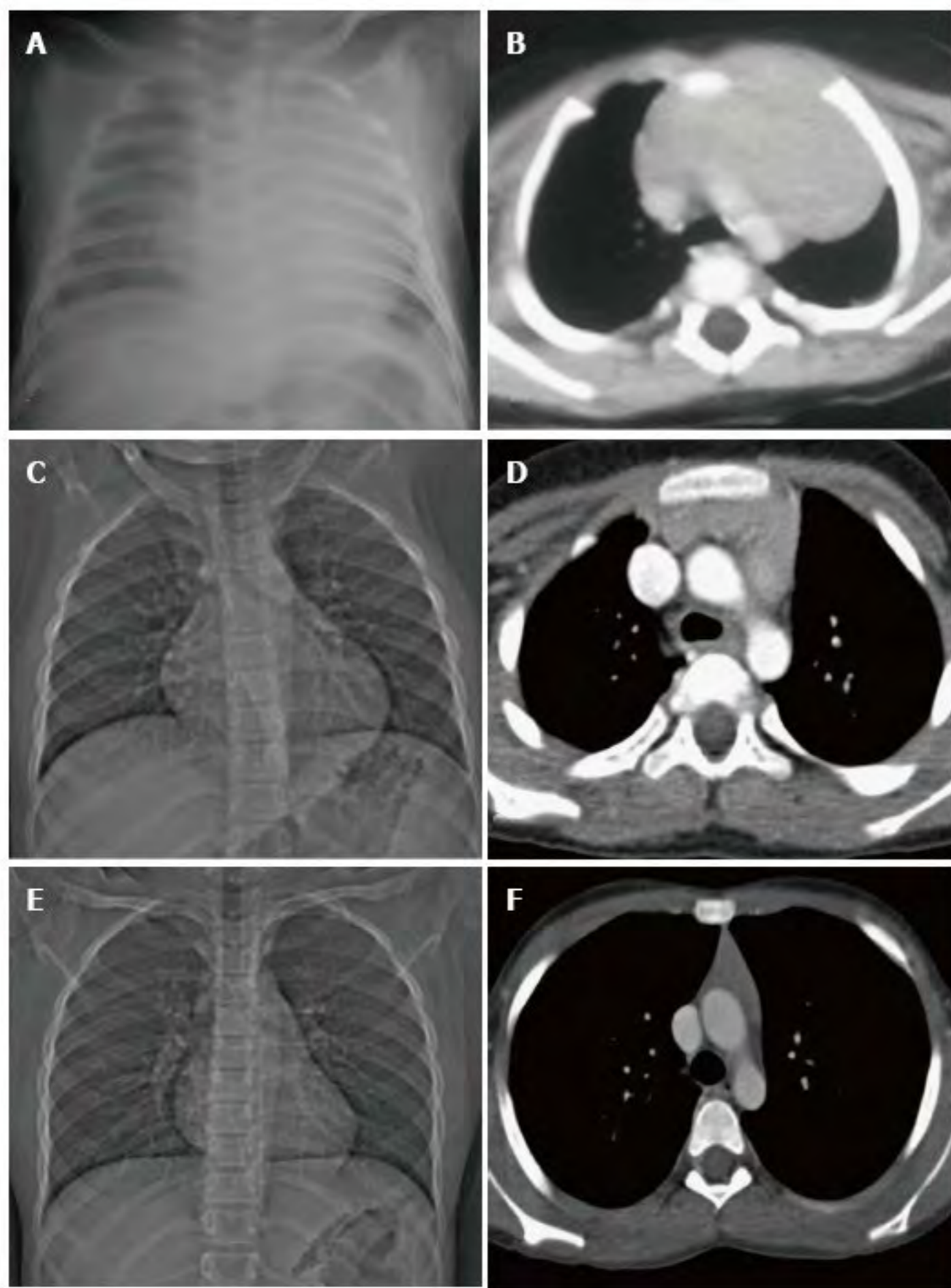
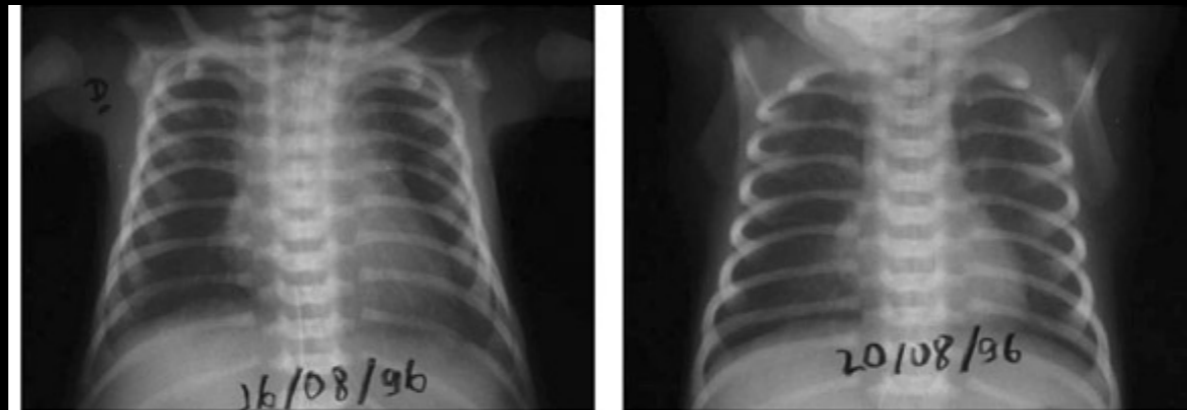


Figure 8. Nine-day-old newborn infant x-ray demonstrating "wave-sign" (arrow).

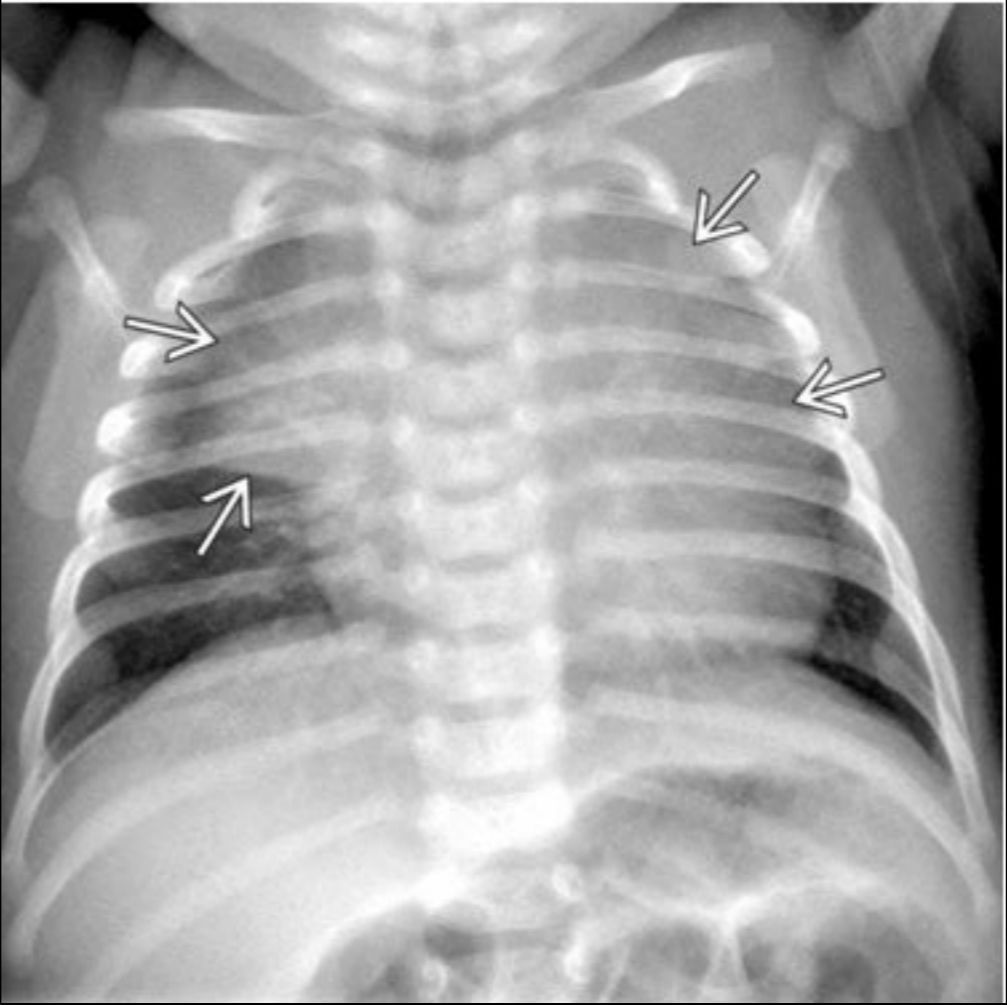
- “Wave sign”
- Gentle undulation on surface of thymus caused by rib impressions



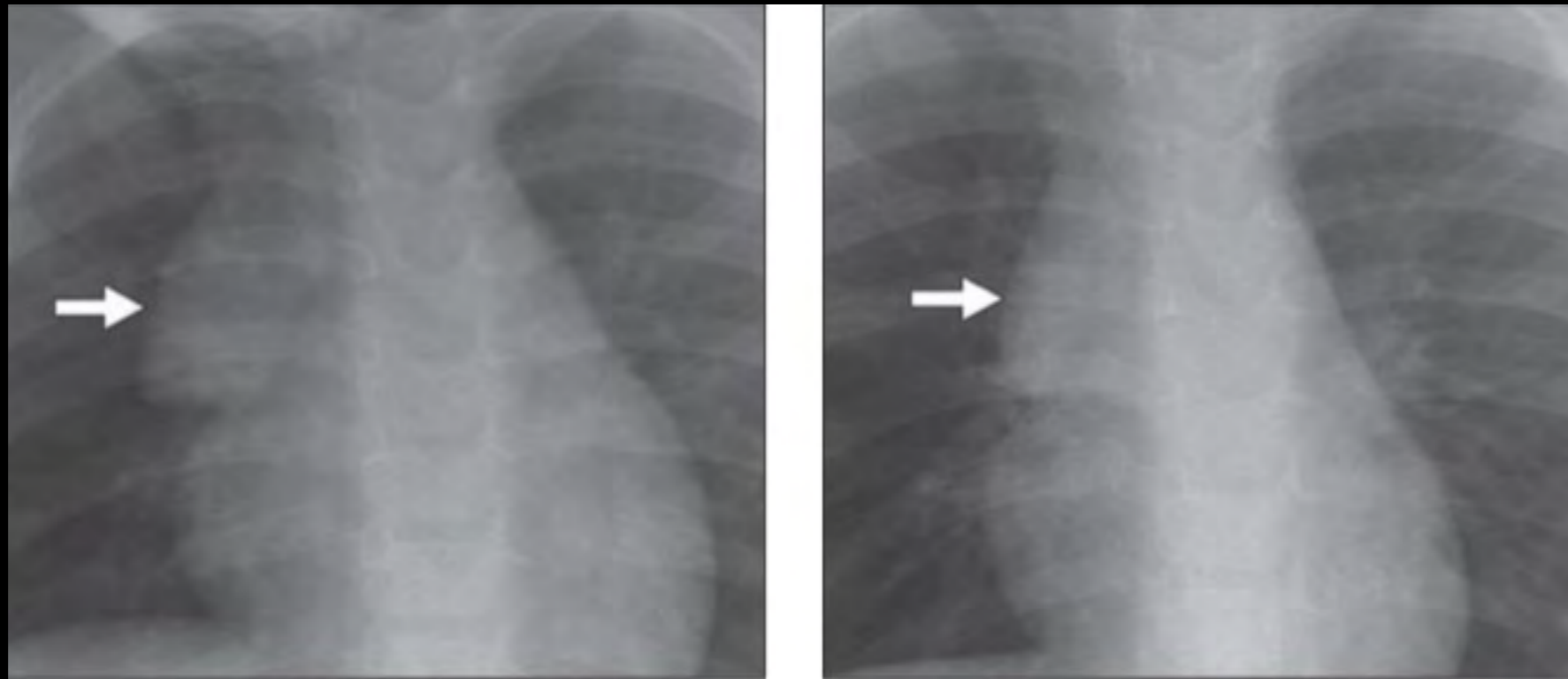
- Normal variation in size
- 2 month old: prominent, rounded shape
- 7 year old: assumes “quadrilateral shape” with convex margins
- 12 year old: triangular configuration.



- 3 hr old and 4 day old male
- Thymic atrophy.
 - Response to any stress
 - sepsis, major surgery, use of steroids or other immunosuppressants

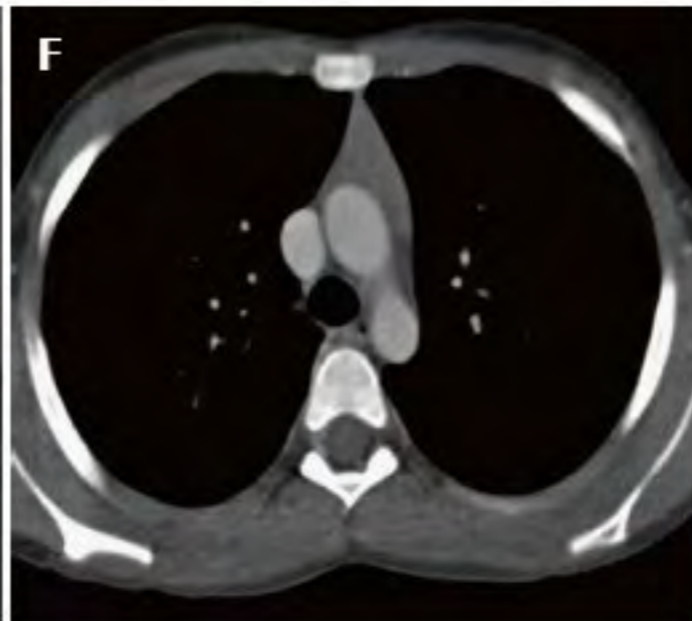
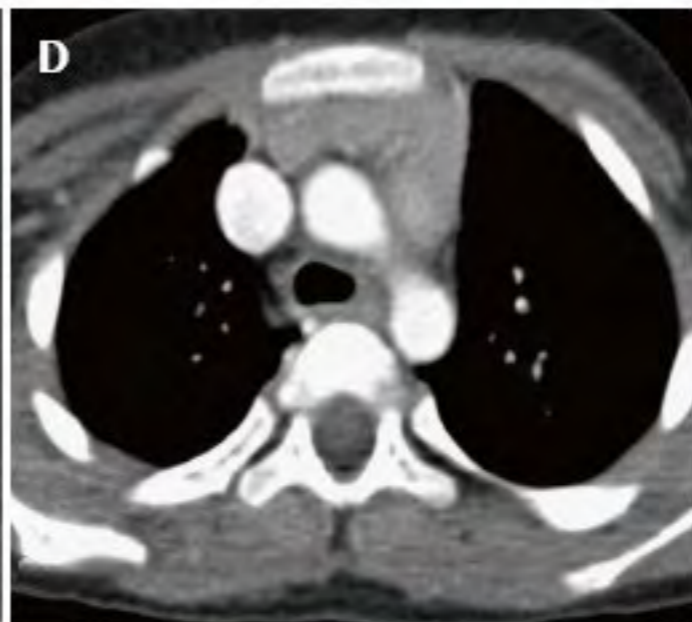
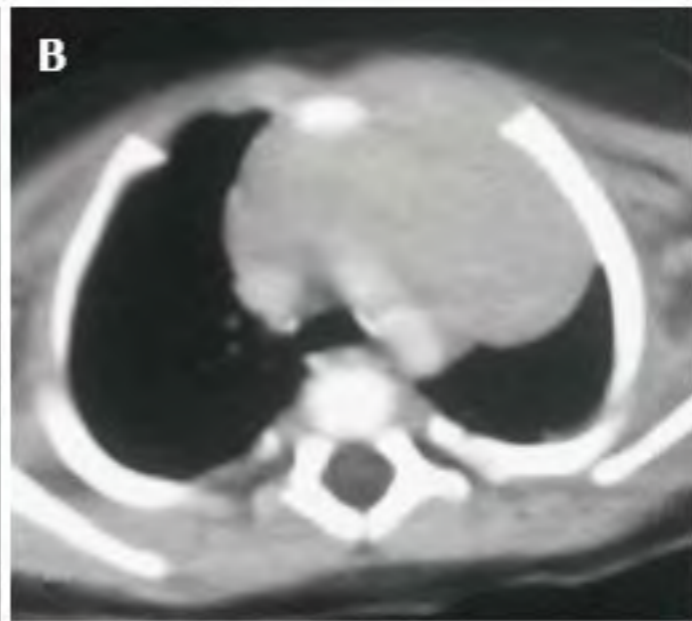


Thymus changes shape with respiratory cycle



- Expiration

Inspiration



Hodgkin's Lymphoma

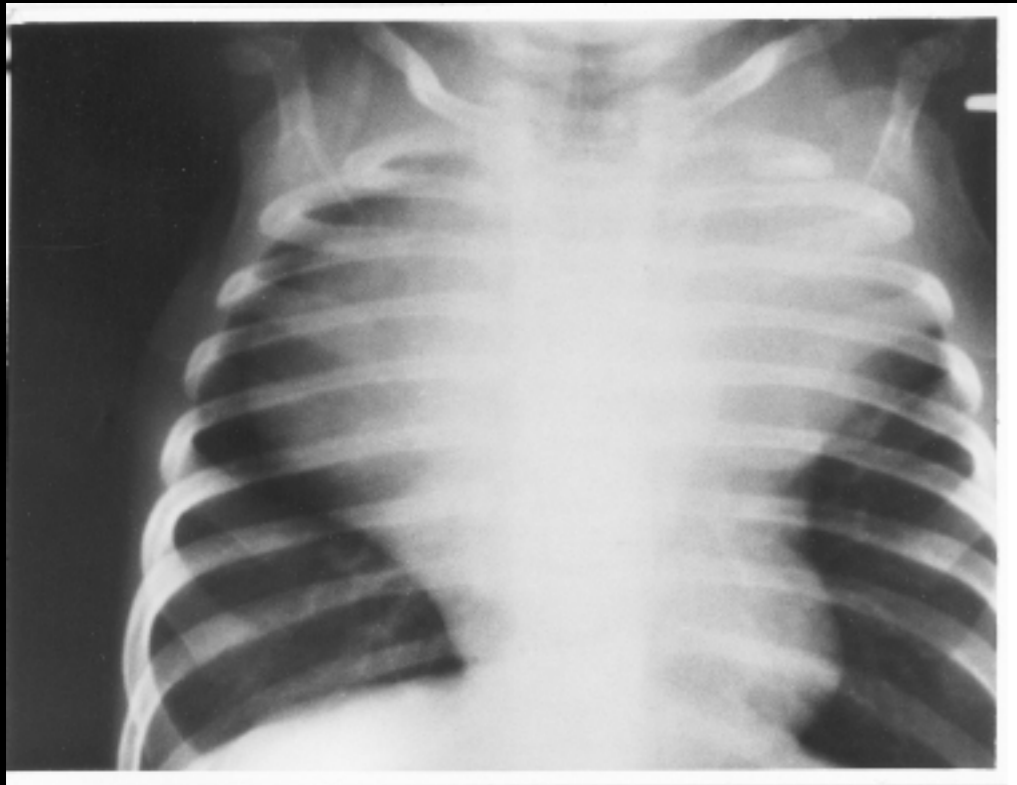


- Accounts for 10-15% of childhood tumors
- Present with nodal or extra nodal disease
 - Mass effect from nodal diseases such as SVC obstruction
 - Infiltrative involvement of organs
- Can often present with B symptoms
 - Fever, night sweats, weight loss

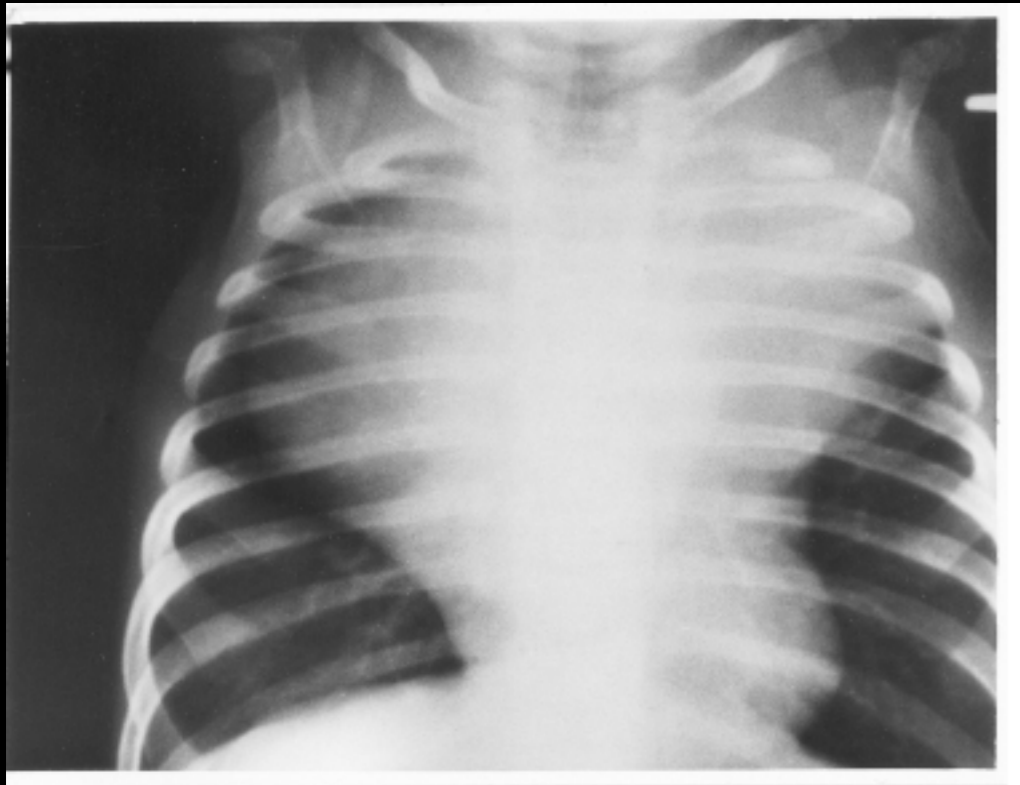


- Radiographic features depend on location and subtype of lymphoma

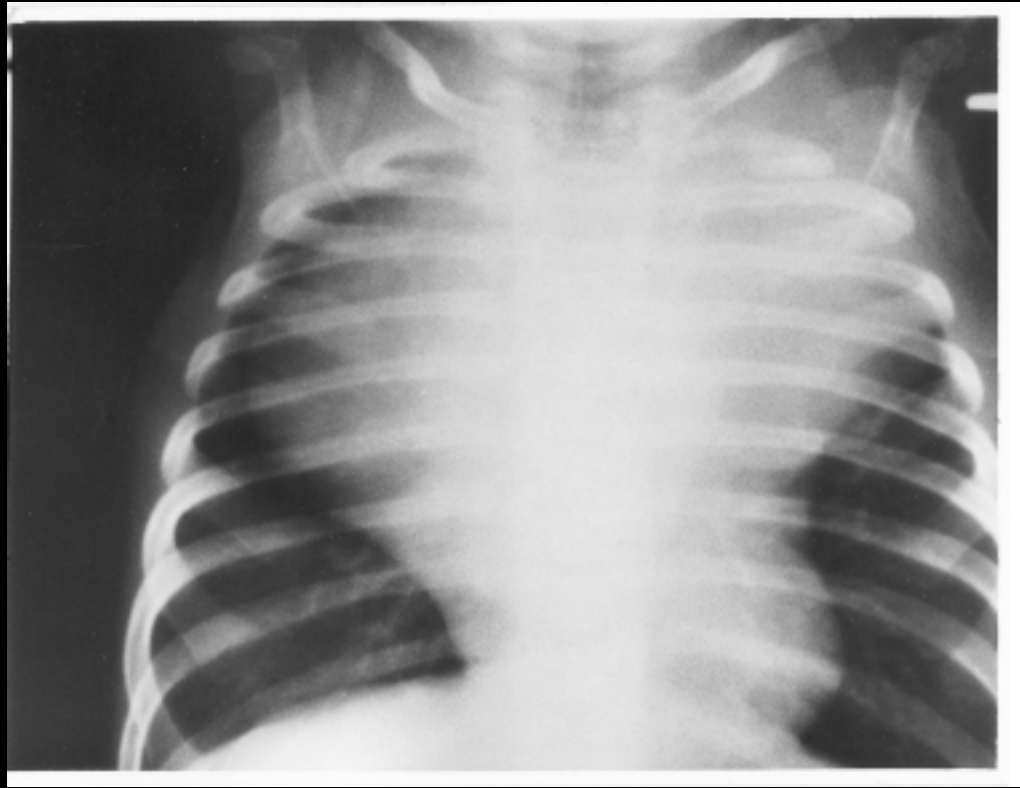
Mediastinal Teratoma



- Most common extragonadal germ cell tumors
- Account for 55% of anterior mediastinal tumors in children
- Typical presentation is below 1 year of age (immature teratoma)
- May be detected antenatally



- Clinical presentation
 - Mass effect
 - Respiratory distress, neck mass,
 - Endocrine function
 - Hormone production (beta-HCG, insulin)
 - Rupture
 - Chest pain, hemoptysis, respiratory failure, pleural effusions, cardiac tamponade

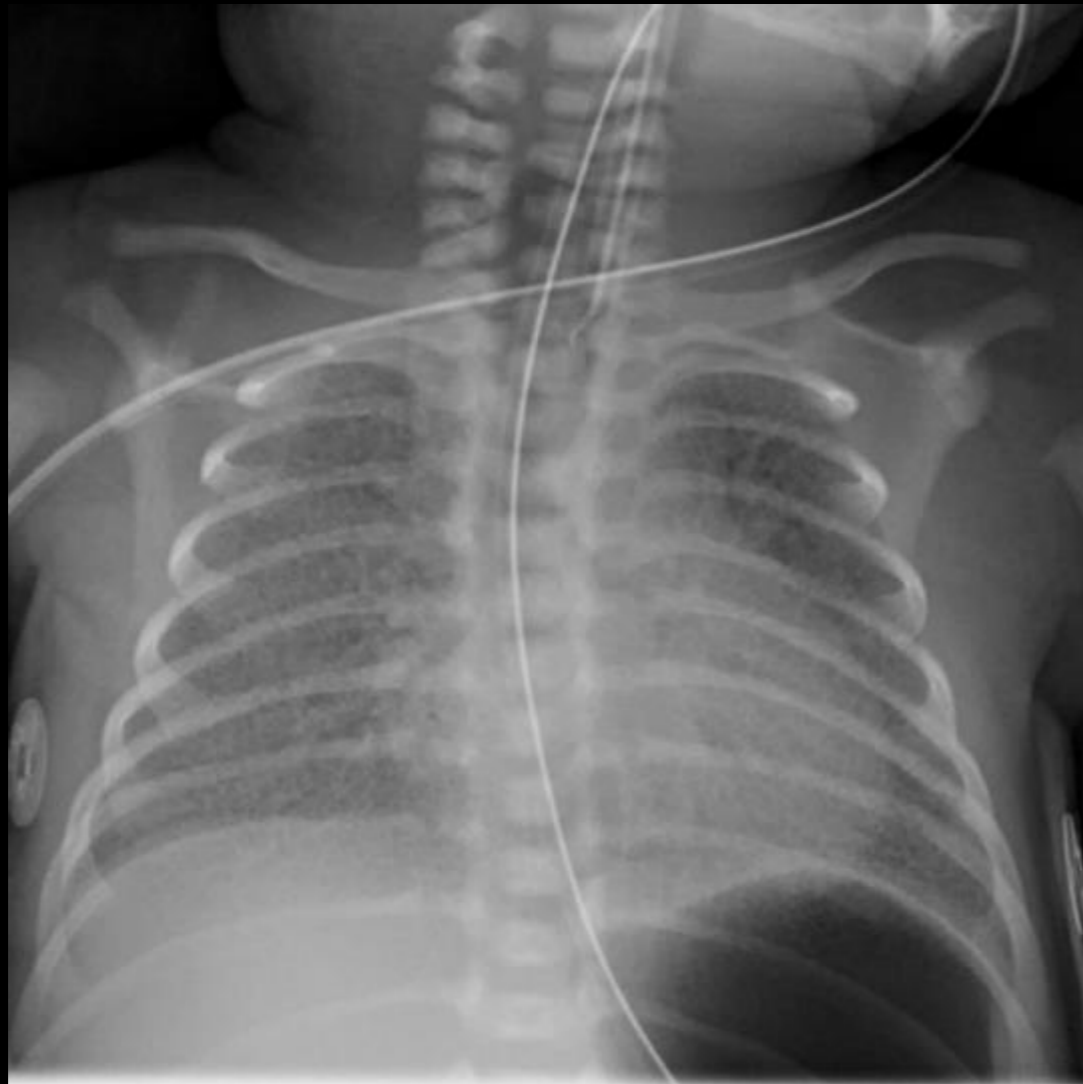


- Solid masses with fatty and cystic components. Calcifications.
- Xray
 - Indistinguishable from other causes of anterior mediastinal mass
 - Calcifications may be visible
- CT
 - Large mass, anterior mediastinum
 - Calcifications



- Treatment
 - Mature teratoma: surgery
 - Seminoma: chemotherapy followed by surgery for residual disease
 - Non- Seminomatous: chemotherapy and surgery

Surfactant Deficiency



- Risk factors
 - Prematurity
 - Maternal diabetes
 - Prenatal asphyxia
 - Chorioamnionitis

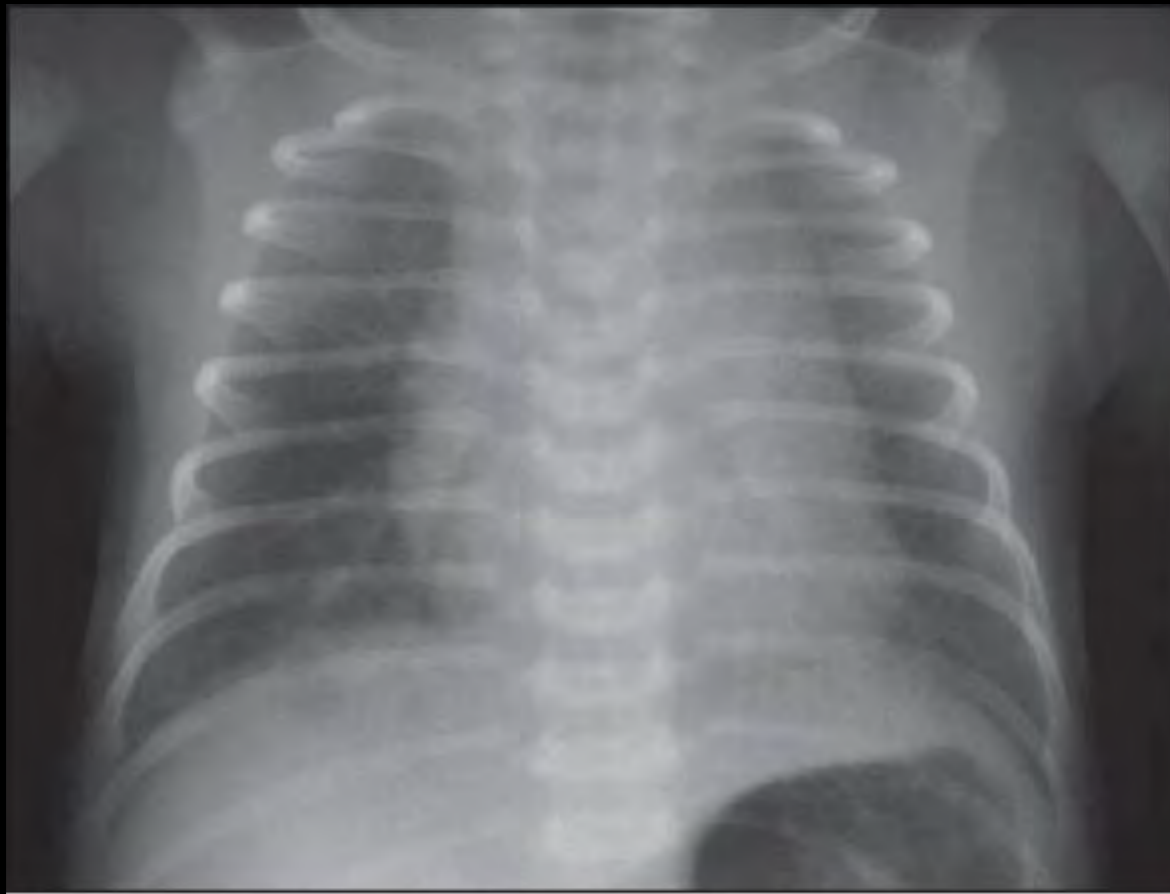
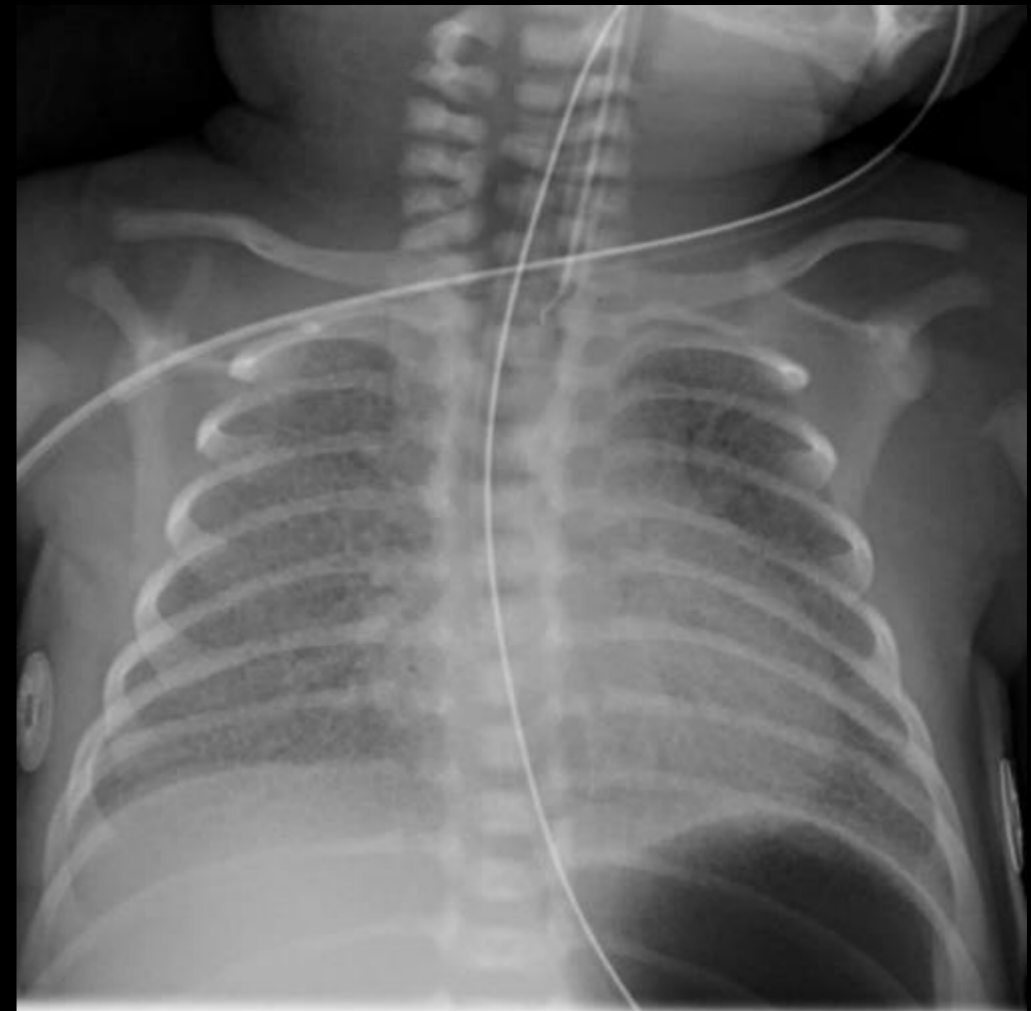
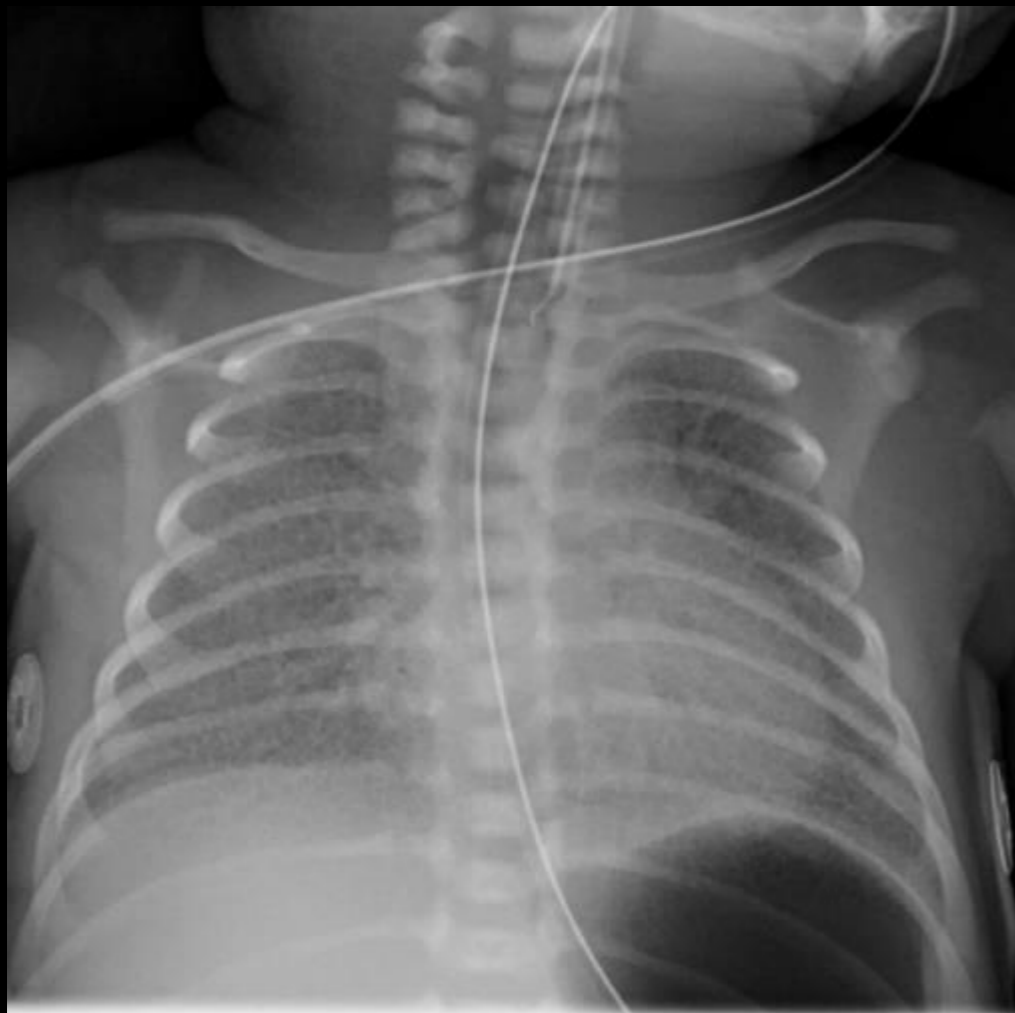
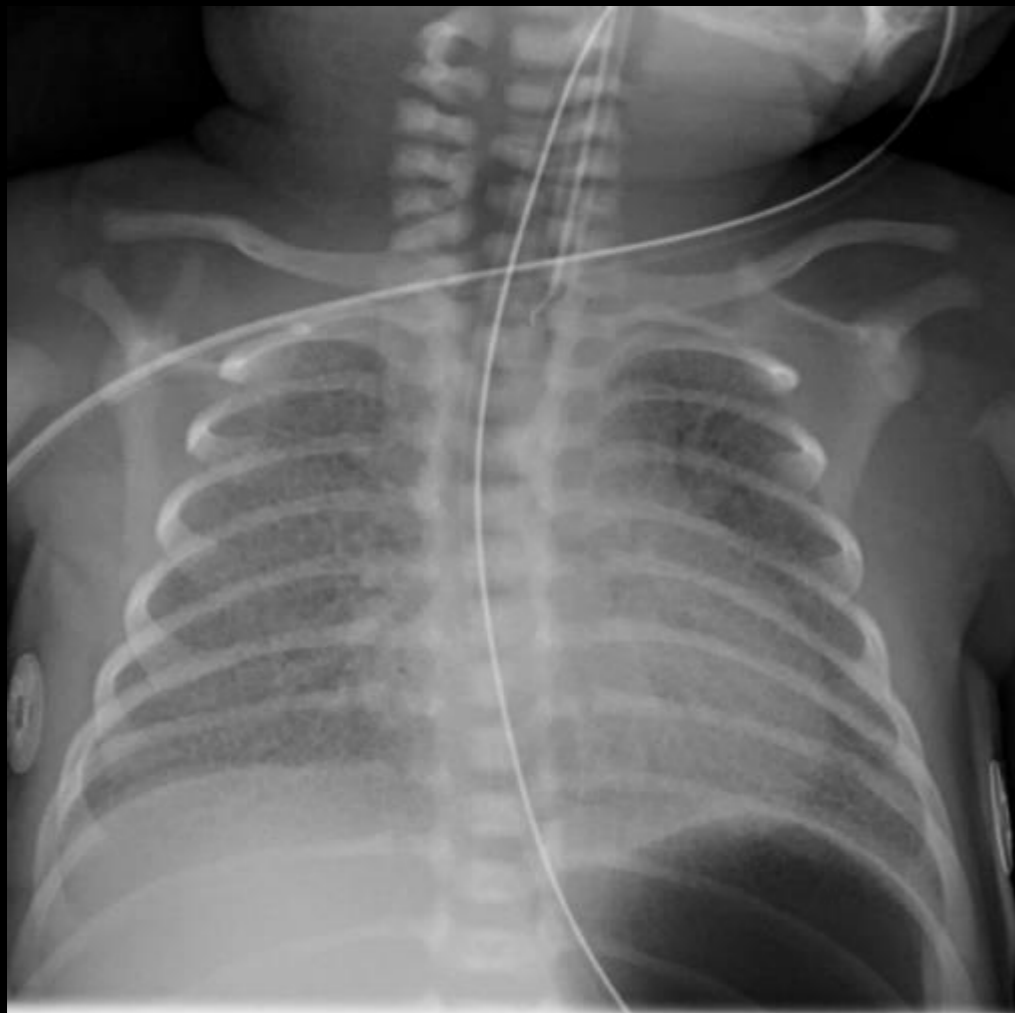


Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance

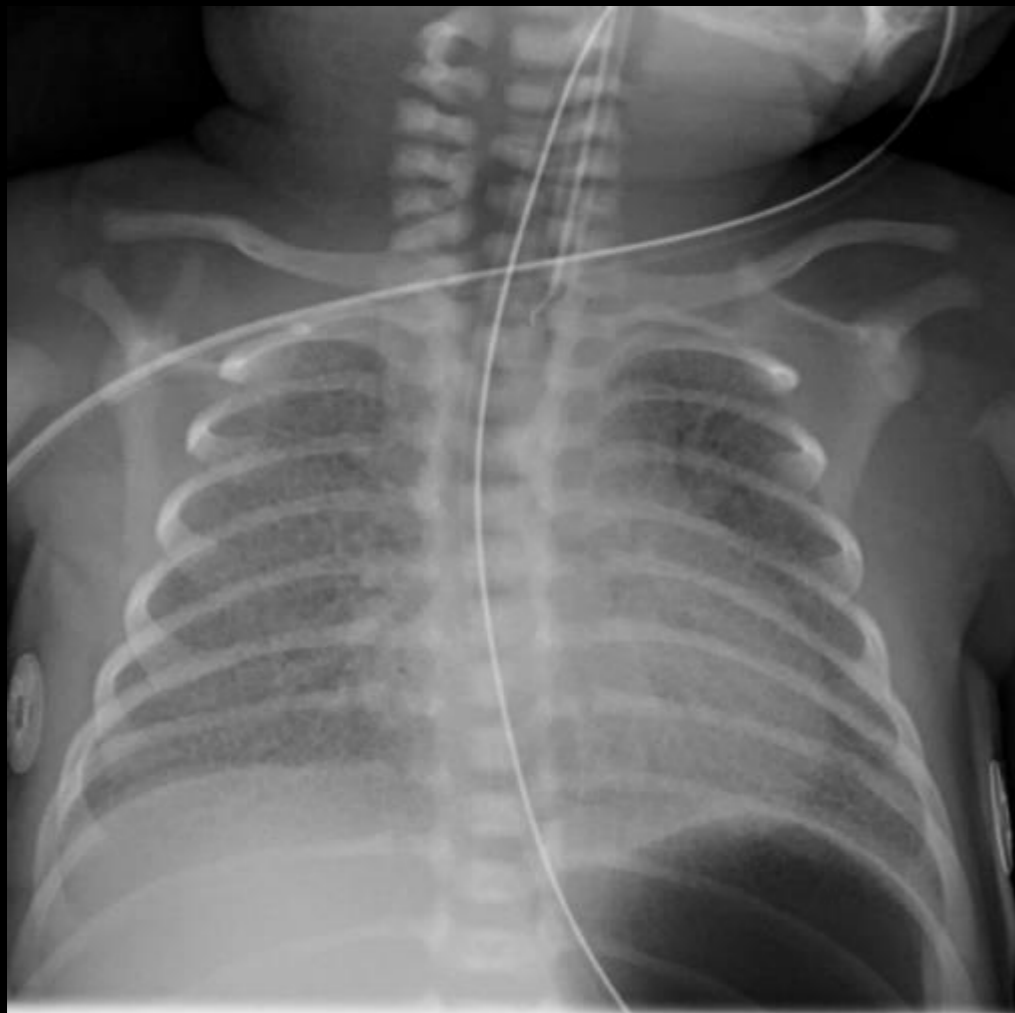




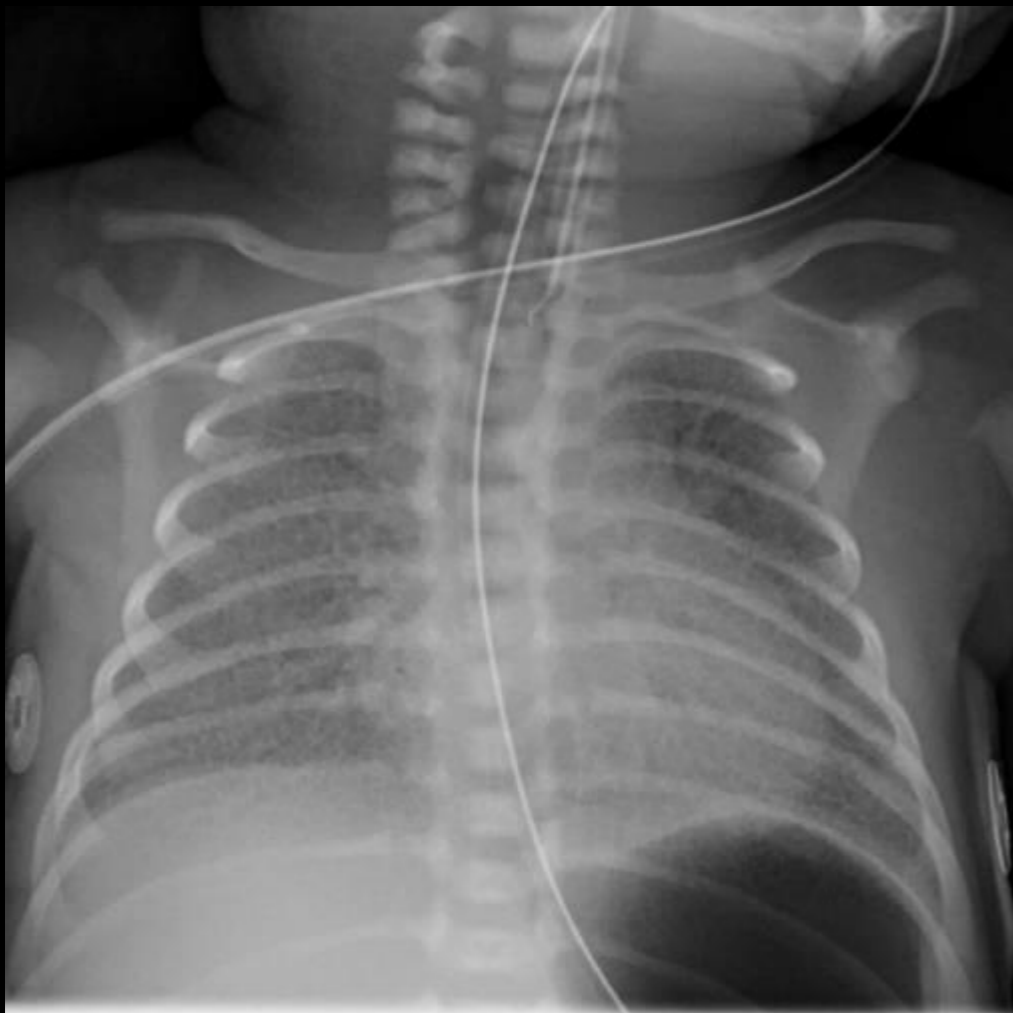
- Diffuse “ground glass” lungs
- Low lung volumes
- Waxes and wanes with doses of surfactant
- Air bronchograms may be evident

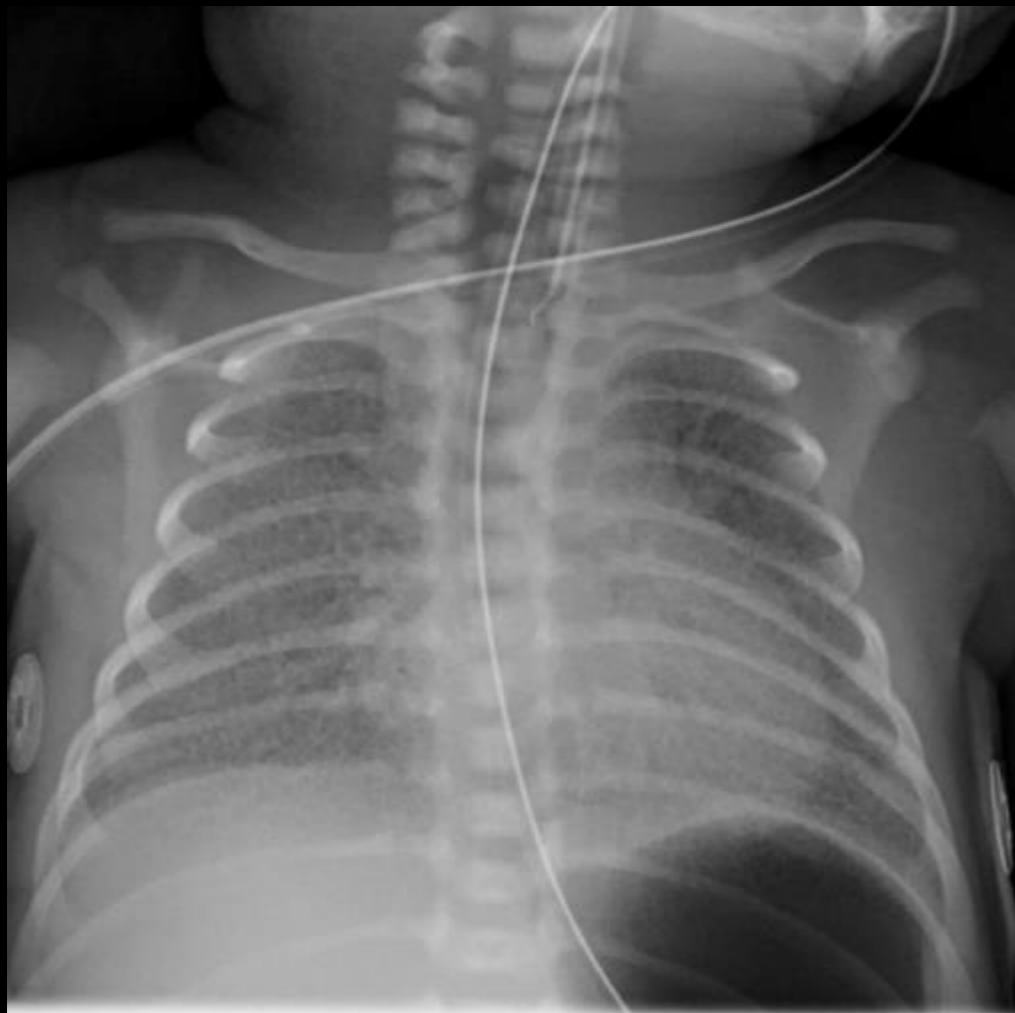


- Hyperinflation in non-ventilated patient excludes diagnosis

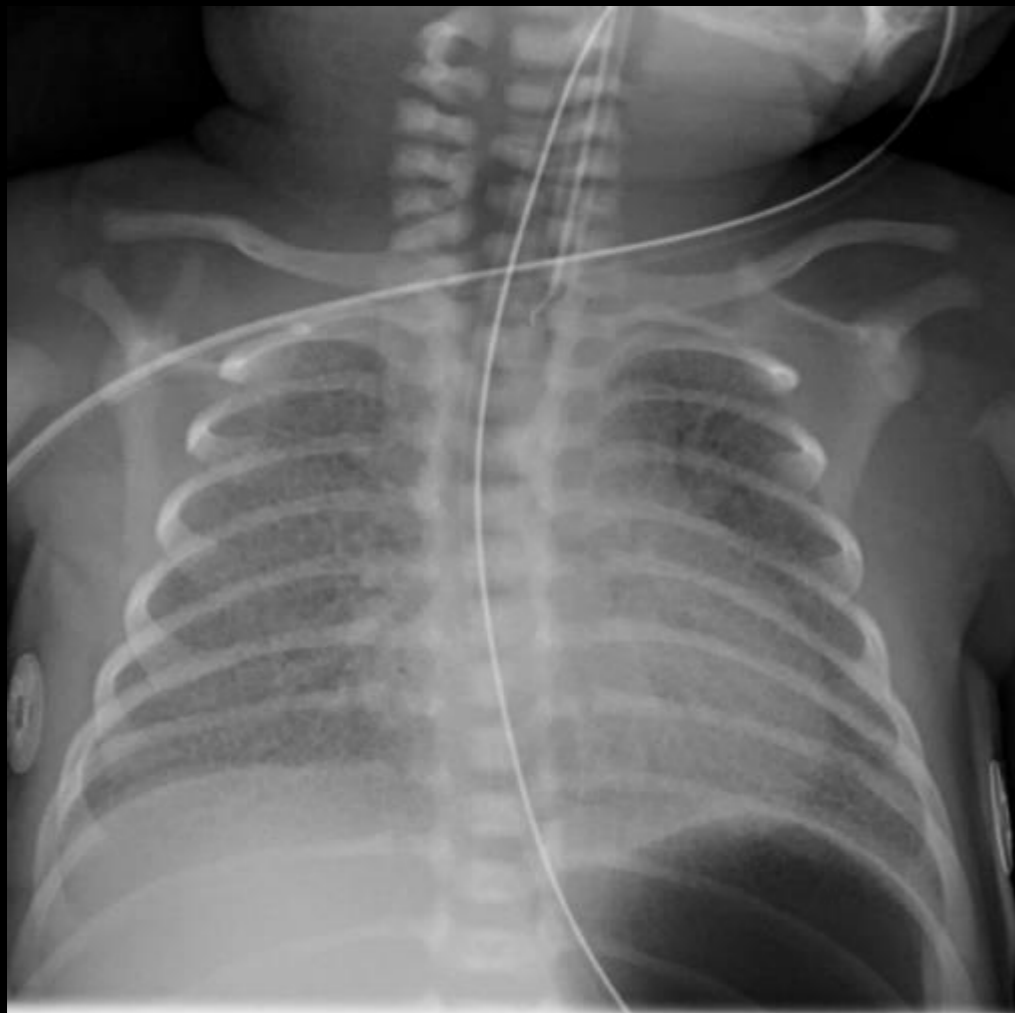


- Associations
 - Persistent PDA: due to reduced oxygen stimulus
 - Germinal matrix hemorrhage
 - Necrotising enterocolitis

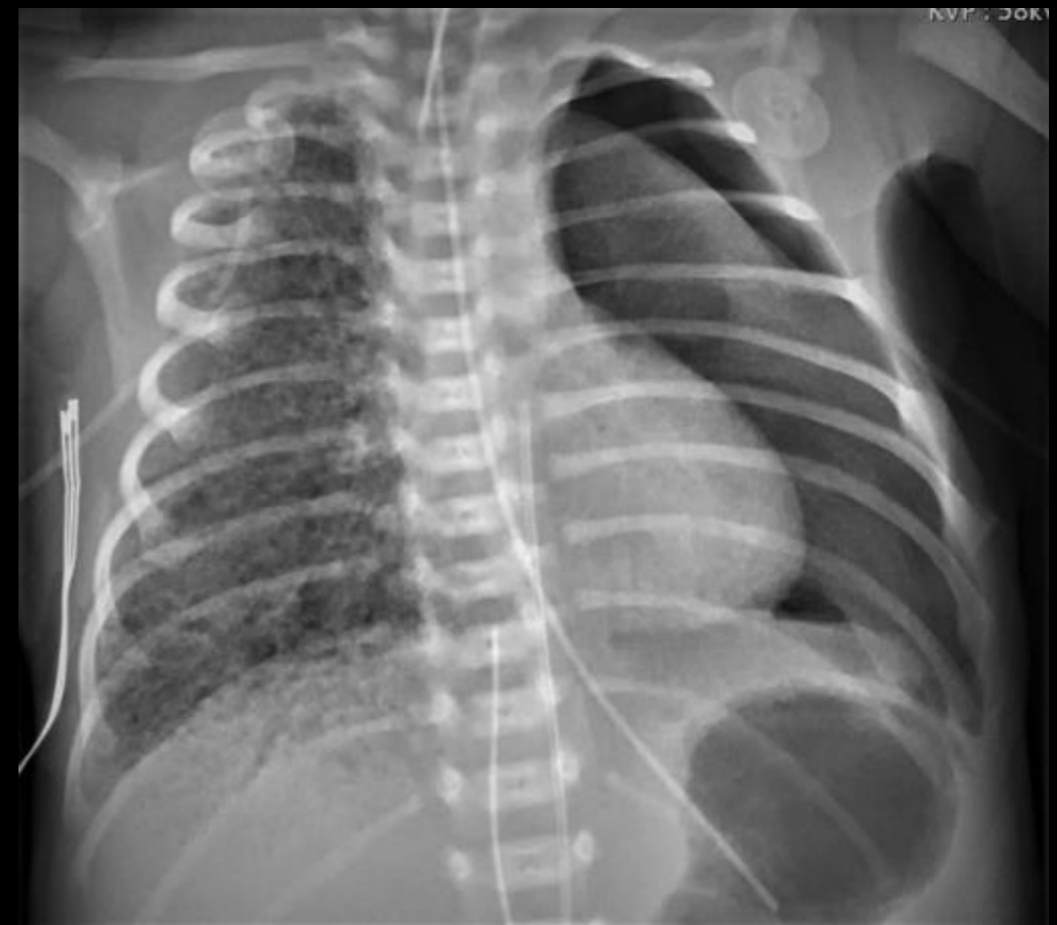
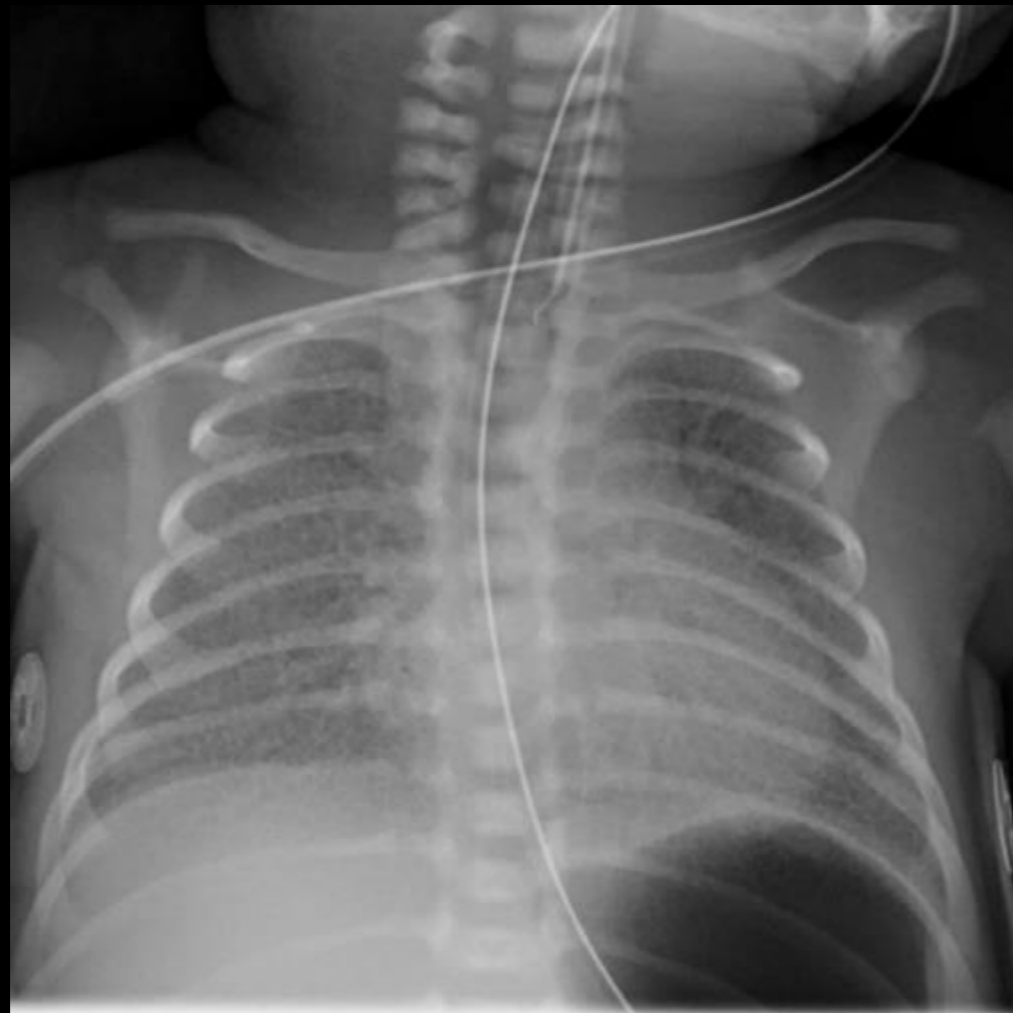




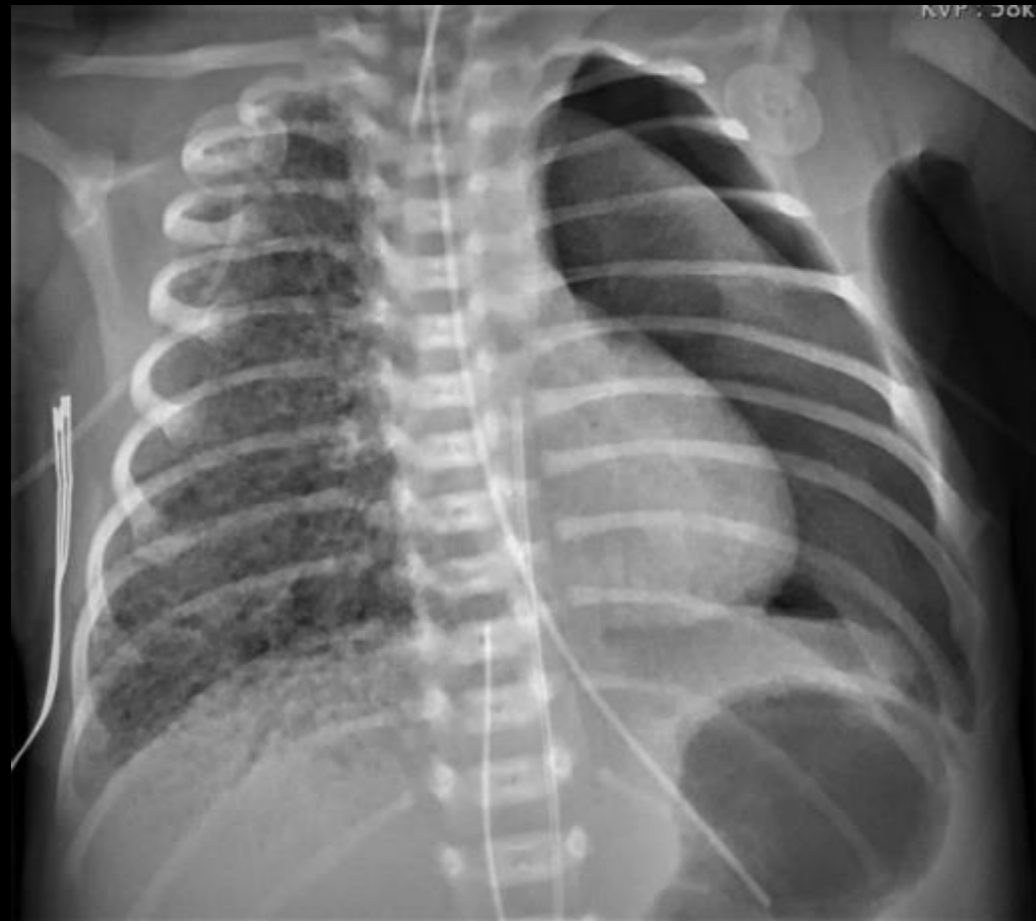
- Complications
 - Acute
 - Pulmonary interstitial emphysema (tx related)
 - Pulmonary hemorrhage
 - Chronic
 - Bronchopulmonary dysplasia
 - Subglottic stenosis from intubation
 - Recurrent pulmonary infections



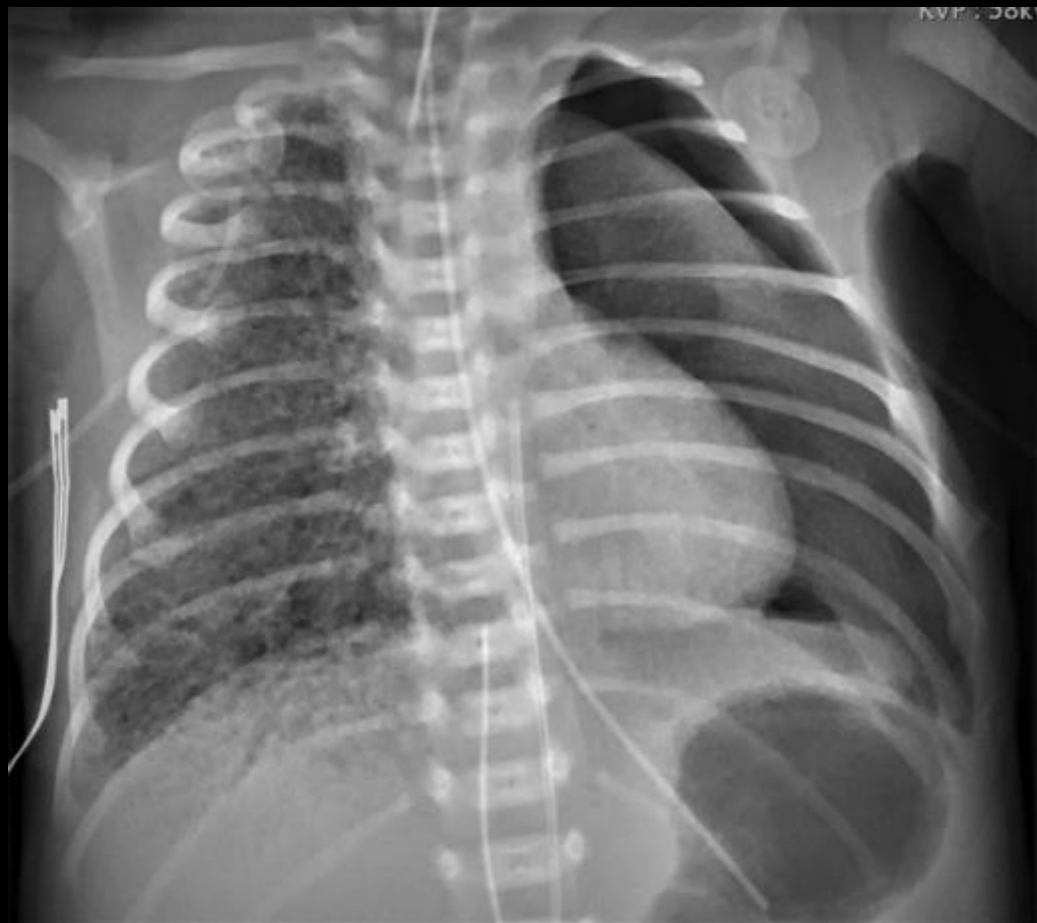
- Differential diagnosis
 - Neonatal pneumonia
 - Pulmonary edema
 - Pulmonary hemorrhage



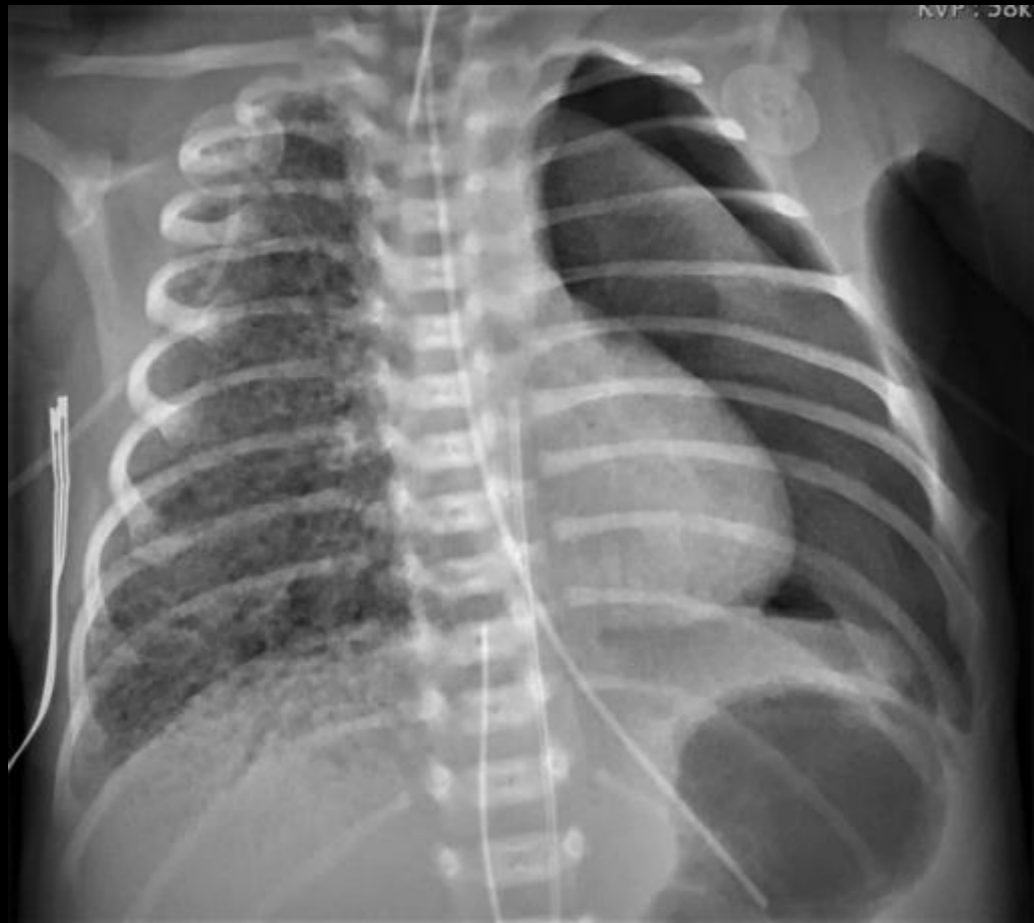
Pulmonary interstitial emphysema



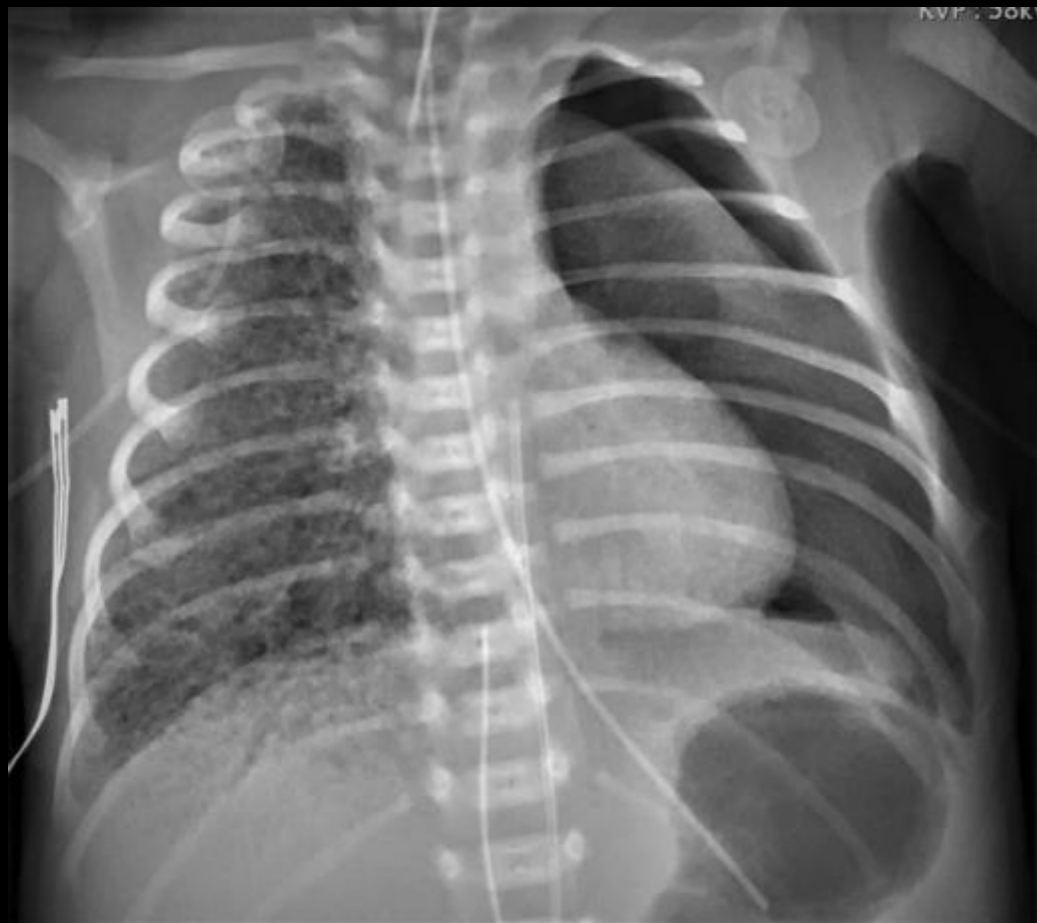
- Almost always associated with mechanical ventilation or continuous positive airway pressure in first weeks of life
- Other risk factors
 - Reduced lung compliance, prematurity
 - low birth weight
 - meconium aspiration syndrome
 - pneumonia



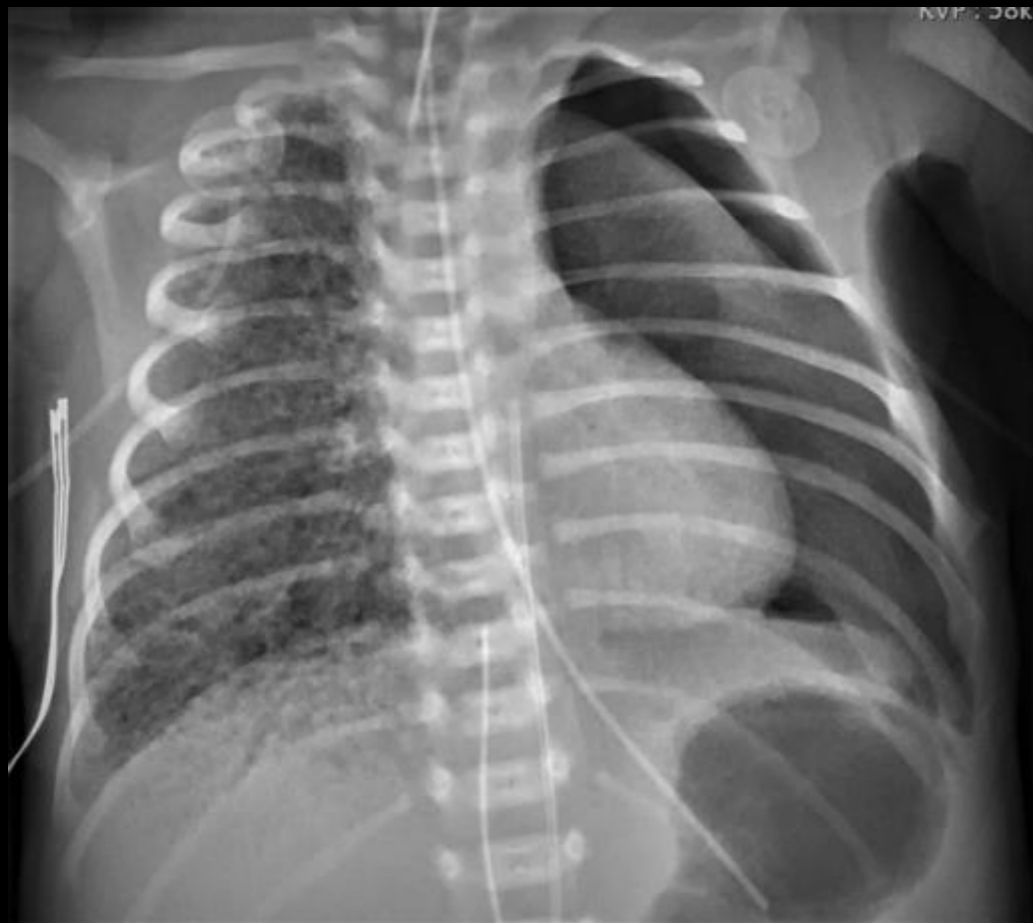
- First week of life newborns on ventilatory support
 - Increased alveolar pressures and poor compliance
 - Alveolar rupture with escape of air into adjacent interstitial and lymphatics
- Overall
 - Lung volumes are increased
 - Maybe focal affecting one lobe or diffuse and bilateral
 - No predilection for particular lobe



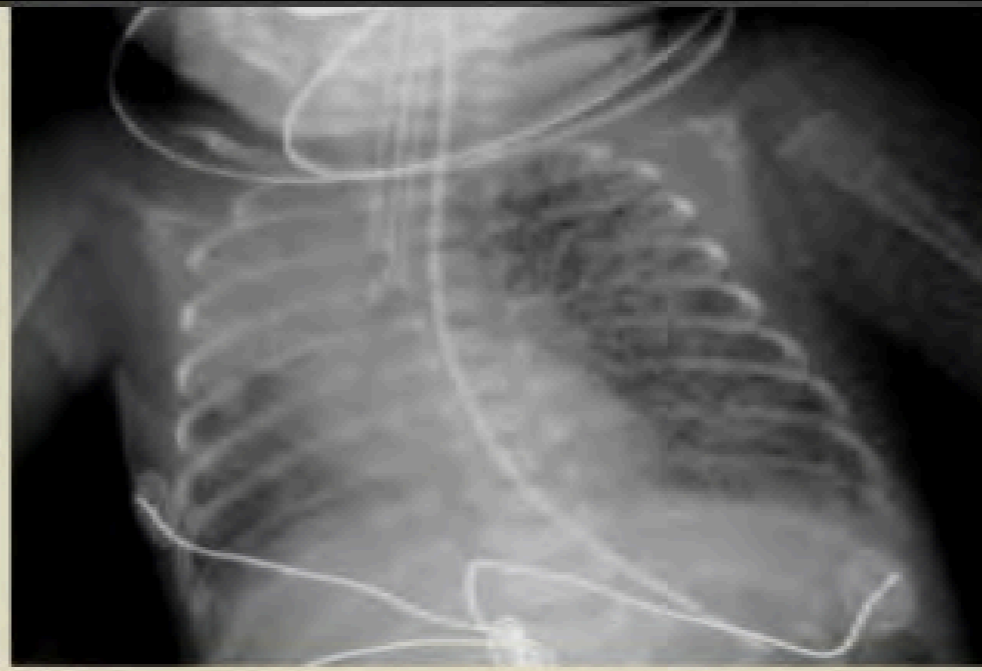
- Typically incidental finding
- May present with air-block complications such as
 - Pneumomediastinum
 - Pneumothorax
 - Pneumopericardium
 - Pneumoperitonium
 - Subcutaneous emphysema



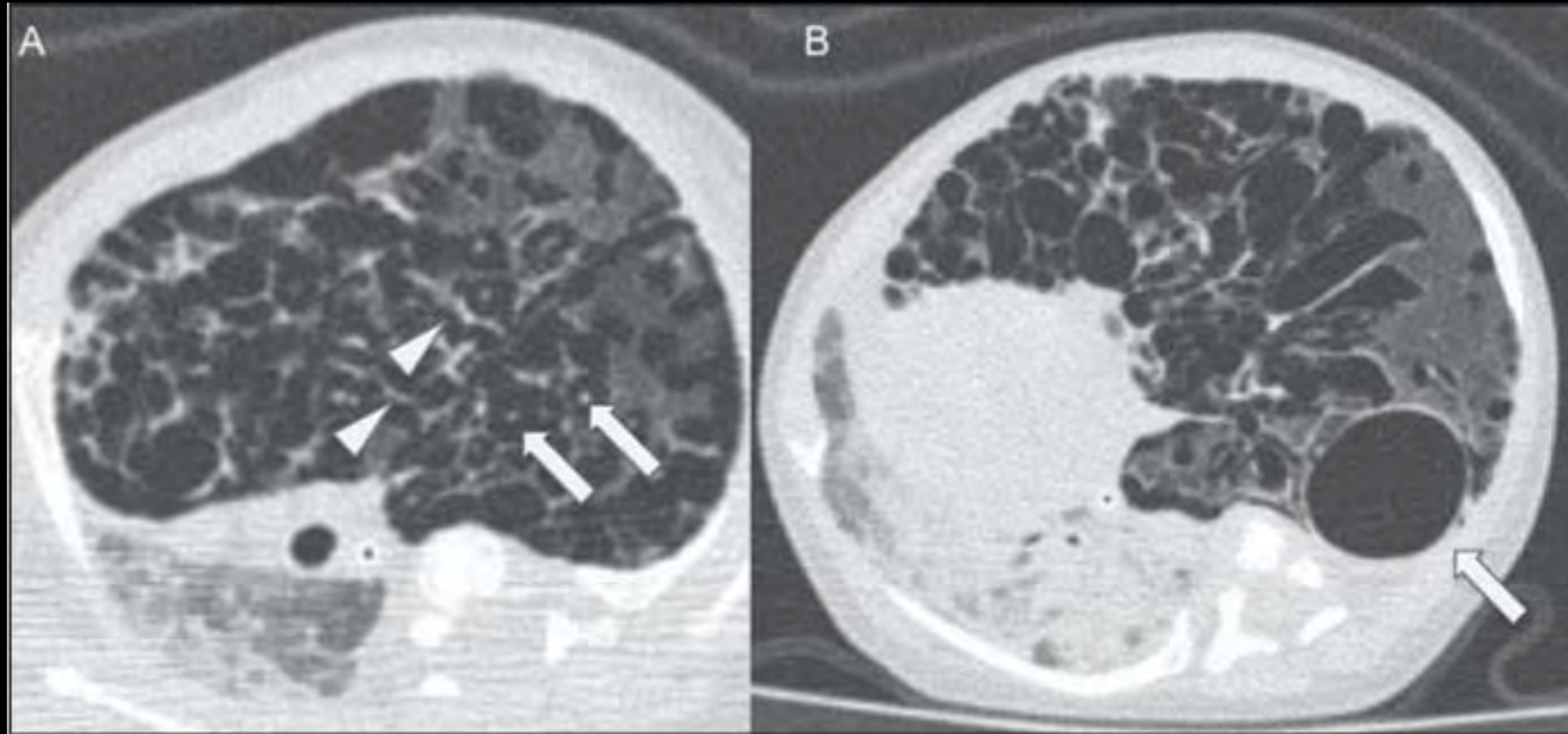
- Cystic or linear lucency's in intersitium radiating from hilum
- Affected segment is often hyper expanded and static in volume on multiple radiographs
- Pneumo:
thorax/pericardium/mediastinum/
peritoneum



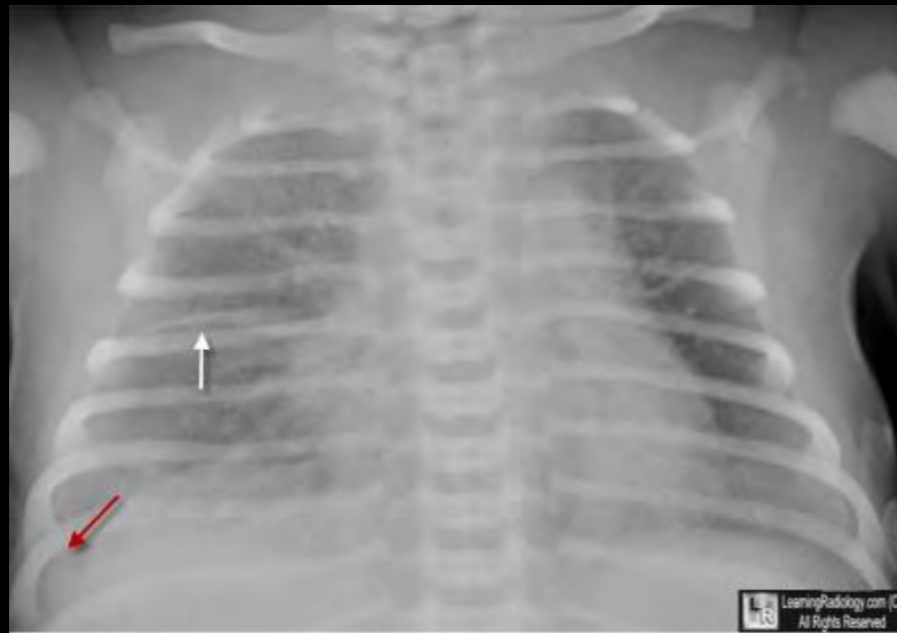
- Differential diagnosis
 - Partially treated surfactant deficiency
 - Bronchopulmonary dysplasia
 - Congenital pulmonary airway malformation
 - Congenital lobar overinflation
 - Congenital diaphragmatic hernia



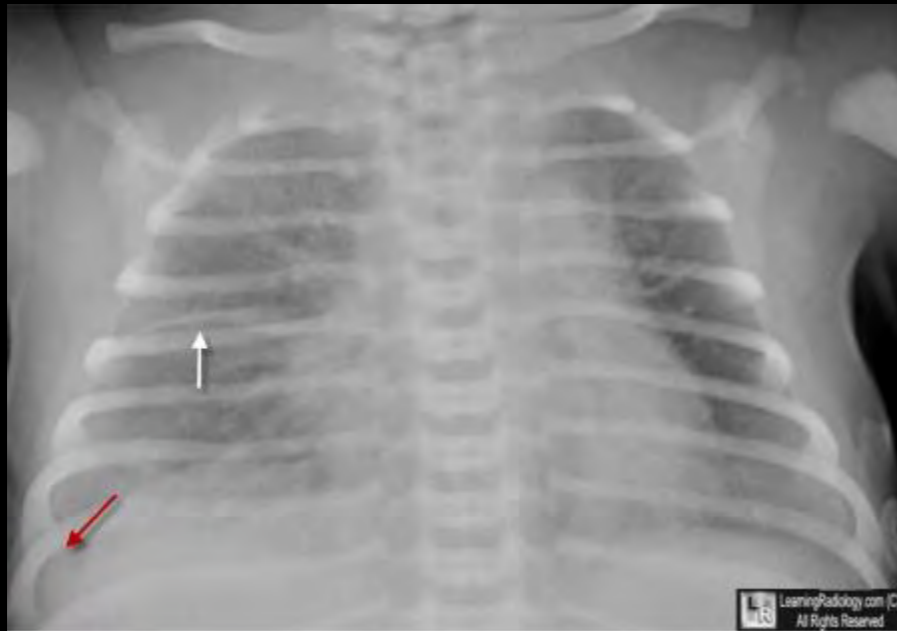
PIE on CT



Transient Tachypnea of Newborn



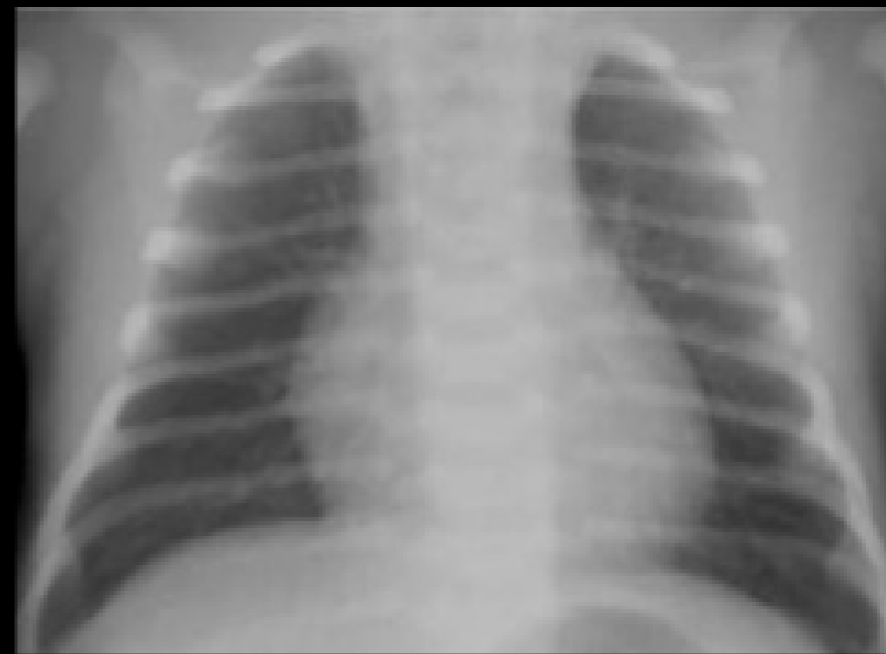
- Aka
 - Retained fetal fluid or wet lung disease
- Neonate with tachypnea in first few hours of life, resolving within 48 hrs
- Most common cause of respiratory distress in term or near term newborns
 - Grunting, nasal flaring within first 6 hrs of life
 - Can be mild cyanosis



- Perihilar streakiness- interstitial edema
- Small pleural effusions
- Fissural prominence
- Normal chest radiograph by 48-72 hrs postpartum



- First day of life x-ray.



X-ray at 48hrs

Meconium aspiration



- Secondary to intrapartum or intrauterine aspiration of meconium
- Usually in setting of fetal distress
- Usually in term and post term infants
- Usually history of meconium stained fluid at birth
- Aspirated meconium causes small airway obstruction and chemical pneumonitis

- Increased lung volumes
 - Hyperinflated lungs with flattened diaphragms
 - Secondary to distal small airway obstruction and air trapping
- Asymmetric patchy pulmonary opacities
 - Due to subsegmental atelectasis
 - Rope like opacities
- Pleural effusions maybe present
- **Pneumothorax and pneuomediastinum**
 - Due to increased alveolar tension from obstructed airways
- Multifocal consolidation
 - Due to chemical pneumonitis



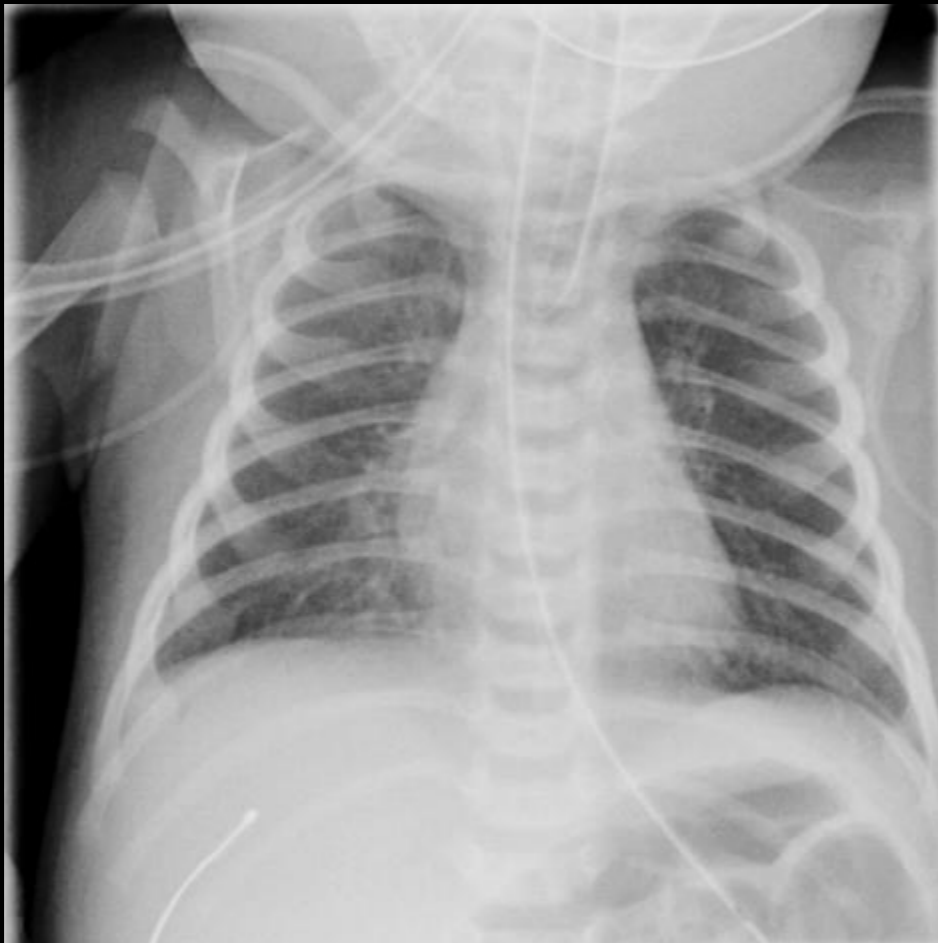
2 examples of Meconium aspiration of x-ray



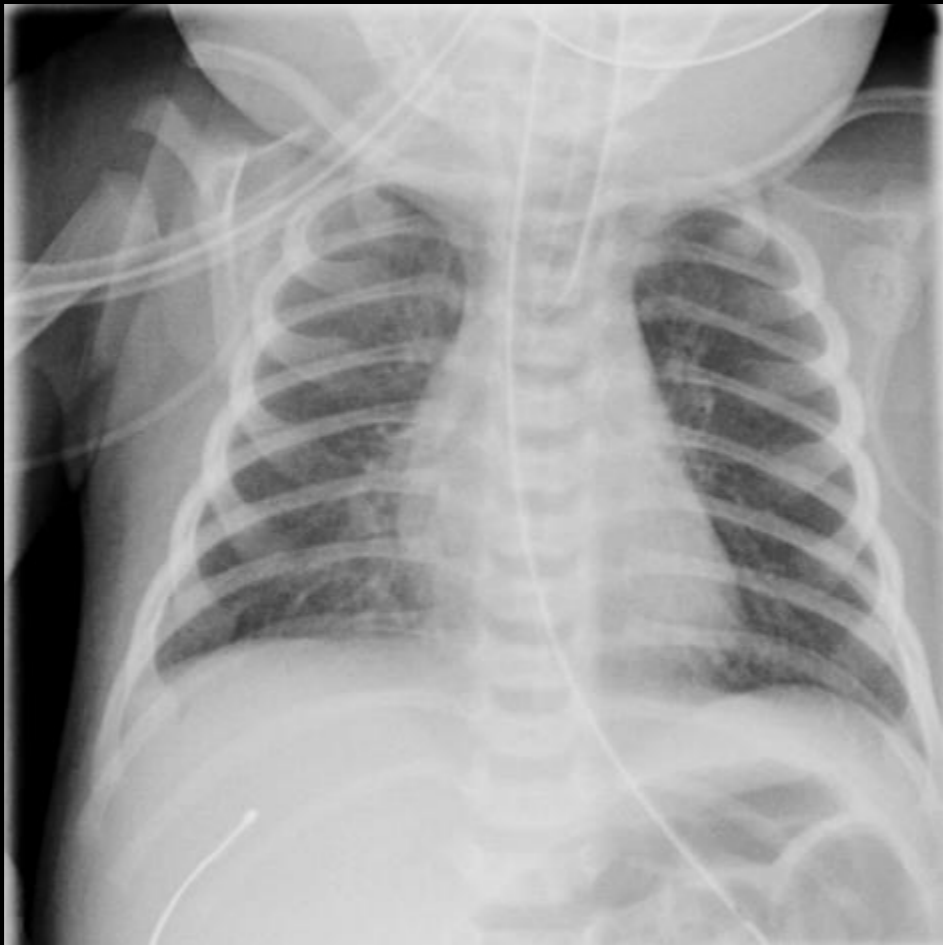
Meconium aspiration Complication Pneumothorax



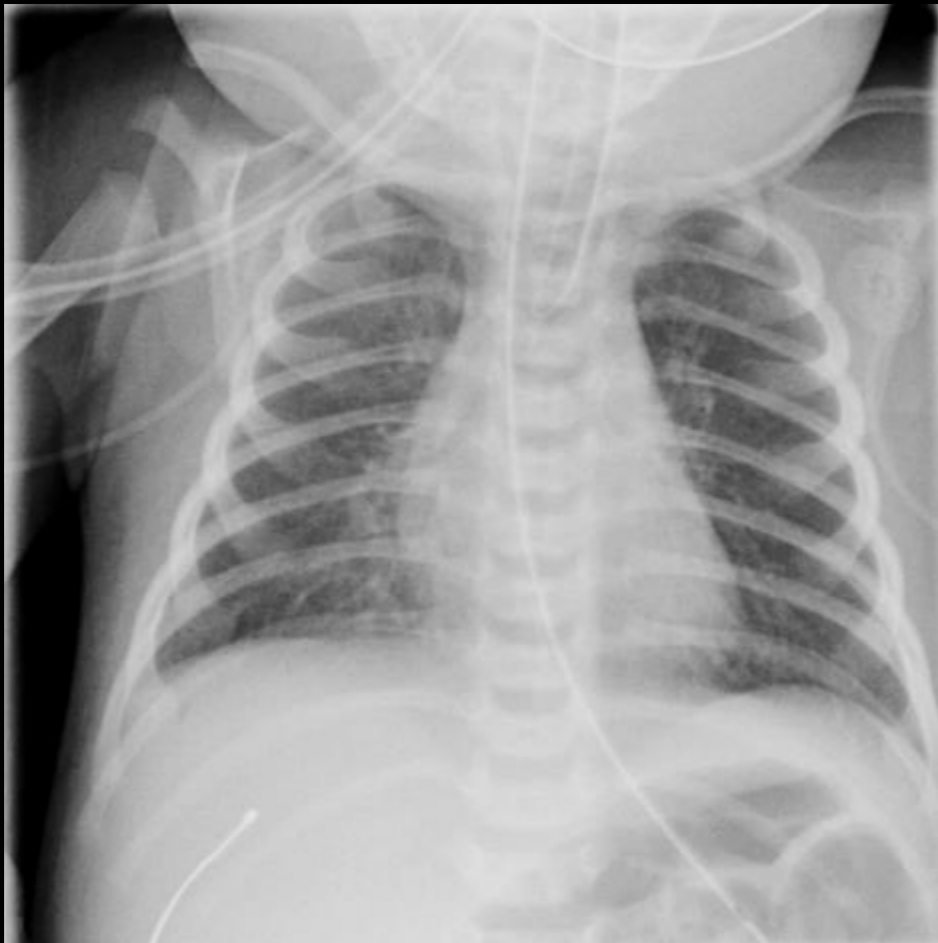
Neonatal Pneumonia



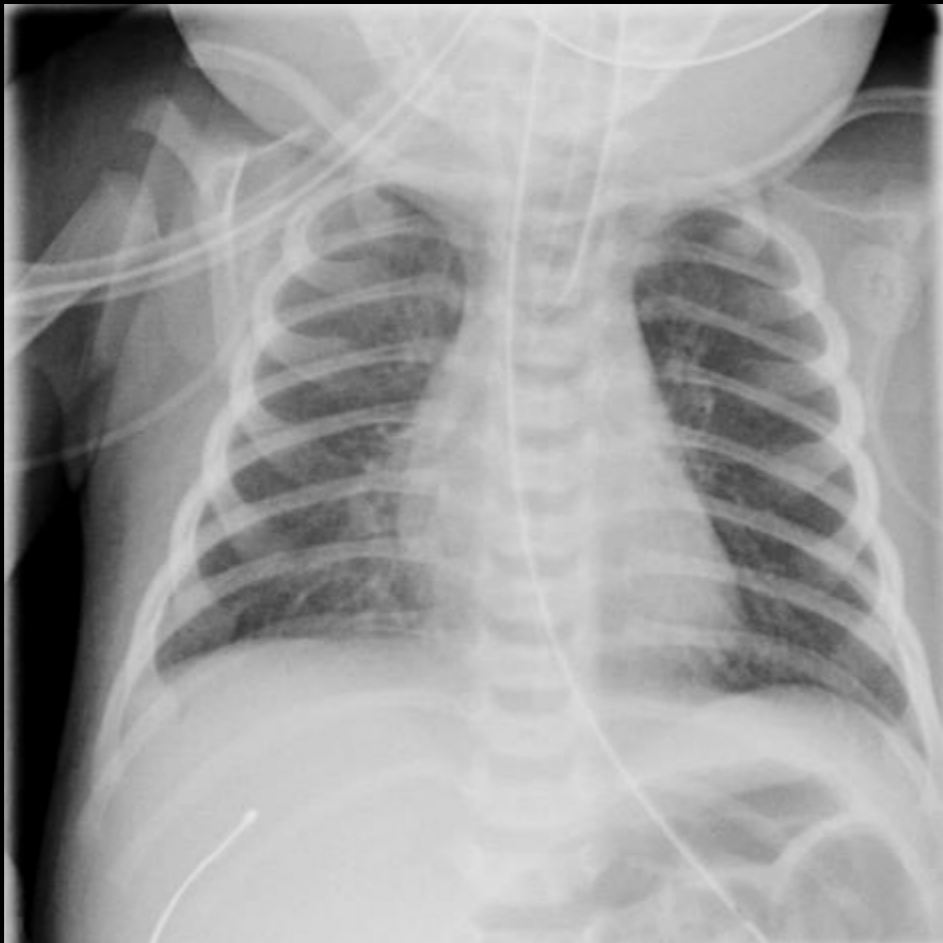
- Inflammatory changes caused by neonatal infection
- Leading cause of morbidity and mortality
- Acquired transplacentally or perinatally
- Risk factors
 - Premature rupture of membranes
 - Prolonged and complicated labors
 - Prematurity
 - Immune disorders
 - Maternal systemic infection
 - Chorioamnionitis
 - Fetal asphyxia- gasping and aspiration of infected amniotic fluid



- Fetal distress or tachycardia
- Respiratory distress
- Sepsis
- Other physical exam finding depending on offending organism...

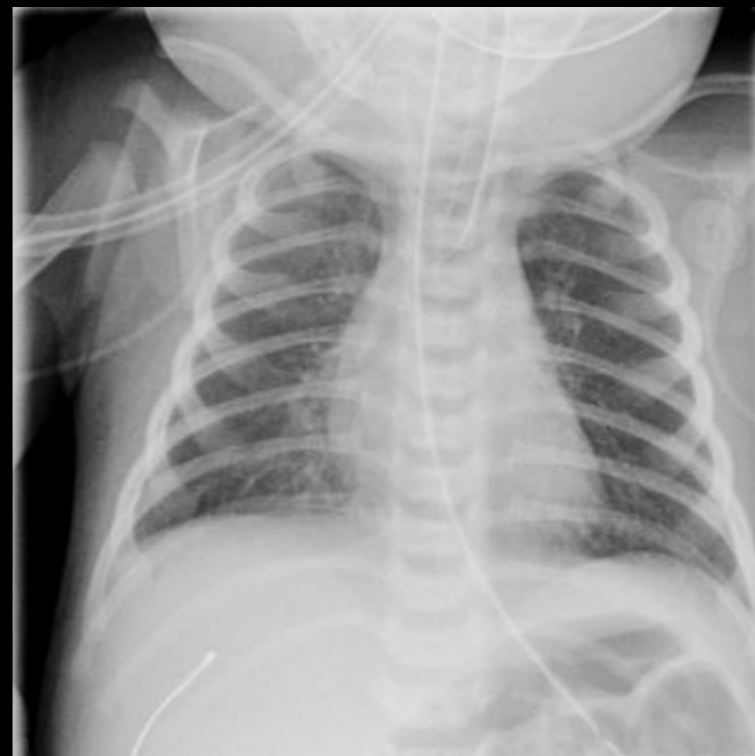
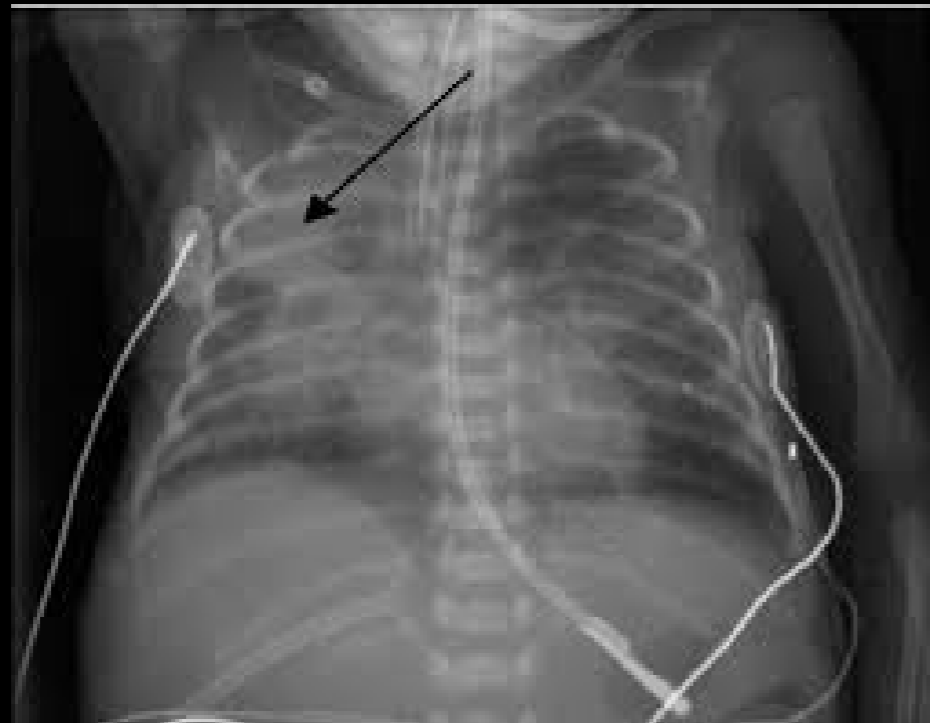


- Maternal systemic infection
 - Rubella
 - CMV
 - Treponema Pallidum
 - Listeria
 - TB
 - HIV
- Most commonly isolated Bacteria
 - Strep (group A and B)
 - Staph A.
 - E. coli
 - Klebsiella
 - Proteus



- **Imaging findings variable**
 - Normal chest
 - Focal or diffuse opacities
 - Interstitial opacities-
similar to surfactant
deficiency
- Patchy parenchymal opacities
with air bronchograms

2 examples of neonatal pneumonia on x-ray



Round Pneumonia

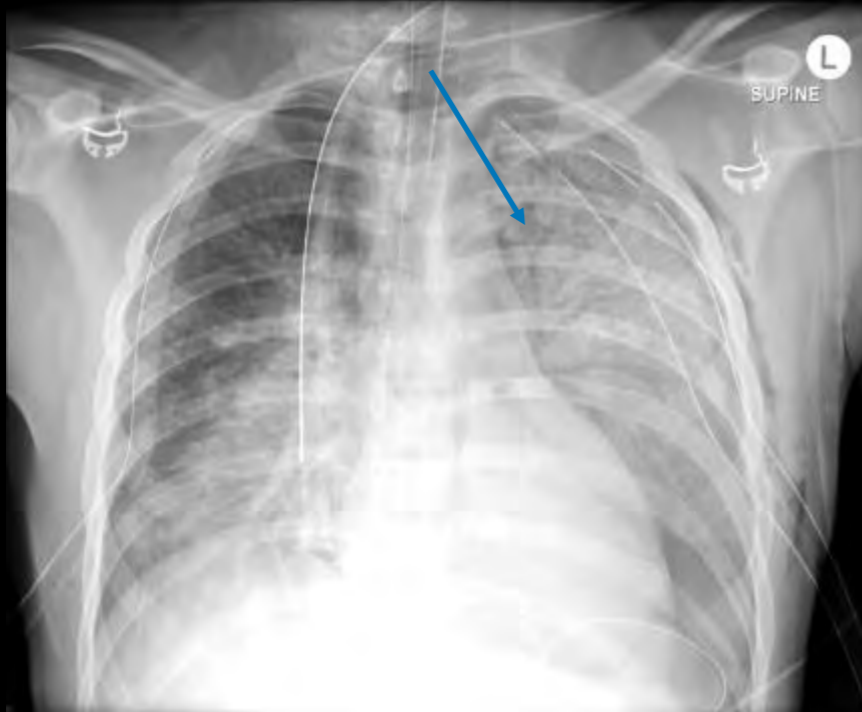


- Common imaging manifestation of bacterial pneumonia in children and young adolescents
- Underdeveloped pathways of collateral ventilation
 - Pores of Kohn
 - Canals of Lambert
 - In adults, permit lateral dissemination of infection through lobe → lobar pneumonia
- In one study
 - 75% of patients were under 8 years old and 90% were under 12

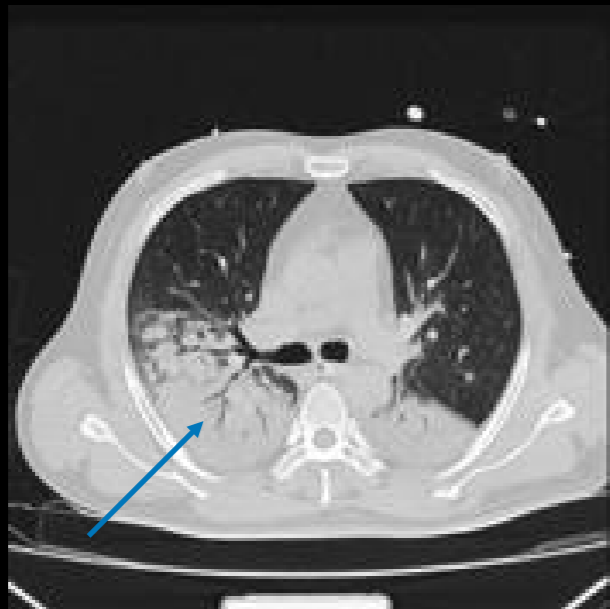


- Round-is opacities
- Irregular margins
- Air bronchograms

Air bronchogram



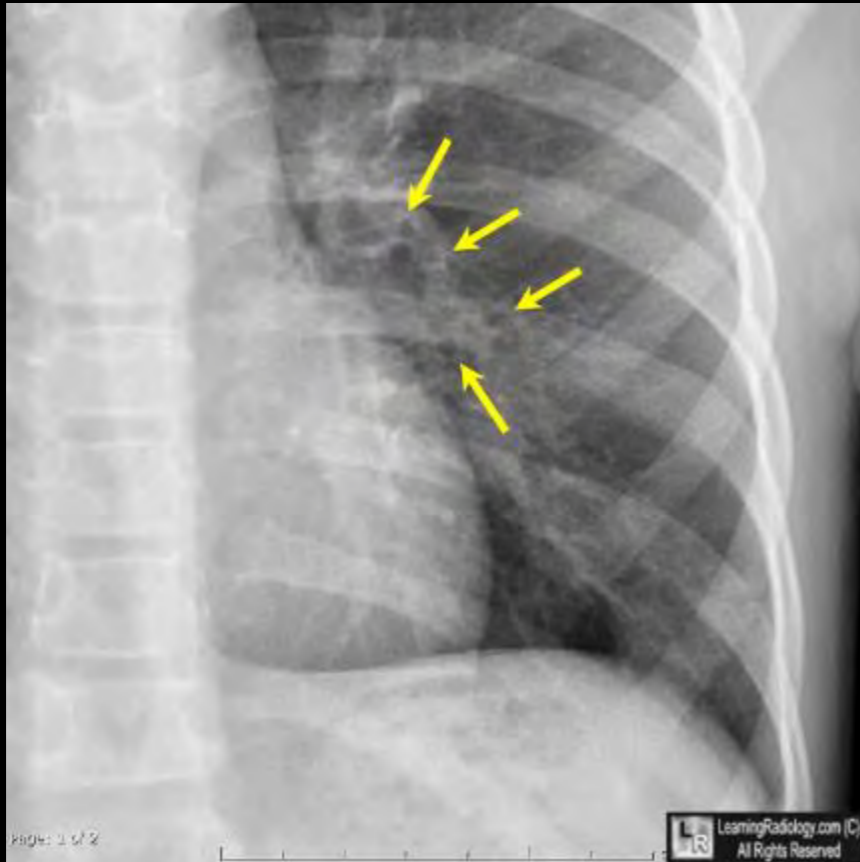
- Phenomenon of air-filled bronchi (dark) being made visible by the opacification of surrounding alveoli (grey/white).
- Caused by a pathologic airspace/alveolar process, in which something other than air fills the alveoli.
- Air bronchograms will not be visible if the bronchi themselves are opacified (e.g. by fluid) and thus indicate patent proximal airways.



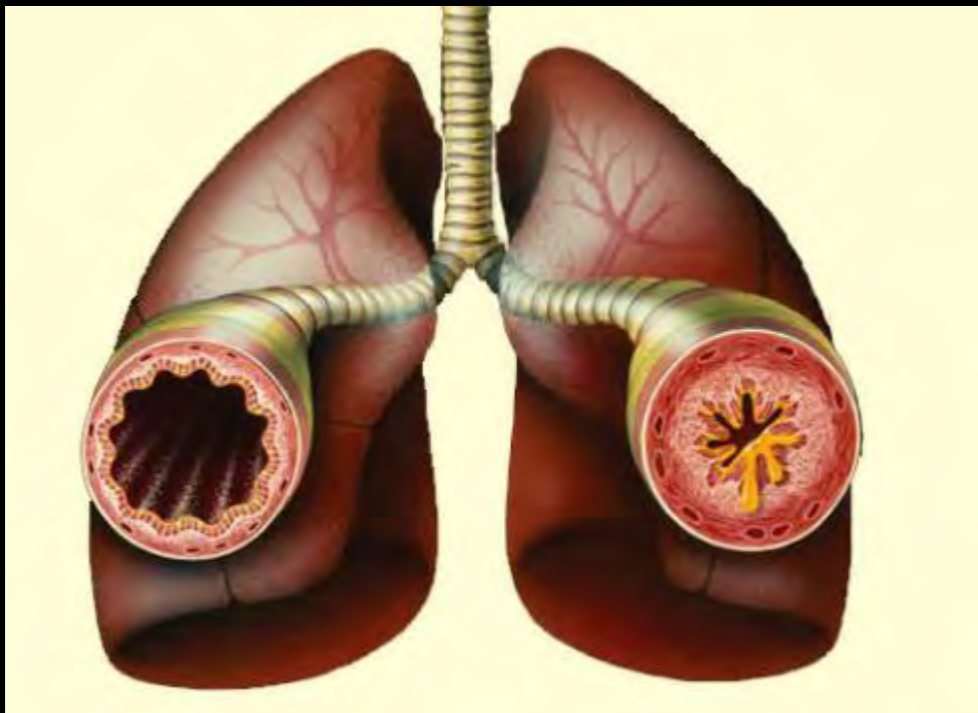


- Differential diagnosis
 - **Neuroblastoma:**
 - Arise anywhere along paraspinal sympathetic chain
 - May contain calcifications
 - Typ 3 CPAM
 - Bronchogenic cyst

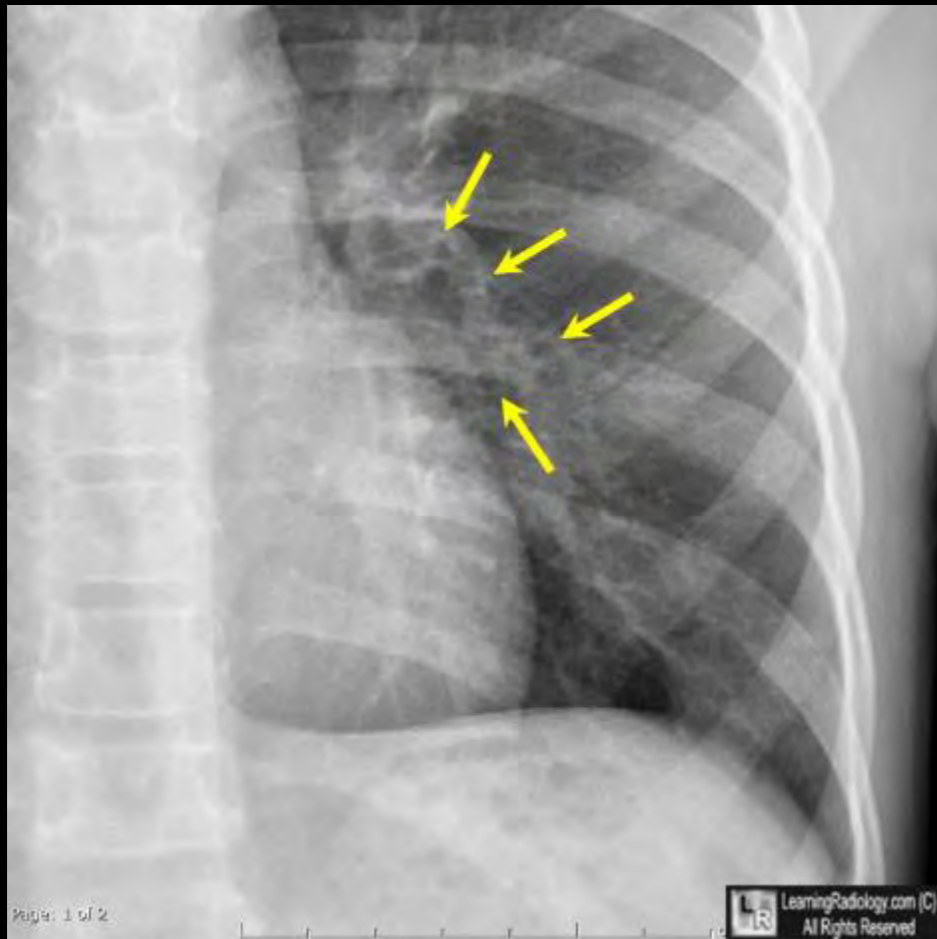
Reactive airway disease



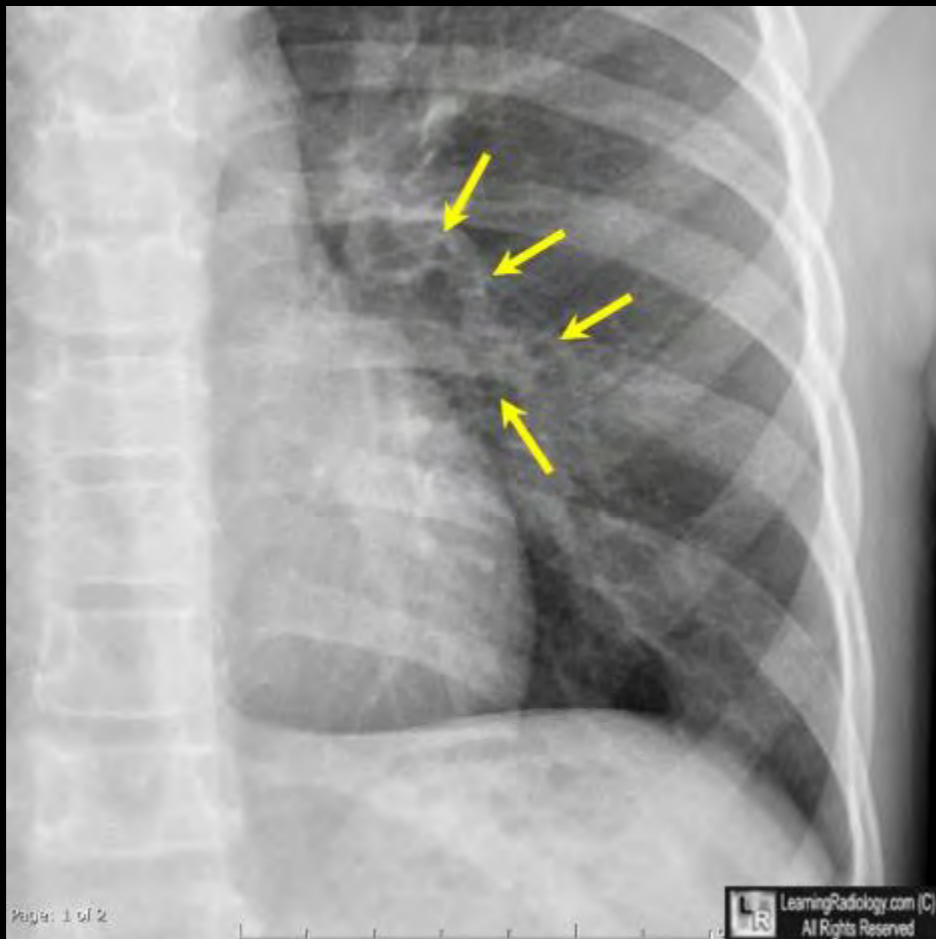
- General term for pediatric disease entity characterized by wheezing, shortness of breath and coughing
- Initial episodes frequently referred to as bronchiolitis
- Unlike asthma, which is chronic, reactive airway disease is usually transient
- May be triggered by
 - Viral URI, esp RSV
 - Pollen and mold
 - Cigarette smoke
 - Extreme cold
- Most (60%) of children with wheezing before age 3 will outgrow it by age 6



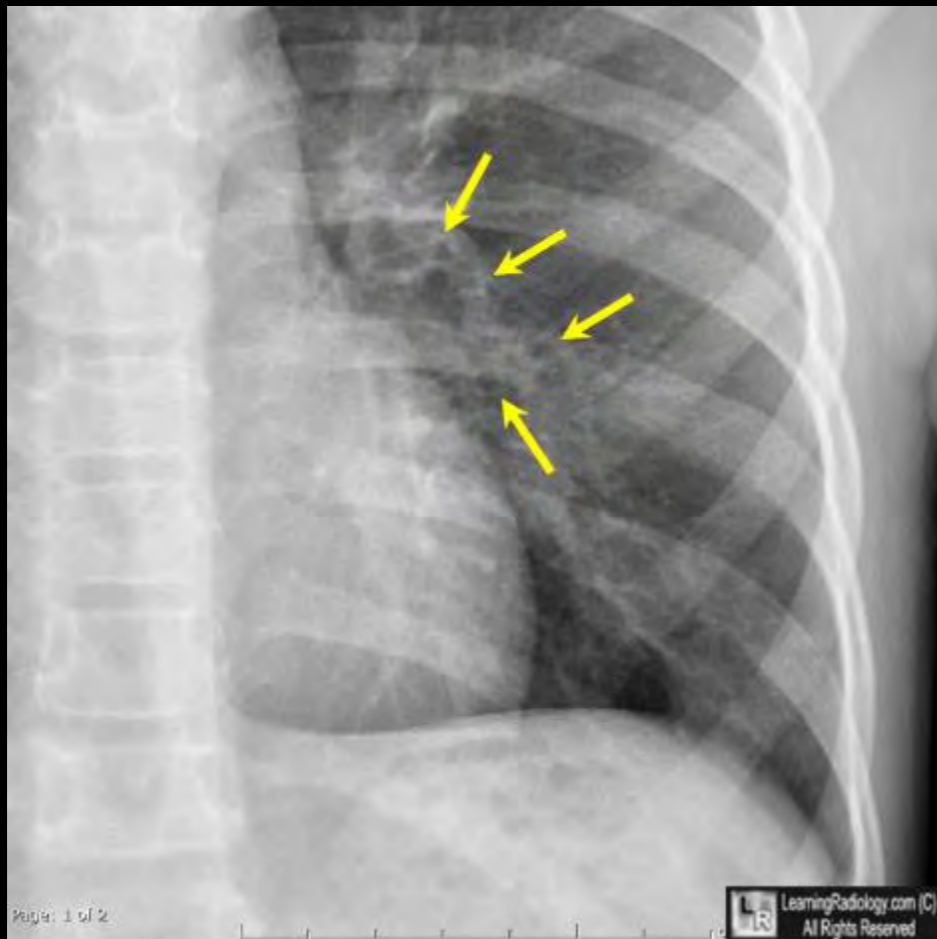
- Clinical findings



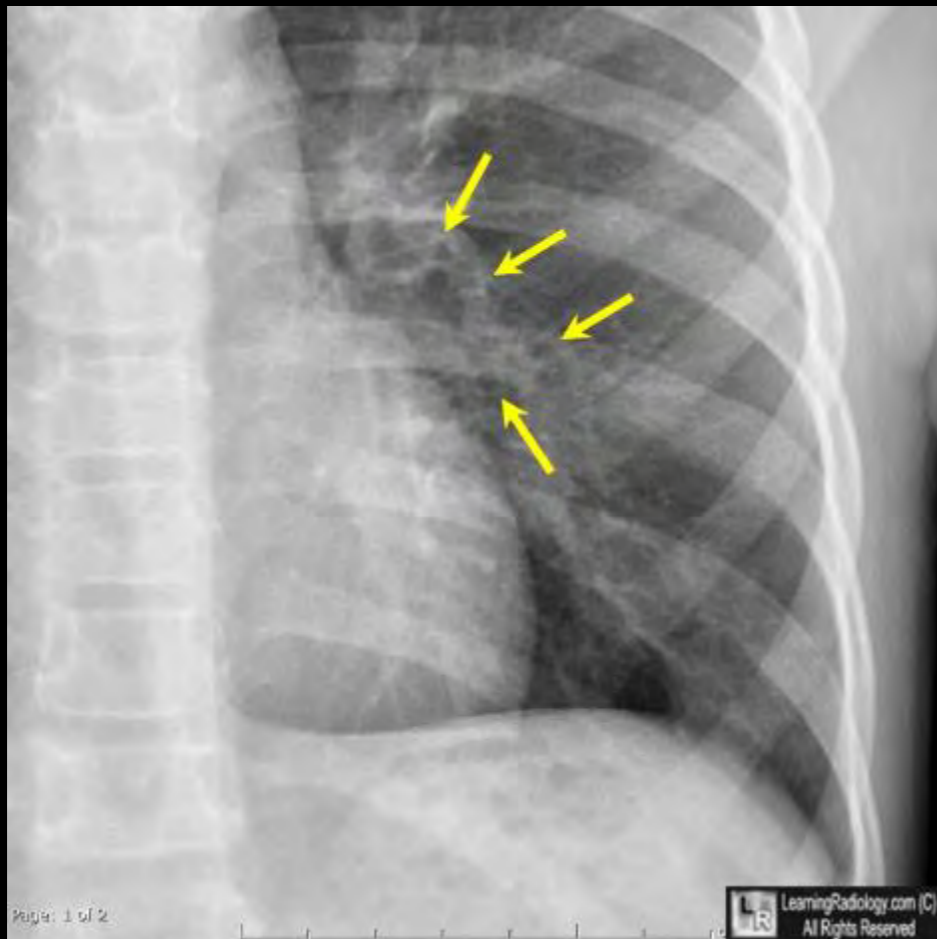
- Increased respiratory rate
- Retractions
- Cough
- Fever
- Rhinorrhea



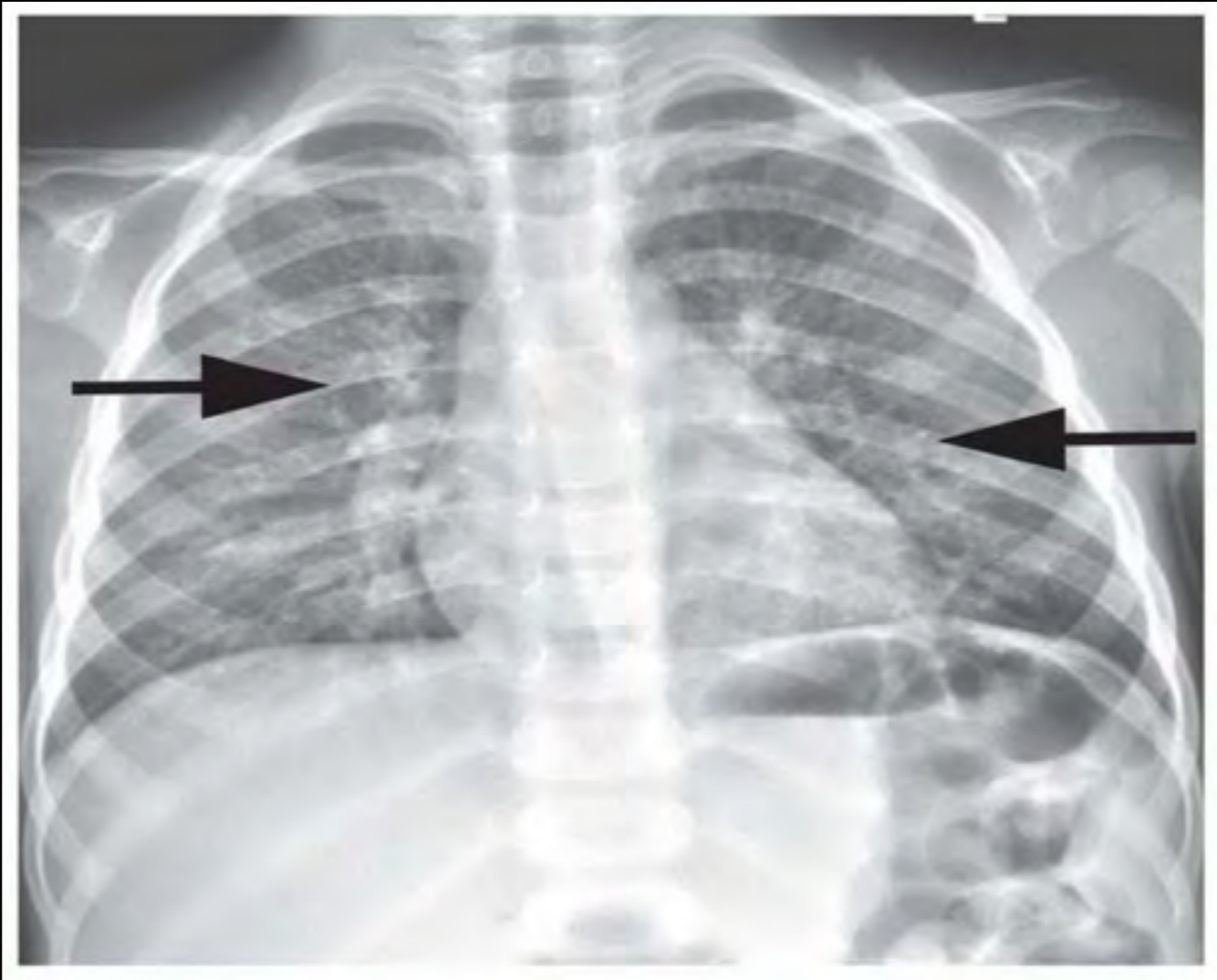
- Imaging findings
 - Peribronchovascular thickening
 - Primarily lobar or segmental bronchi
 - May produce tram-track like linear densities
 - Hyperinflation
 - Atelectasis from mucus plugging



- Differential diagnosis
 - Usually difficult to distinguish viral bronchiolitis and asthma in young children
 - 2 may coexist
 - Foreign body aspiration
 - Anaphylactic reaction



- Treatment
 - Bronchodilator
 - Steroids
 - Oxygen





R

LMB

Foreign body aspiration

- Potentially fatal
- Immediate recognition is important
- Children under 4 at increased risk
 - 70% are witnessed to have choking episode at time of aspiration
 - May otherwise present with cough, dyspnea or irritability

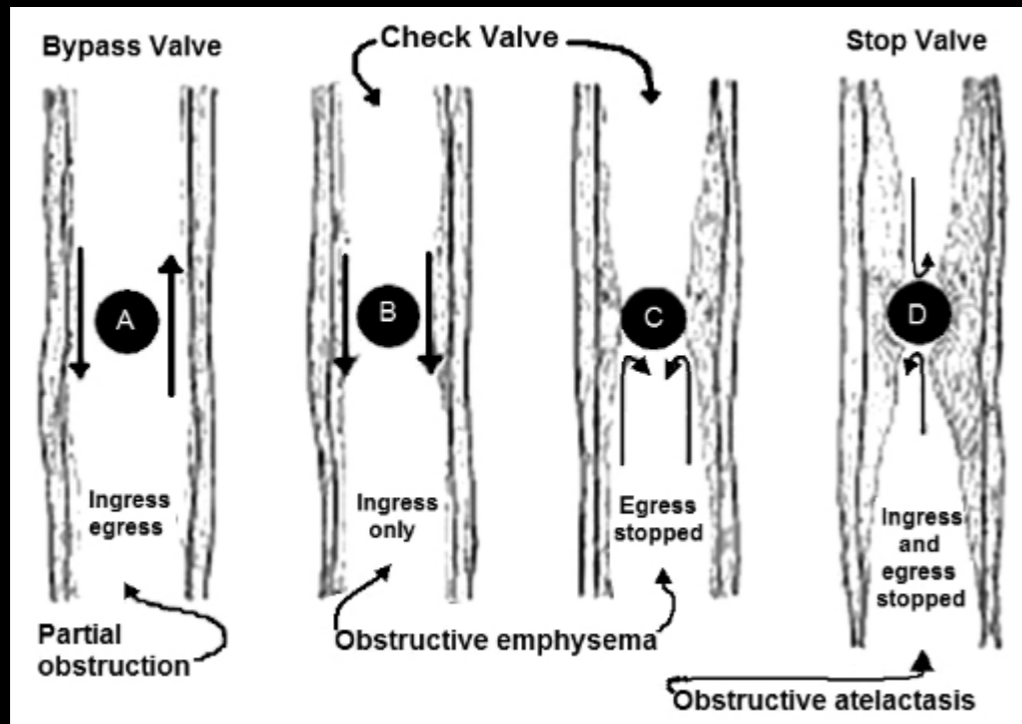




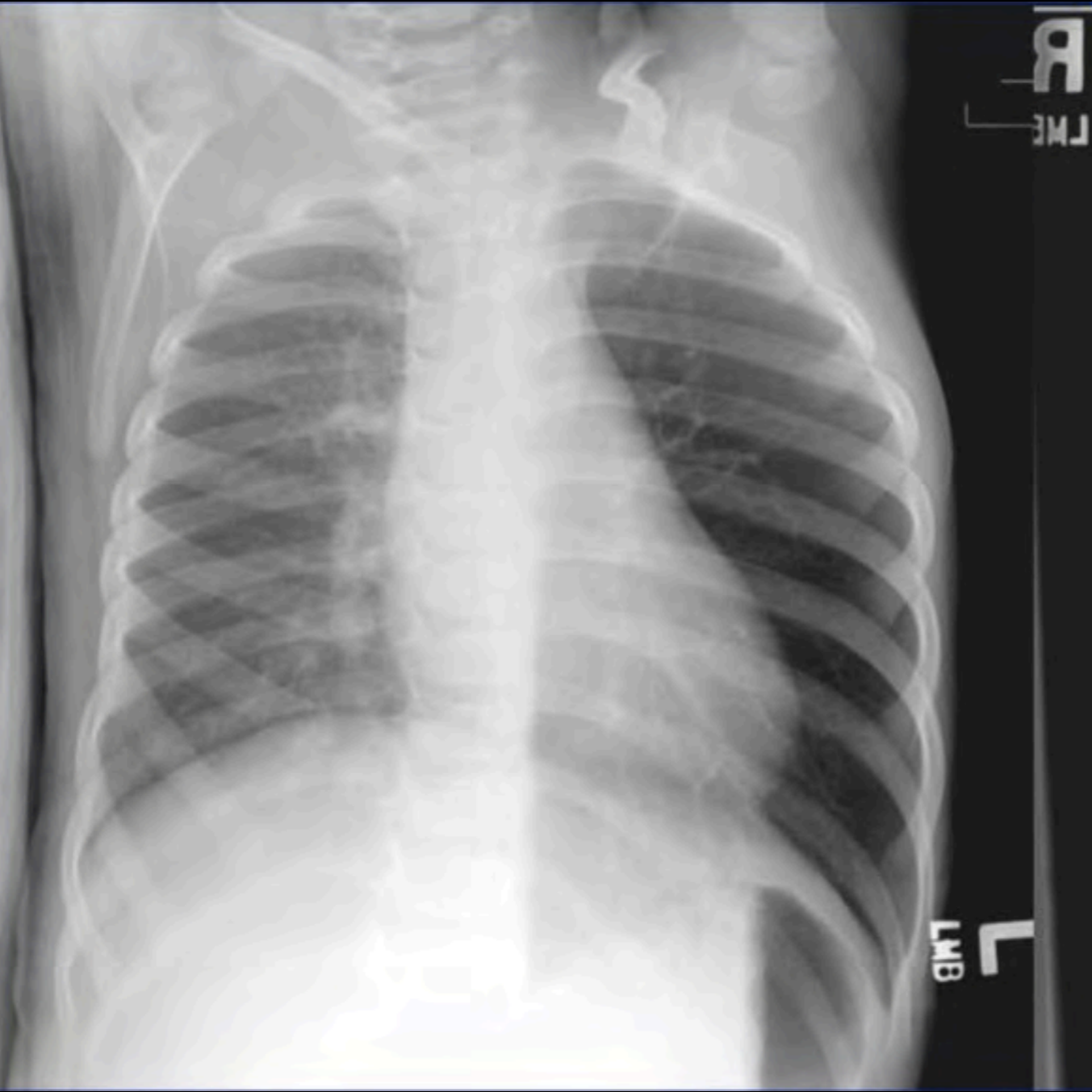
- Aspirated material is not always visible on radiographs
 - Often in organic
 - Seeds, nuts



- Imaging findings
- Image during expiration to



- May be normal in 30% of cases
- If large enough, may see interrupted bronchus sign
- Check valve mechanism: air enters but cannot exit—> hyper inflated lung
- Lobar atelectasis

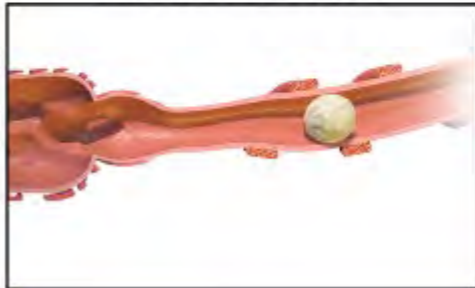




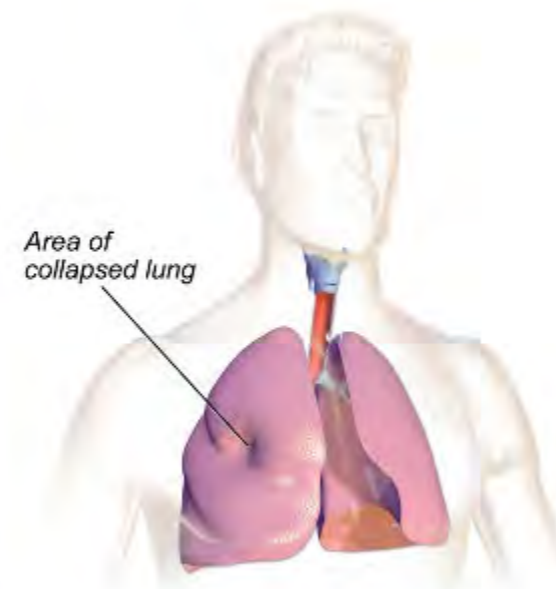
Normal Bronchiole



Blocked Bronchiole

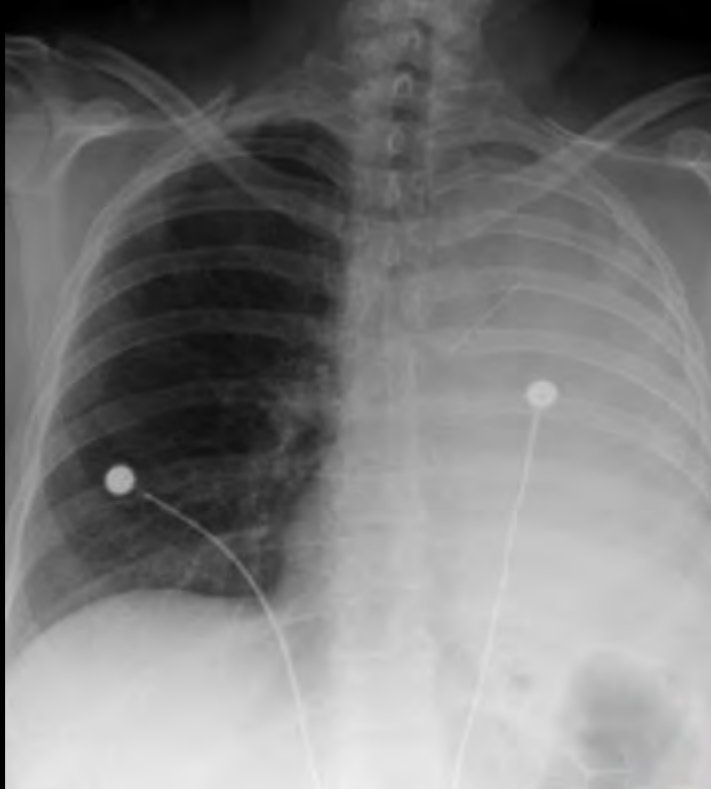


Atelectasis

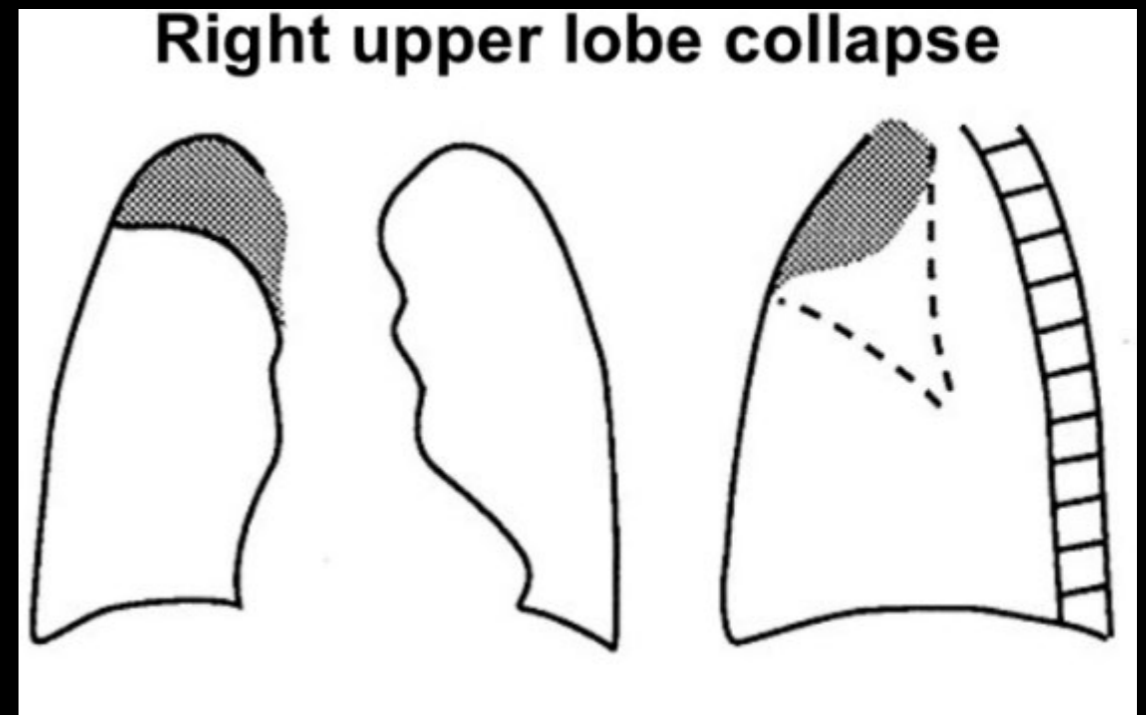
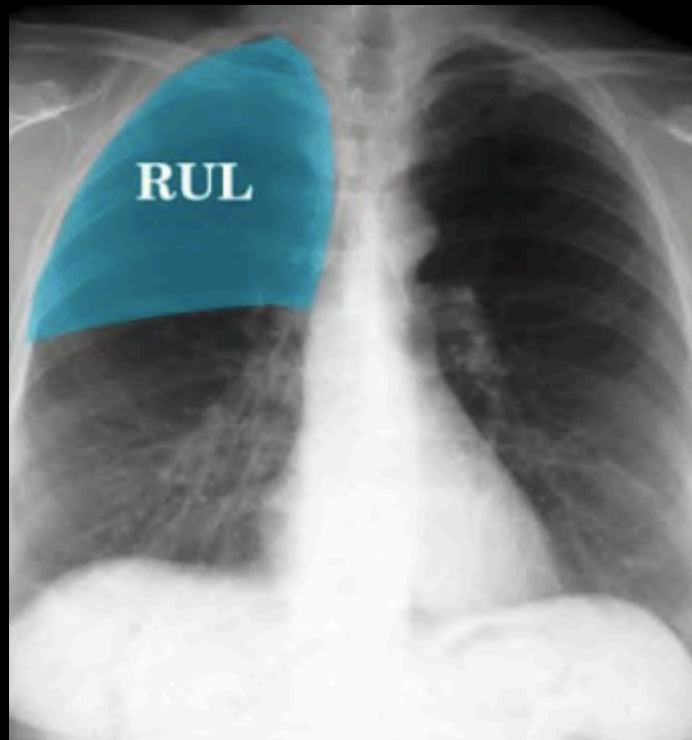


*Area of
collapsed lung*

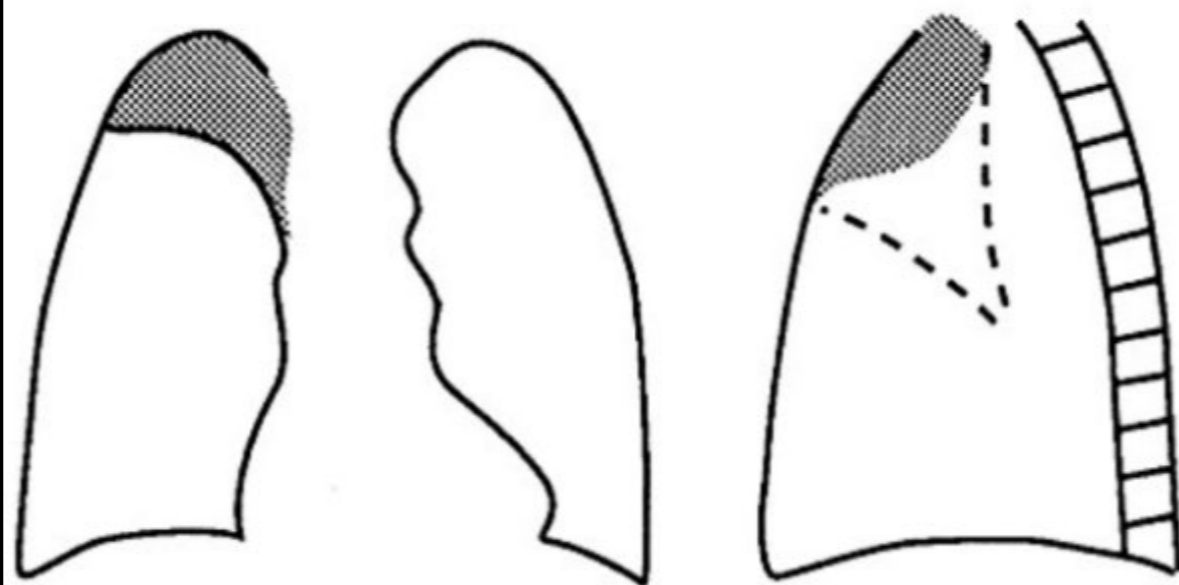
2 examples of bronchus cut-off sign



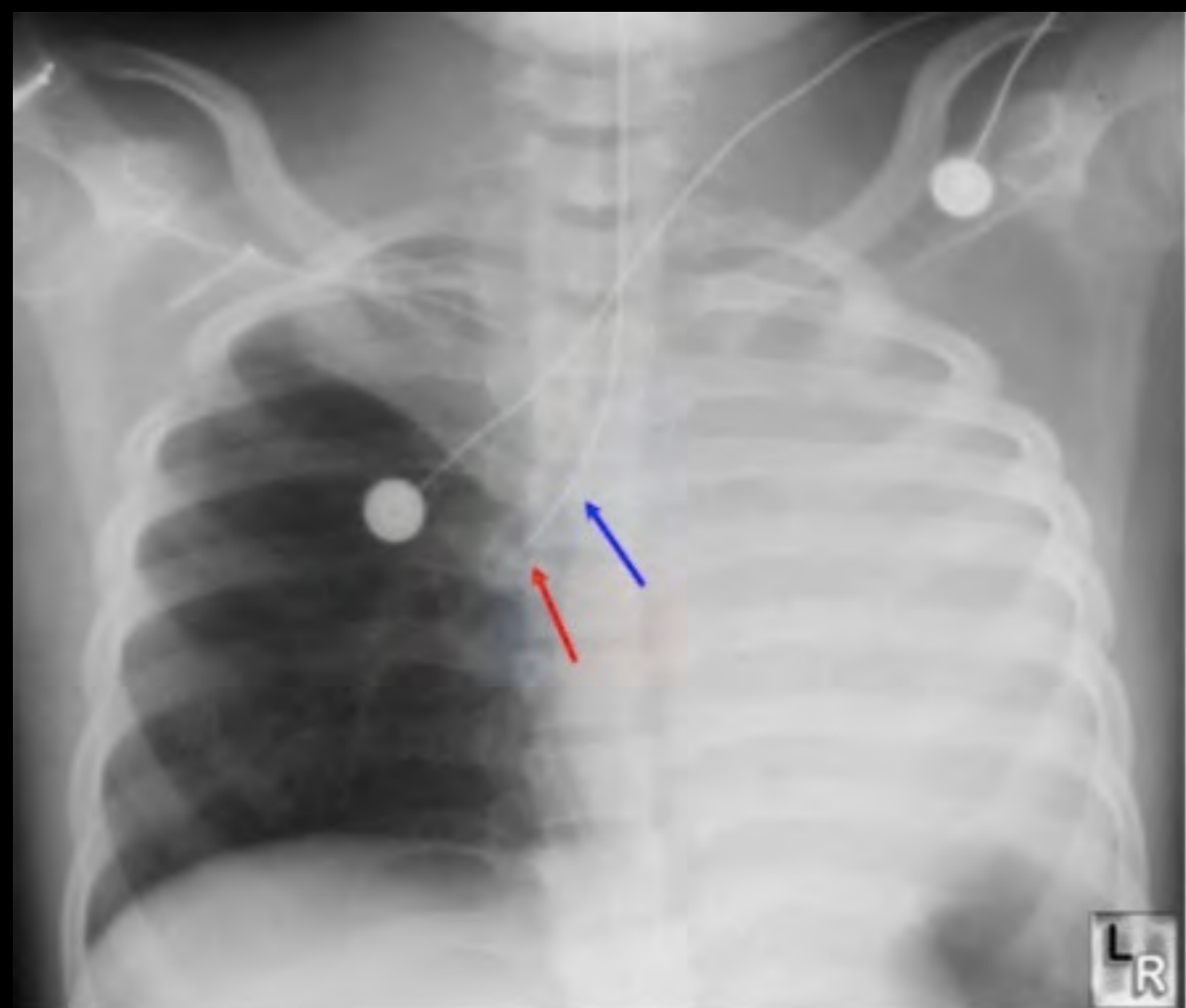
Atelectasis by Lobe



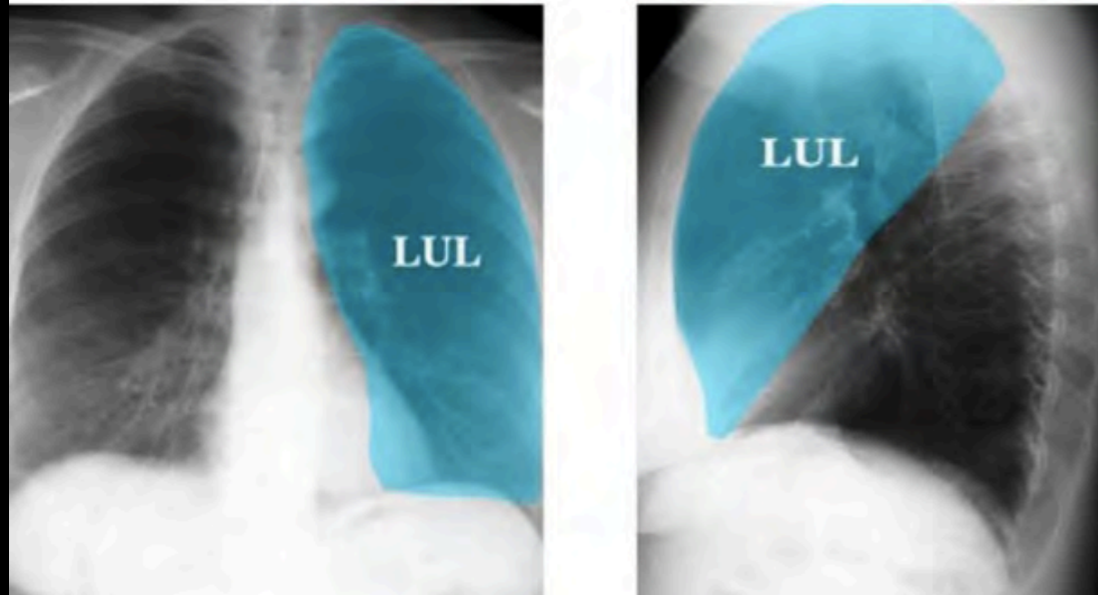
Right upper lobe collapse



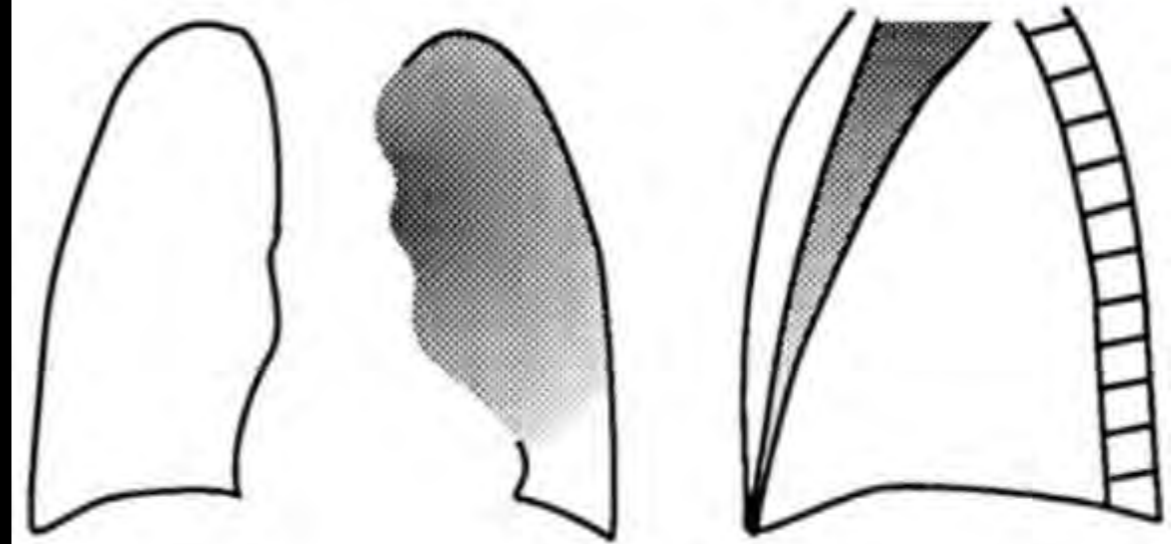
Juxtaphrenic peak

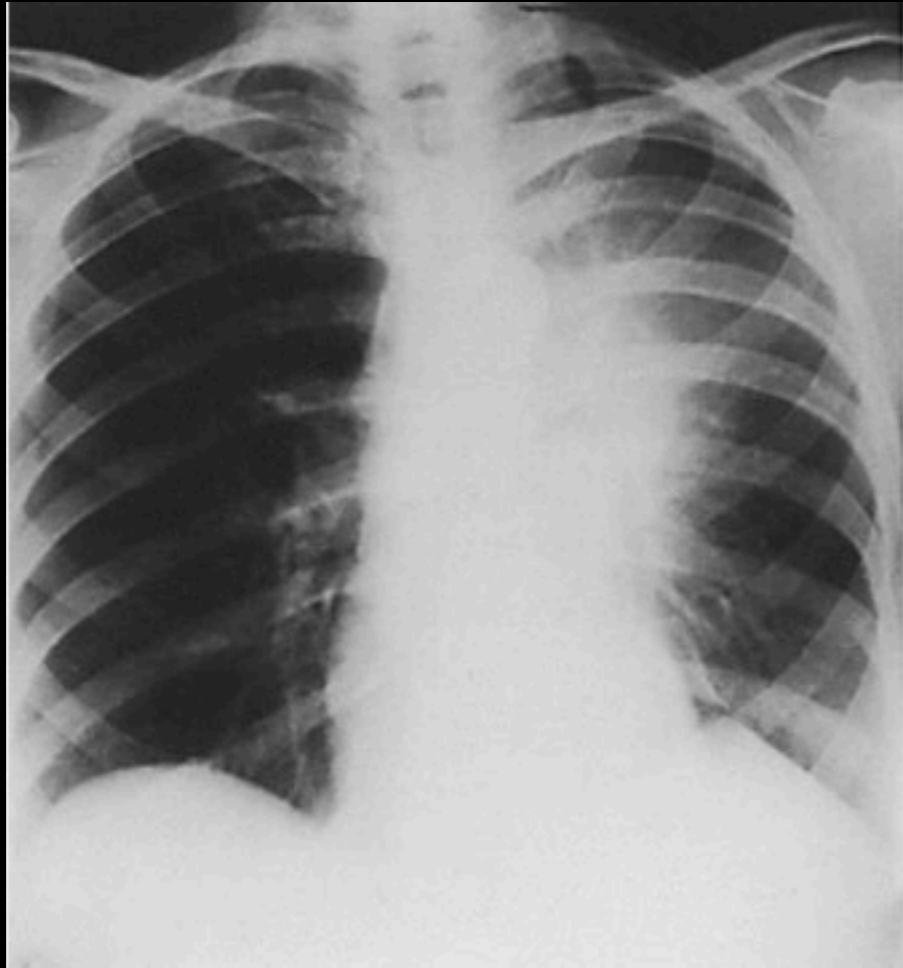


Left upper lung lobe



Left upper lobe collapse





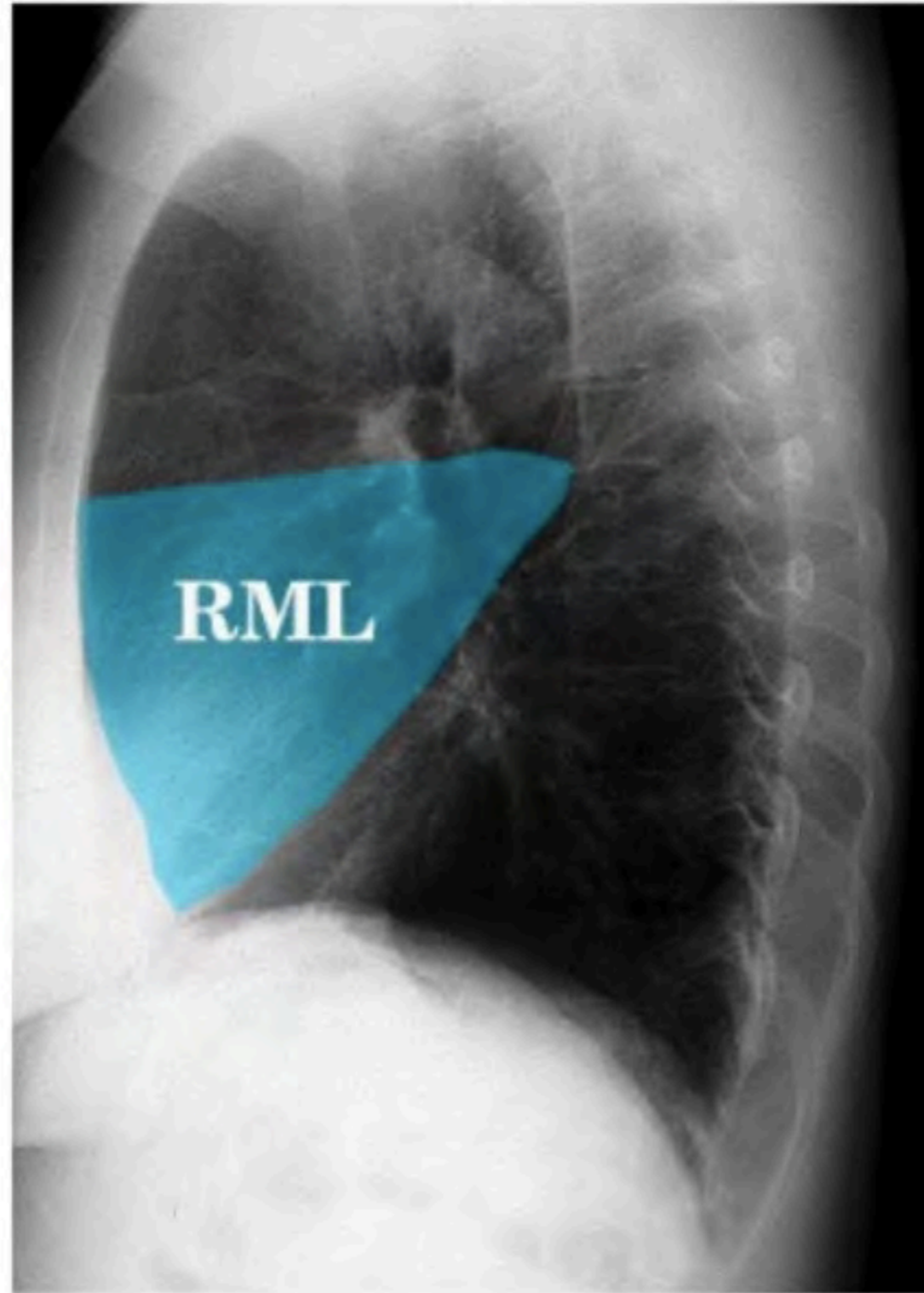


Luftsichle sign

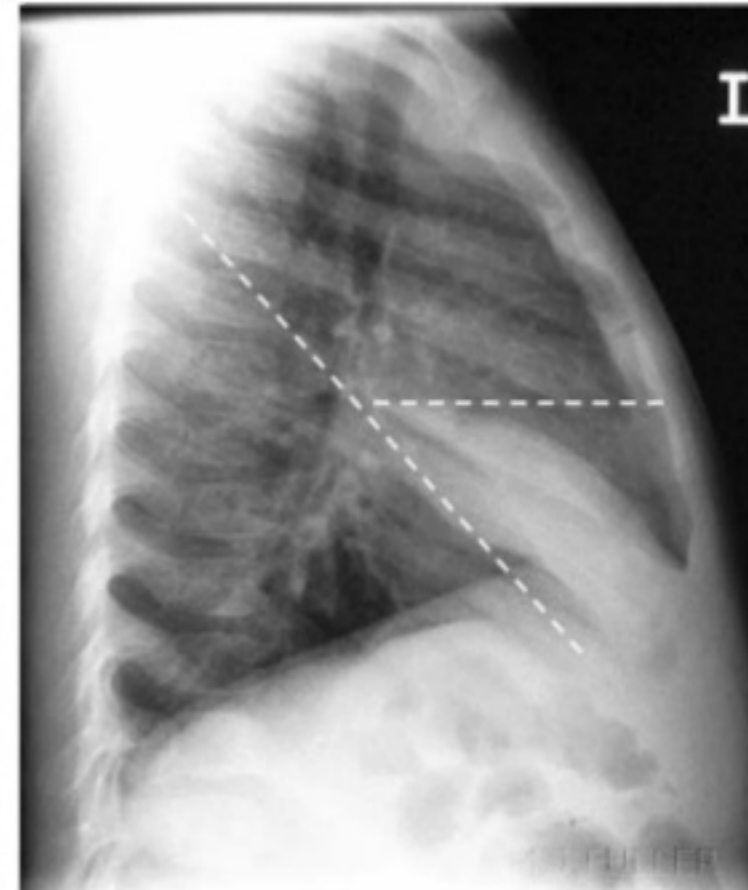
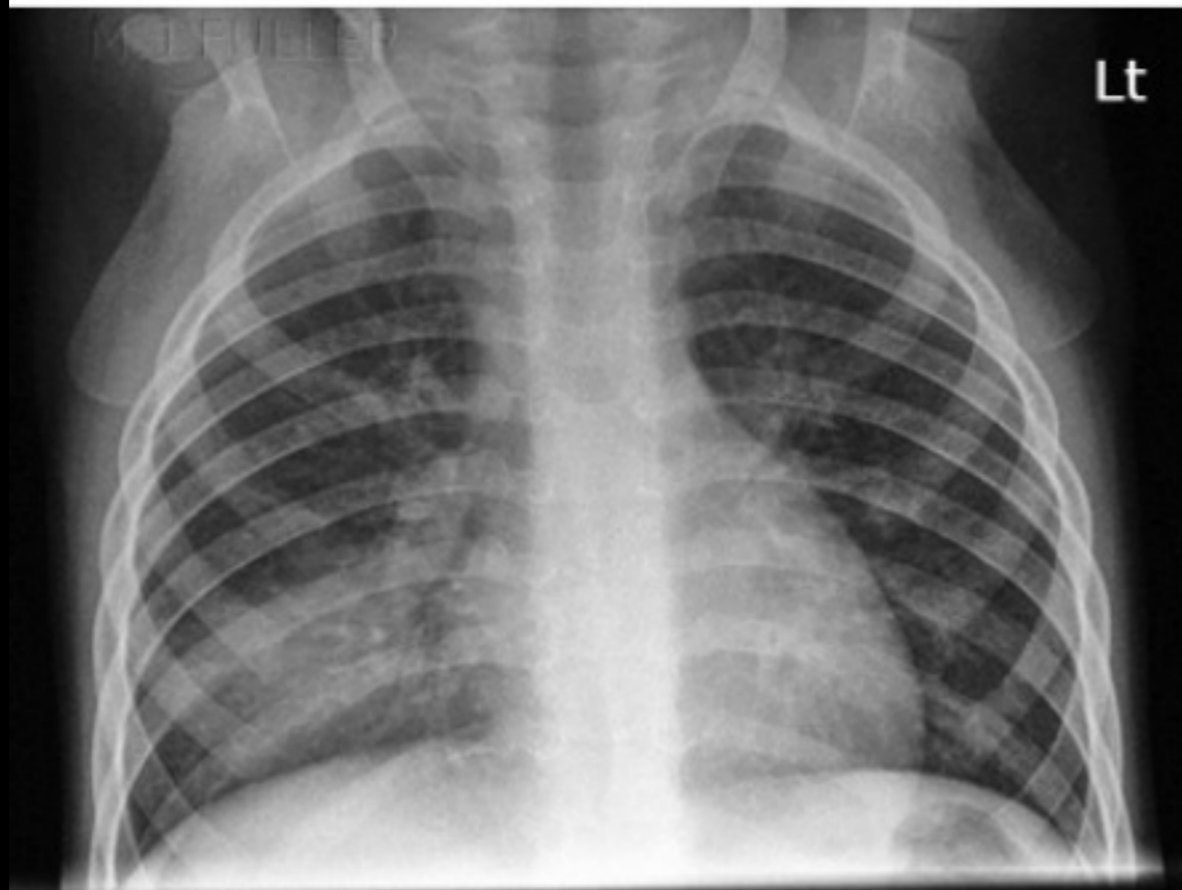
- Air crescent sign
- Herniation of the superior segment of the hyperinflated left lower lobe between the mediastinum & the collapsed left upper lobe.

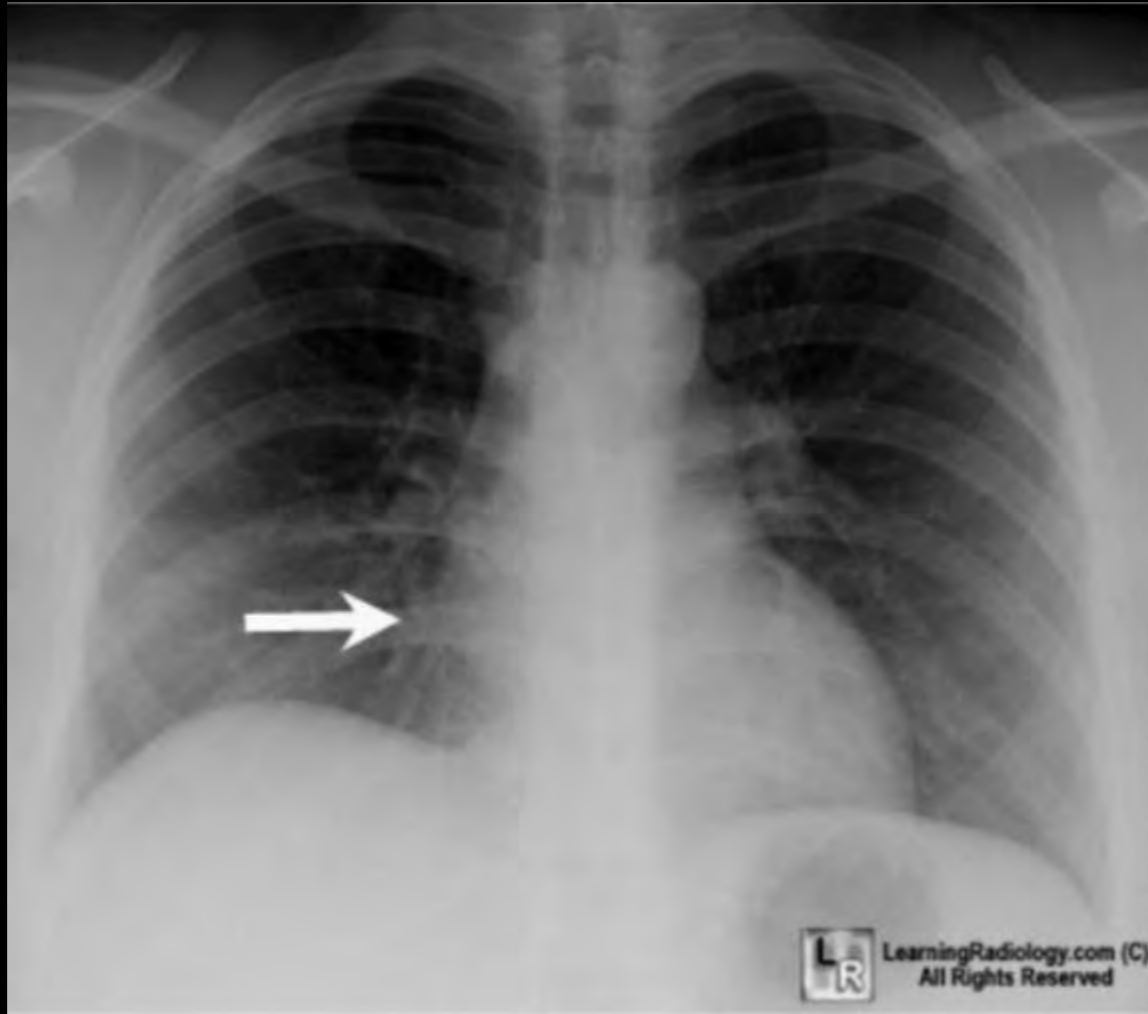


L (Right Middle Lung)

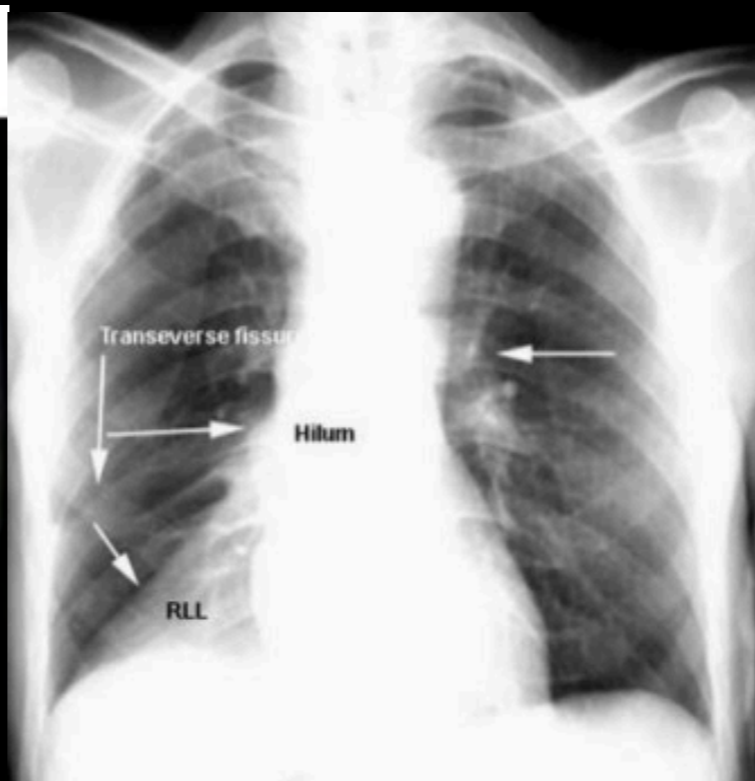


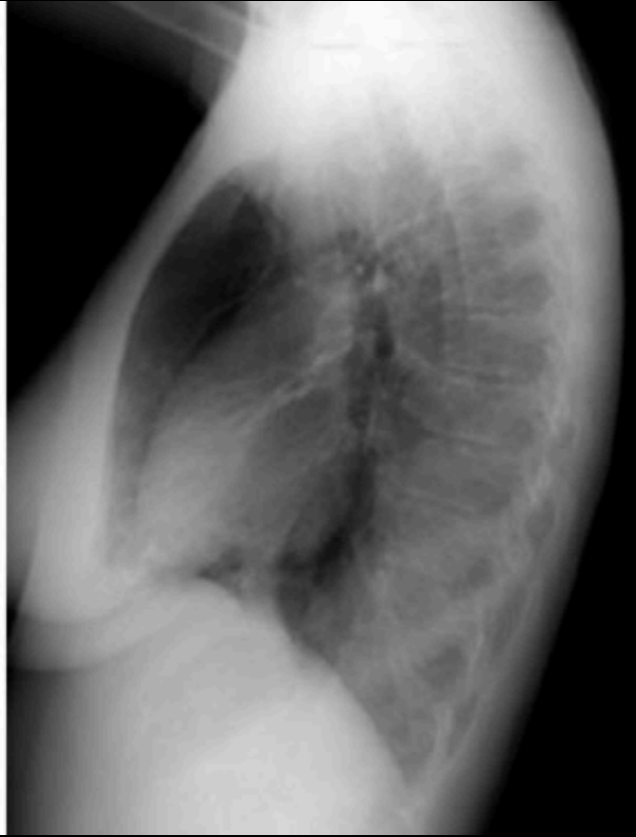
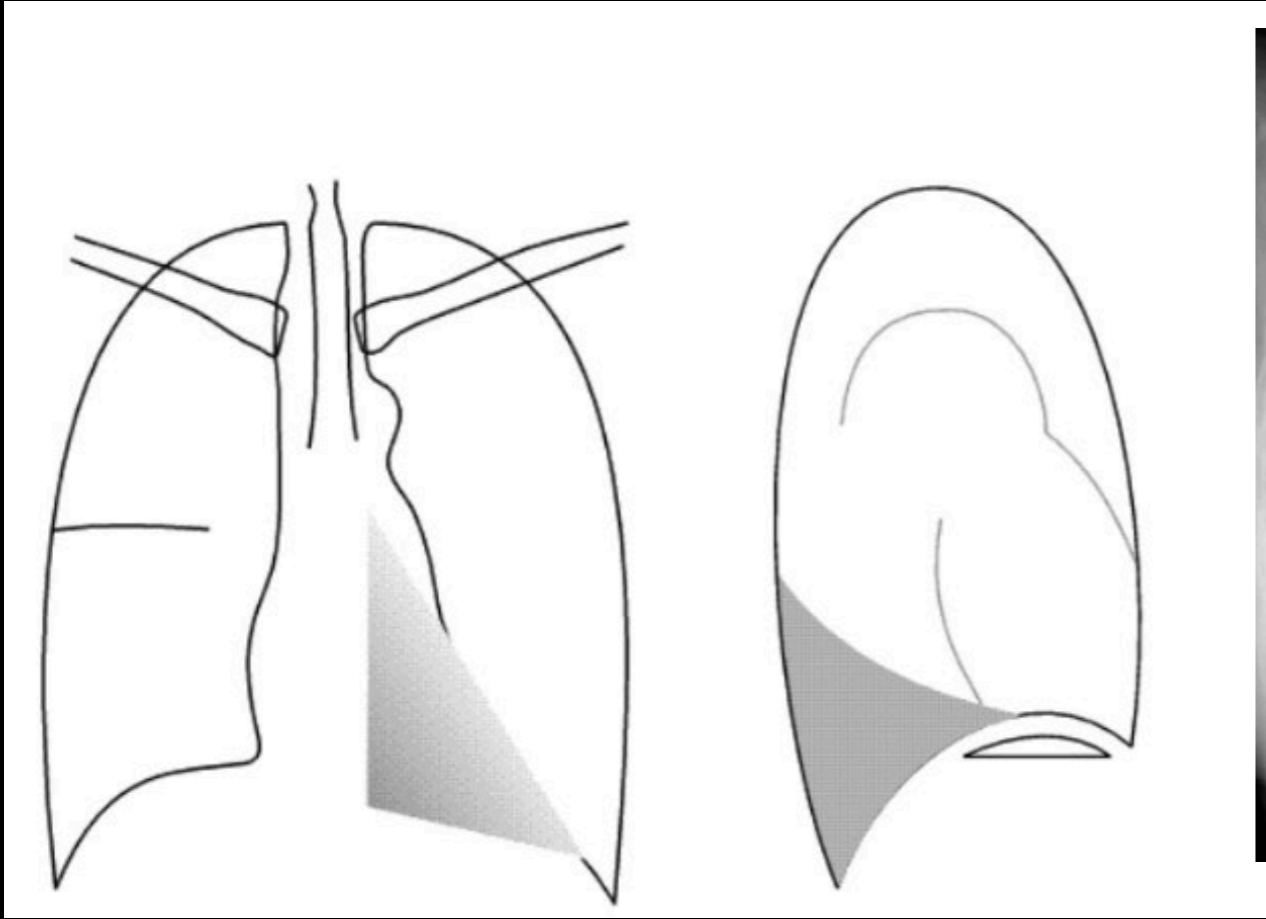
Right middle lobe collapse



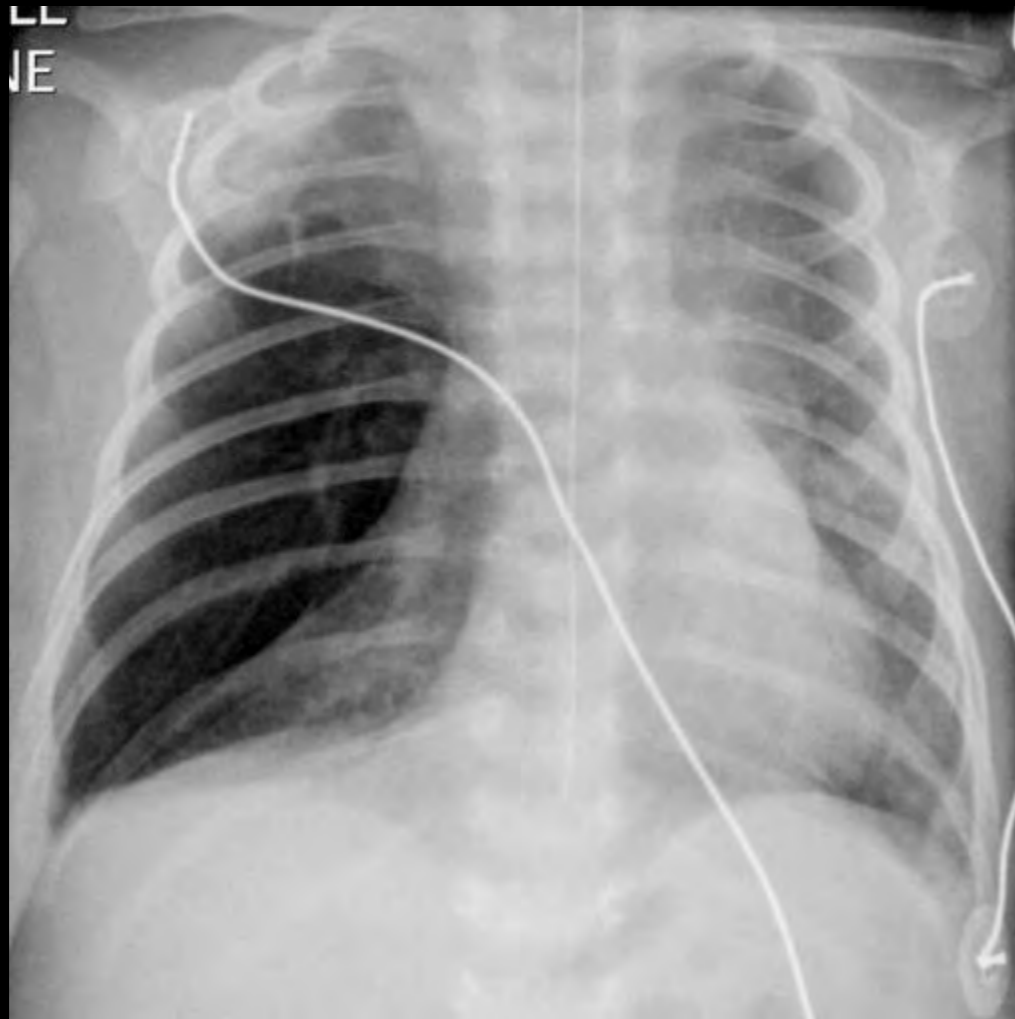


LL (Lower lobe)





Congenital Lobar Over-inflation



- Congenital lung abnormality resulting in progressive overinflation of one or more lobes
- Classically: hyperlucent lung segment with over inflation and contralateral mediastinal shift
- M:F. 3:1
- Mechanism
 - Obstruction
 - Cartilage deficiency
 - Dysplasia
 - Immaturity
 - Most cases are idiopathic
- May be associated with aberrant left pulmonary artery and congenital heart defects



- Presentation
 - Respiratory distress
 - Most commonly neonatal period- usually within first 6 months of life



- Predilection for lobes
 - LUL- most common 40-45%
 - RML 30%
 - RUL 20%
 - May involve more than a single lobe 5%
 - Much rarer in lower lobes



- Imaging
 - Immediate post partum: opaque because of fetal lung fluid or may show diffuse reticular pattern related to distended lymphatic channels filled with fetal lung fluid
- Later
 - Area of hyper lucency with paucity of vessels
 - Mass effect on mediastinum and diaphragm
 - Decubitus film lying on affected side shows little or no change in lung volume



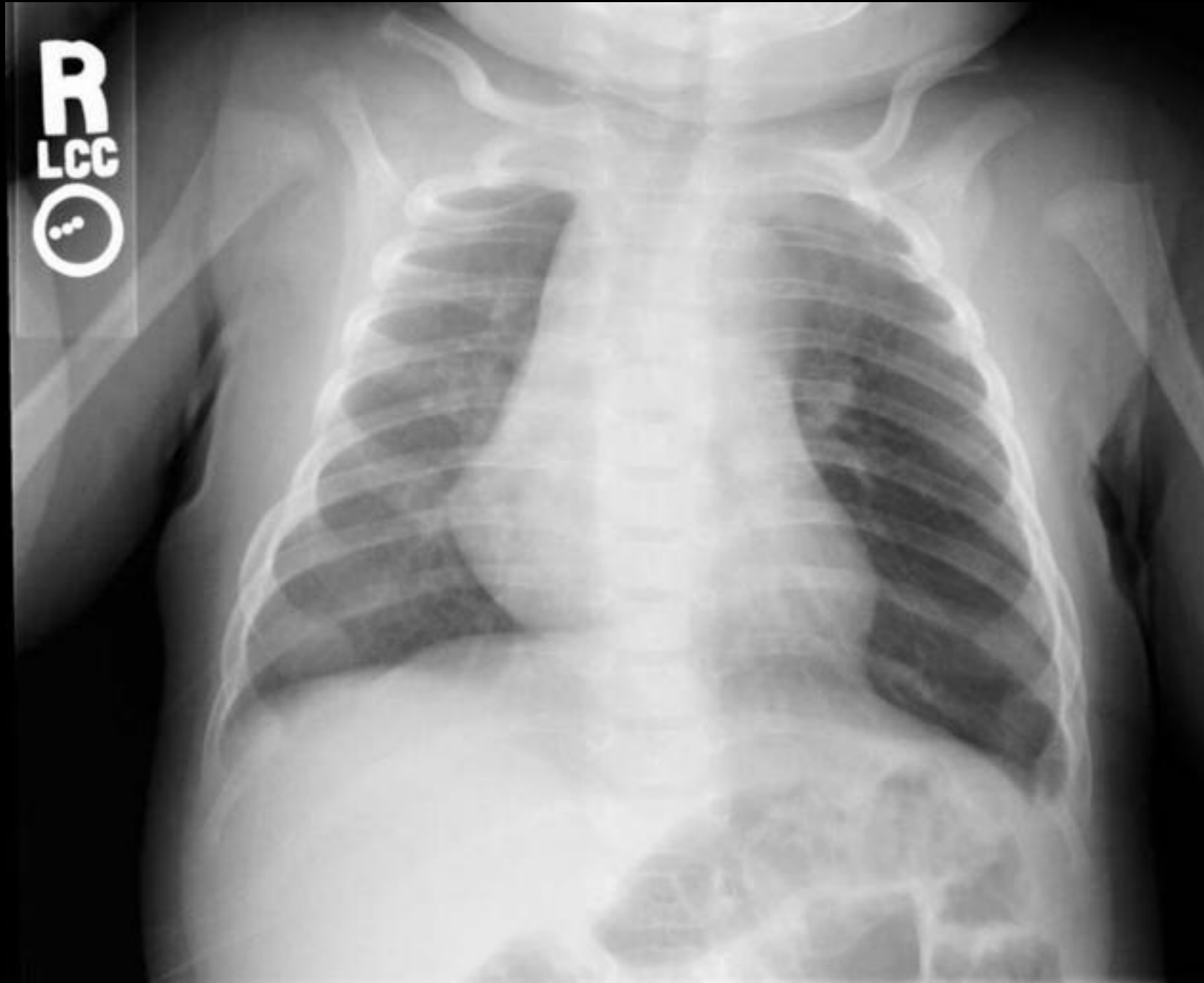
- Treatment
 - Asymptomatic patients are typically followed
 - Lobectomy considered in severe cases

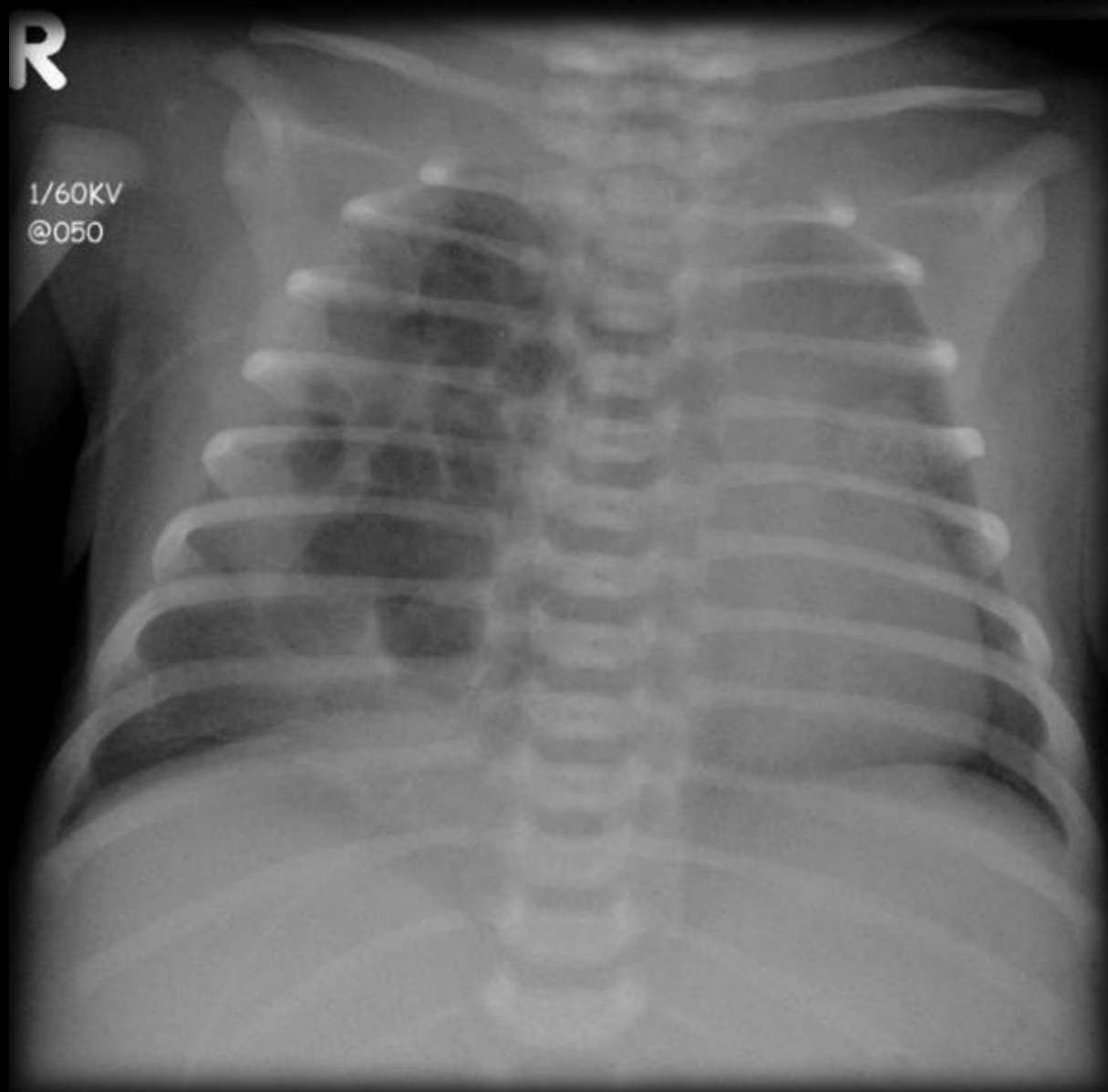


- Differential diagnosis
 - Bronchial atresia: parenchymal distal to atretic segment can have air trapping
 - Sawyer James Syndrome: unilateral lucency secondary to post infectious obliterative bronchiolitis. Typically following viral infection such as adenoviruses or mycoplasma pan in infancy or early childhood
 - Congenital pulmonary airway malformation





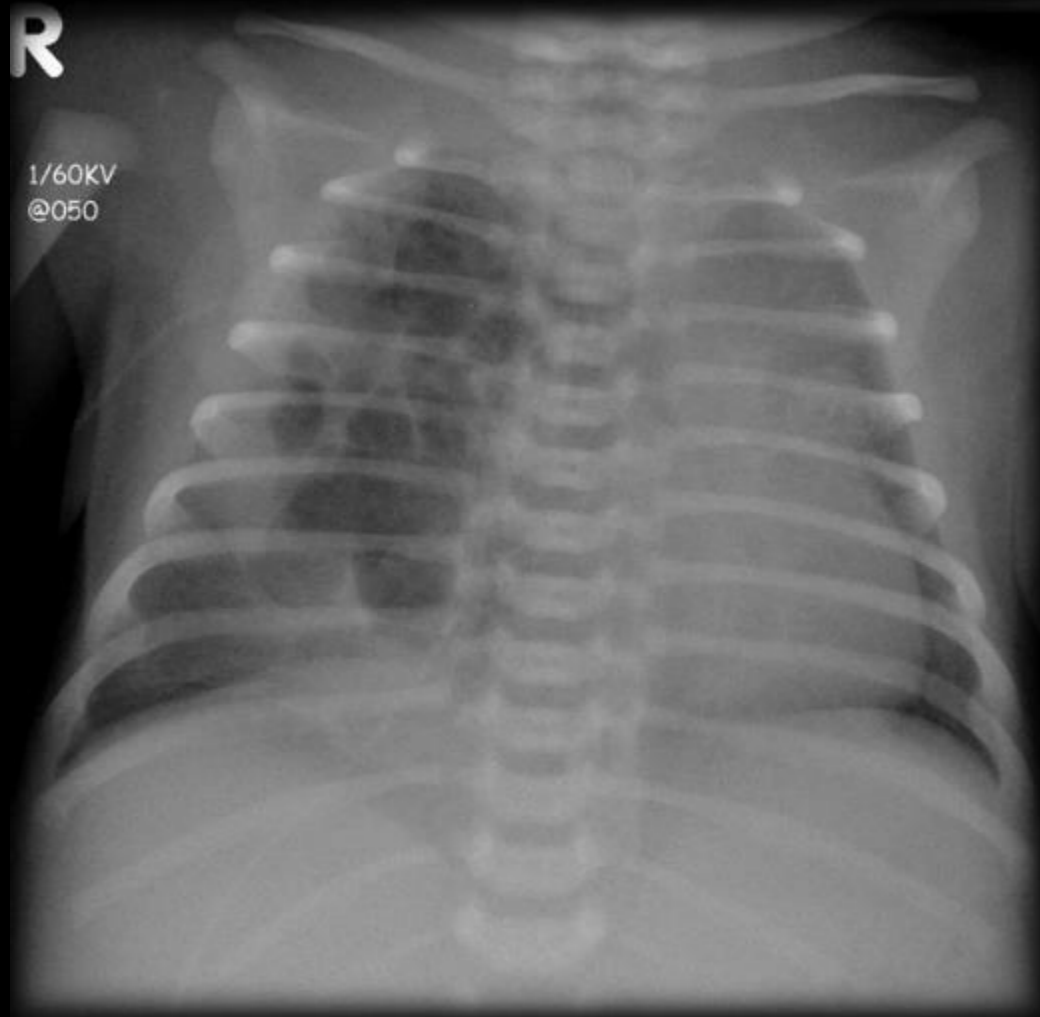


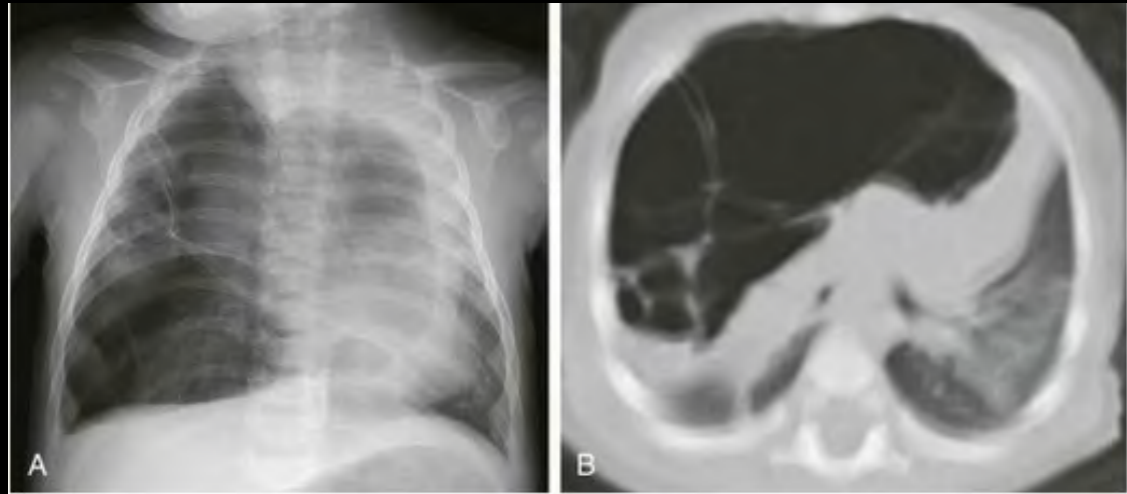


- Congenital Pulmonary Airway Malformation
 - Multicystic pulmonary mass
 - classification—> cysts of varying sizes
 - Variable amounts of air/fluid
 - Very often noted on prenatal ultrasound
 - Neonate- progressive respiratory distress
 - typically solid mass, and gradually fills with air
 - Often, radiograph may appear normal
 - CT always warranted.

Type 0	Rarest, arises from trachea or bronchi and involves whole lung; commonly fatal
Type 1	Commonest (60-70%), arises from distal bronchi or proximal bronchioles; single or multiloculated 2-10 cm sized cyst. Reported association with malignancy
Type 2	15-20% of CPAMs; multiple cysts 0.5-2 cm in diameter with intervening solid-appearing areas
Type 3	5-10% of CPAMs. Alveolar origin; can have small cystic areas (>0.5 cm) with solid tissue or are mostly solid appearing
Type 4	10-15% of CPAMs. Acinar origin. Large air-filled or fluid-filled cysts up to 10 cm; strongly associated with pneumothorax, indistinguishable from cystic pleuropulmonary blastoma

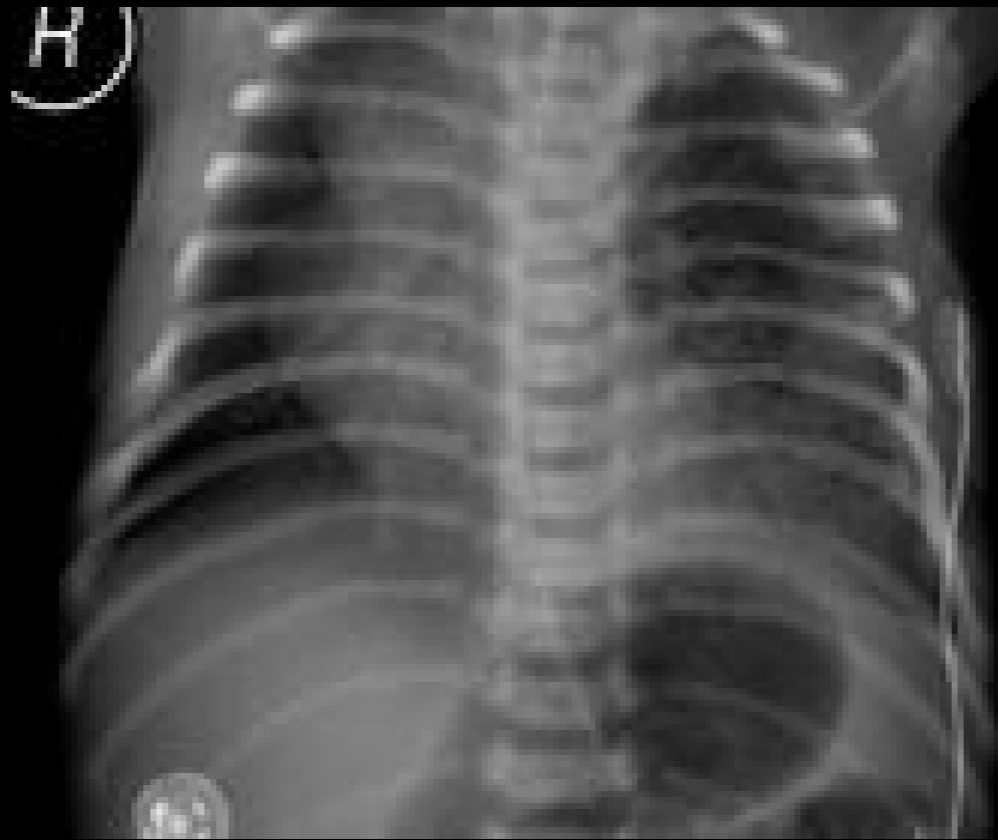
CAPM: Congenital pulmonary airway malformation

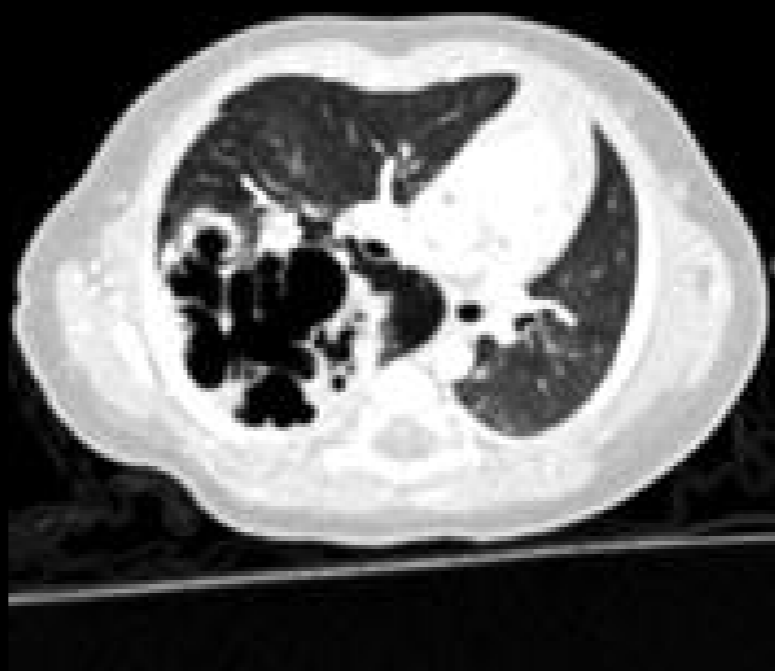




- CPAM in a 6 month old with







Cases



Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance

