

Pediatric Radiology Clerkship

MS3

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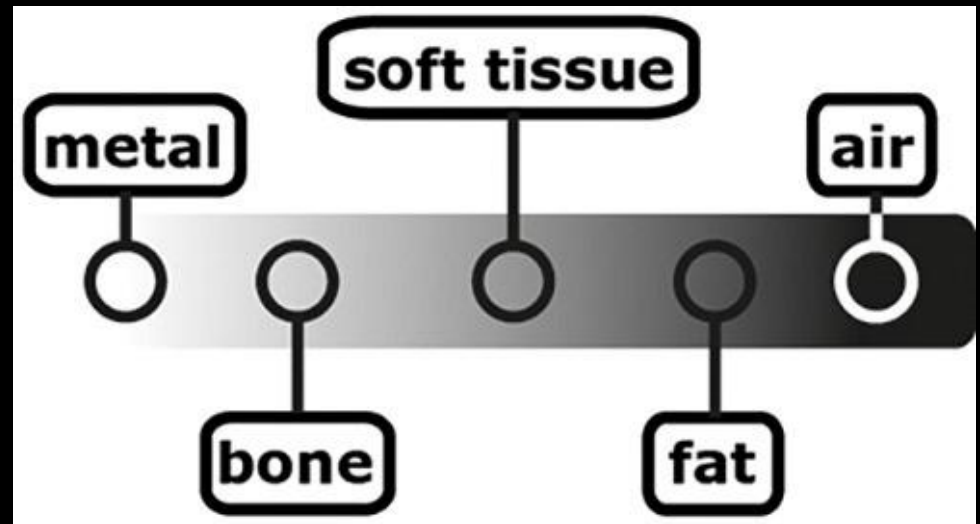
Objectives:

- Introduction to common pathologies encountered in the pediatric population.
- Understand the appropriate radiologic workup.
- Gain a basic understanding of how to describe radiologic findings.
- Provide supplementary examples utilizing www.imagingcases.org

How to read basic CXR and KUB

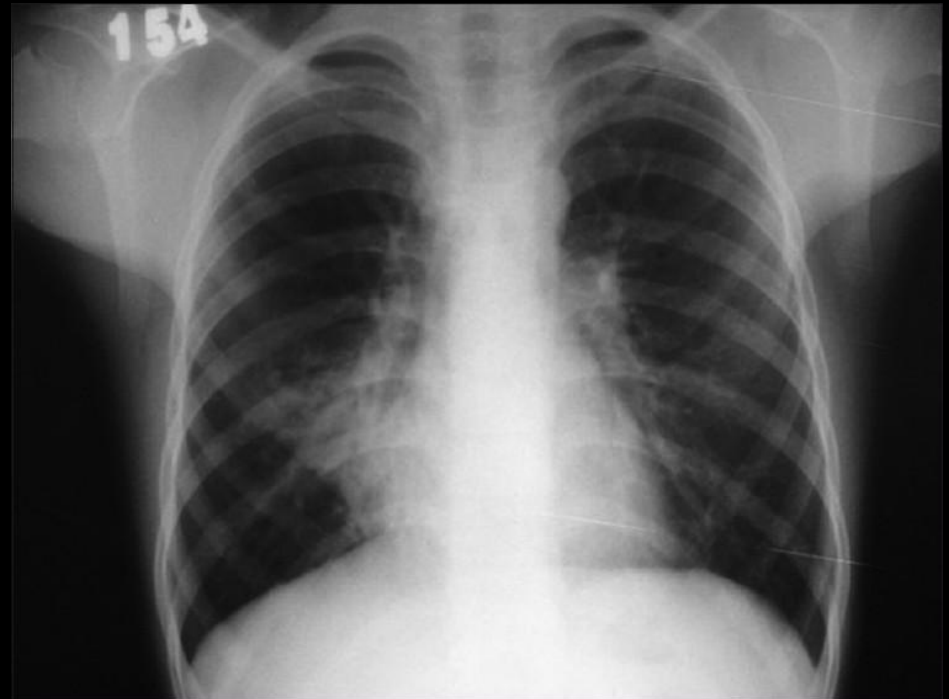
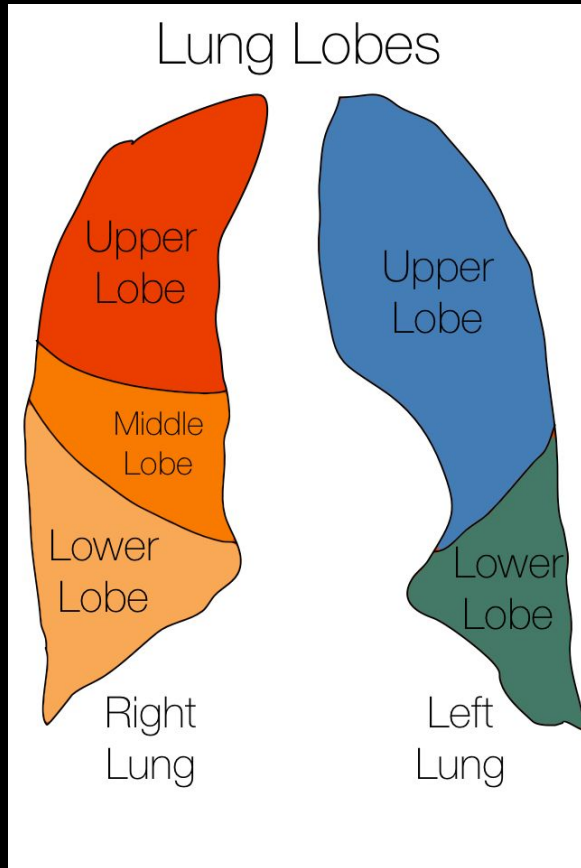
5 basic densities :

- Air
- Fat
- Soft tissue
- Calcium
- Metal



How to read basic CXR and KUB

- When two objects of the same density touch each other, the border between them disappears. This is known as silhouetting. This technique in addition to knowing normal anatomy is used to identify pathology.
- Keep in mind patient positioning and the basic laws of gravity!



Basic Radiology Terminology

- Conventional radiographs
 - Increased density = more opaque = radiopaque = opacity
 - Decreased density = less opaque = radiolucent
- CT
 - Hyperattenuating = hyperdense
 - Hypoattenuating = hypodense
 - Isoattenuating = isodense
- US
 - Hyperechoic = echogenic
 - Hypoechoic = anechoic
 - Isoechoic
- MRI
 - Hyperintense = increased signal
 - Hypointense = decreased signal

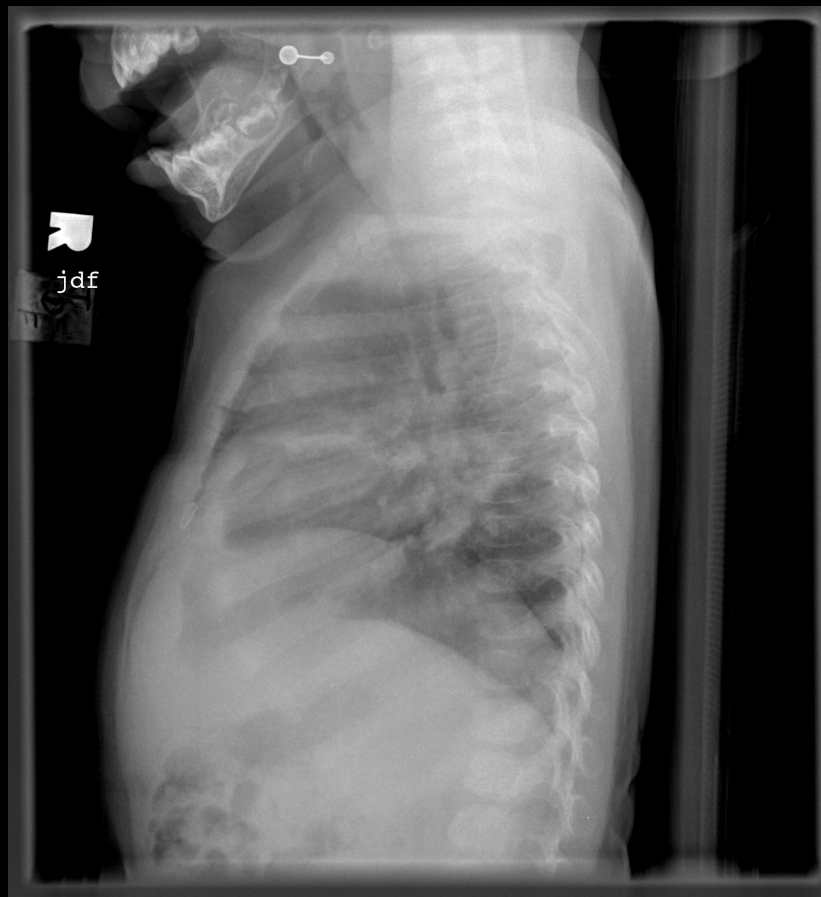
Case 1

9 mo F presenting with cough. RR 30, BP 100/65, P 100, T 98.6

- Differential Diagnosis?
- Next step?

Chest Radiograph

Findings?



Atelectasis

- Collapse or incomplete expansion of the alveoli.
 - Resorptive→ obstruction
 - Passive→ loss of (-) intrathoracic pressure
 - Compressive→ occupying lesion pressing on adjacent alveoli
 - Cicatrisation→ scarring or fibrosis
 - Adhesive→ surfactant deficiency
- Radiographic findings:
 - Opacification with associated volume loss (movement of fissures, upward displacement of hemidiaphragm, crowding of pulmonary vessels).
- Differential considerations:
 - Pneumonia
 - Aspiration
- Generally atelectasis is an incidental finding seen on chest radiographs obtained to rule out other conditions such as pneumonia or pneumothorax and no additional treatment is necessary.

Case 2

4 month old female with 2 days of fever, wheezing, cough, coryza, and apneic spells

- Differential diagnosis?
- Next step?

Chest Radiograph

Findings?



Viral Bronchiolitis

- Infection of the airways, which results in bronchial inflammation, peribronchial edema, and increased mucus production which lead to the classic radiographic findings of perihilar atelectasis and peribronchial thickening. Inflammation of the small airways limits air flow and leads to air trapping and hyperinflation.
- It is important to identify any focal opacity which would suggest a bacterial cause of the patient's symptoms. This would change management!
- Typically affects children less than 2 years old.
- Bronchiolitis is a seasonal infection typically beginning in late October, peaking in January/February, and ending in April.
- Typical viruses include respiratory syncytial virus (RSV), human metapneumovirus, adenovirus, rhinovirus, and parainfluenza virus.

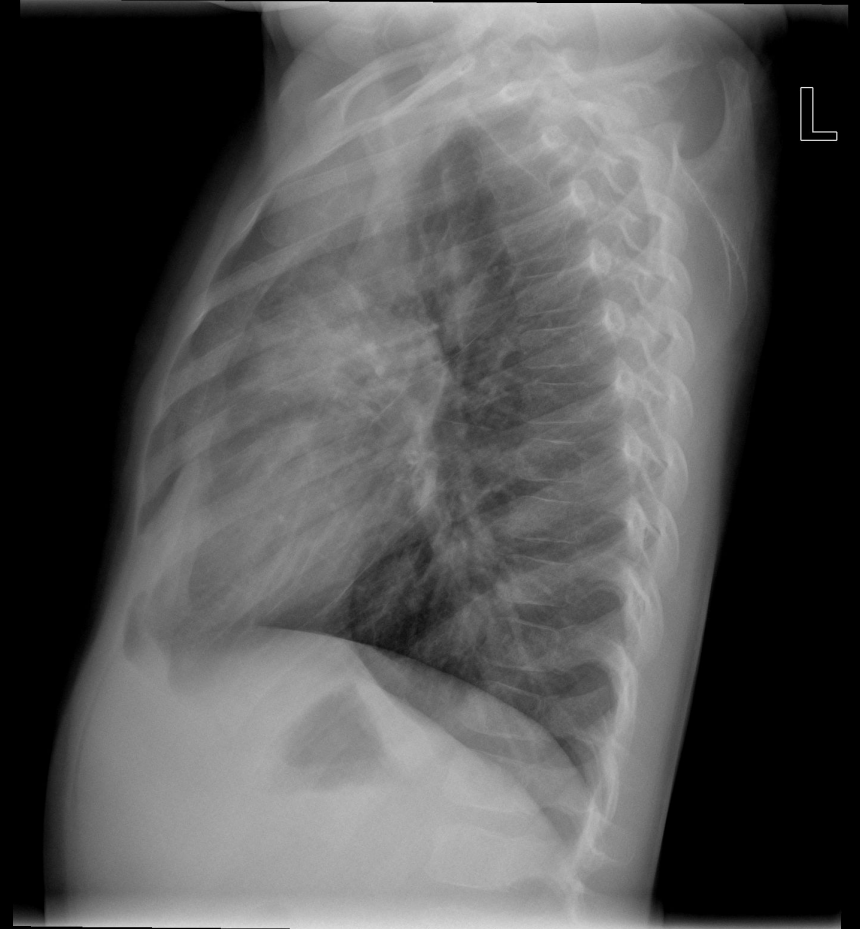
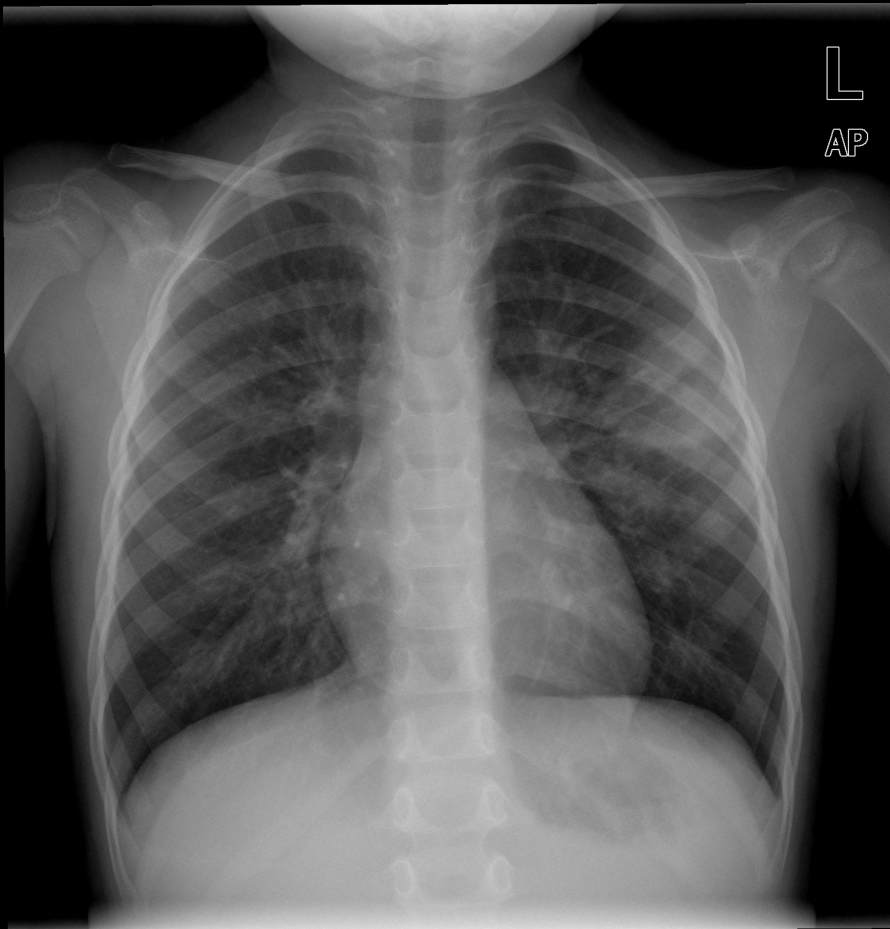
Case 3

5 year old male presents with 3 days of fever, shortness of breath, and productive cough.

- Differential diagnosis?
- Next step?

Chest Radiograph

Findings?



Round Pneumonia

- Pattern of pneumonia which is relatively specific to the pediatric population, typically < 12 years of age.
- The exact reason for this is not fully understood, although it is believed to be related to incomplete development of collateral pathways for air circulation, which results in focalization of infection and a rounded appearance on imaging.
- No specific bacteria is directly responsible for causing round pneumonia; however, *Streptococcus pneumoniae* is most common.
- Typical radiographic findings include a solitary, well circumscribed parenchymal opacity most commonly in the superior segments of lower lobes. Look for focal areas of lucency that could suggest cavitory pneumonia. Follow up imaging after treatment may be considered in certain cases.
- Antibiotics and supportive measures are the treatment of choice.

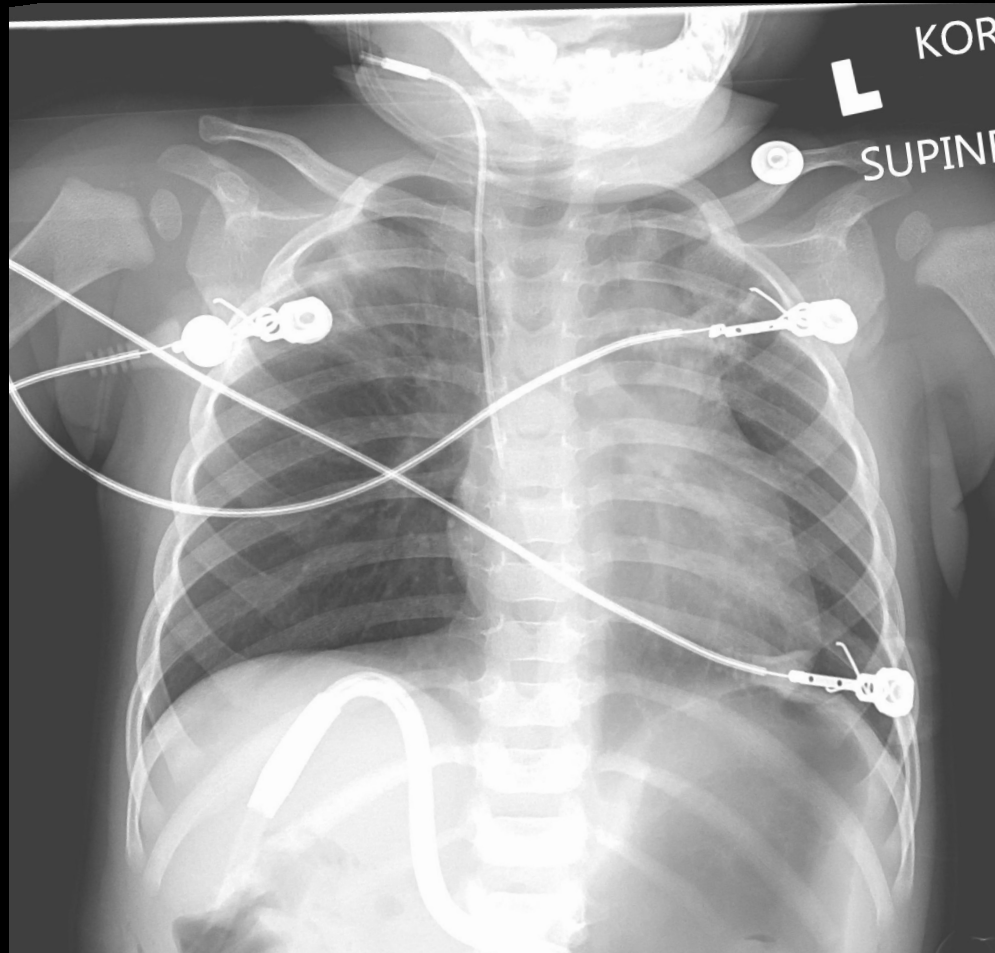
Case 4

13 mo with hepatic lesion with recent placement of right internal jugular central venous line prior to surgery.

- Potential complications?
- Next step?

Chest Radiograph

Findings?



Pneumothorax

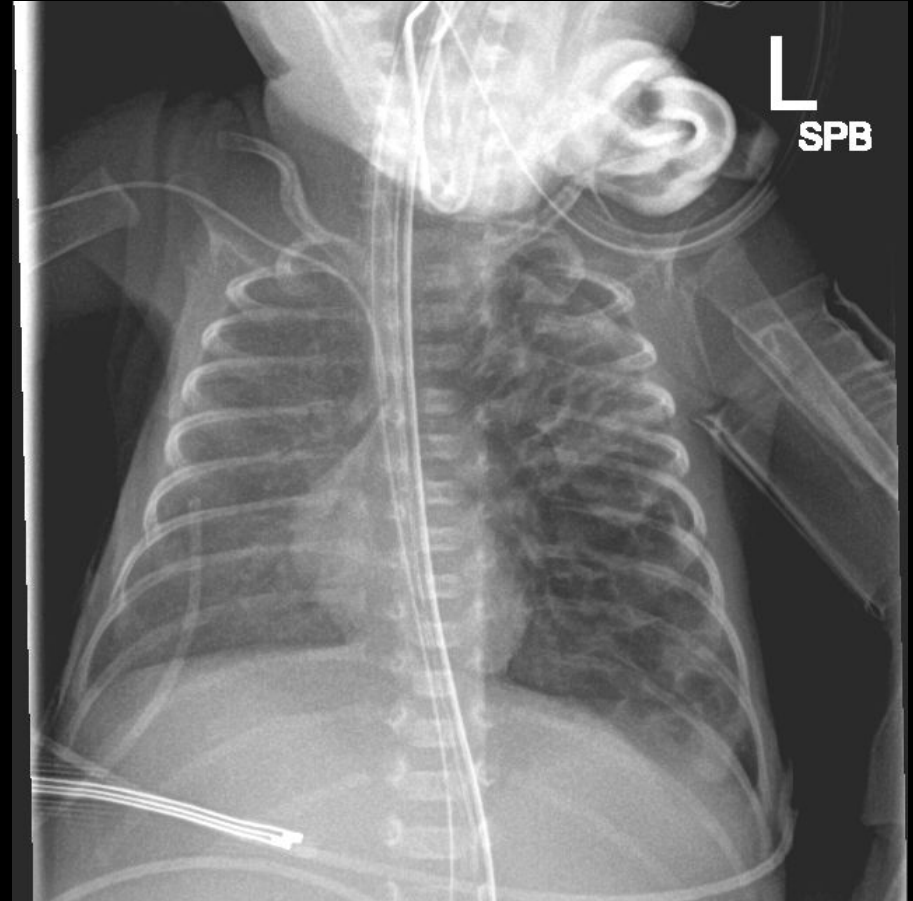
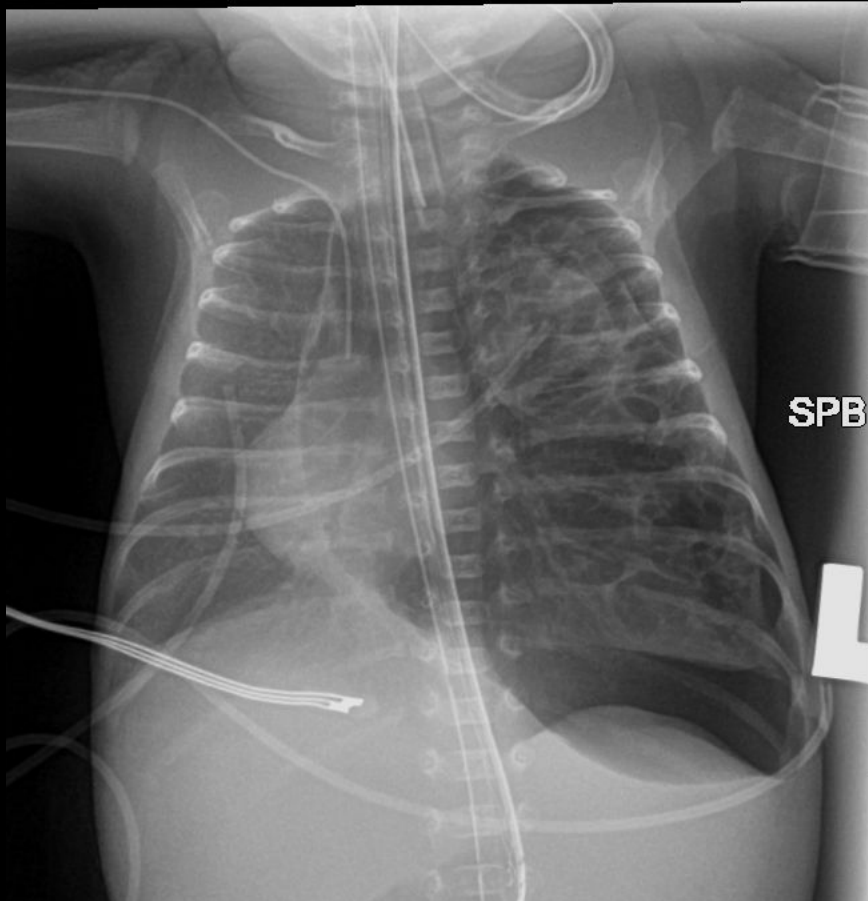
- Refers to the presence of air within the pleural space. The pleural space is a potential space between the visceral and parietal pleura, normally with only a very small amount of fluid. When the pleura gets disrupted, the normal negative intrathoracic pressure is equalized with the atmospheric pressure and develops into a pneumothorax.
- Always look for mediastinal shift or diaphragm flattening. These are signs the pneumothorax is under pressure and considered a tension pneumothorax.
- Common etiologies:
 - Neonatal period include:
 - birth trauma, positive pressure ventilation, underlying obstructive or restrictive lung disease, rupture of congenital or acquired cysts such as pneumatoceles.
 - Older children:
 - spontaneous, rib fractures
 - Iatrogenic causes:
 - Central lines
- Treatment:
 - If small and stable, generally resolve with time.
 - If large, thoracostomy tube.
 - If under tension, immediate needle decompression.

Companion Case

Premature infant (born 24 weeks) with respiratory distress syndrome. Long hospitalization in NICU.

Companion Case

- Findings?
- What do you do next?



Tension Pneumothorax

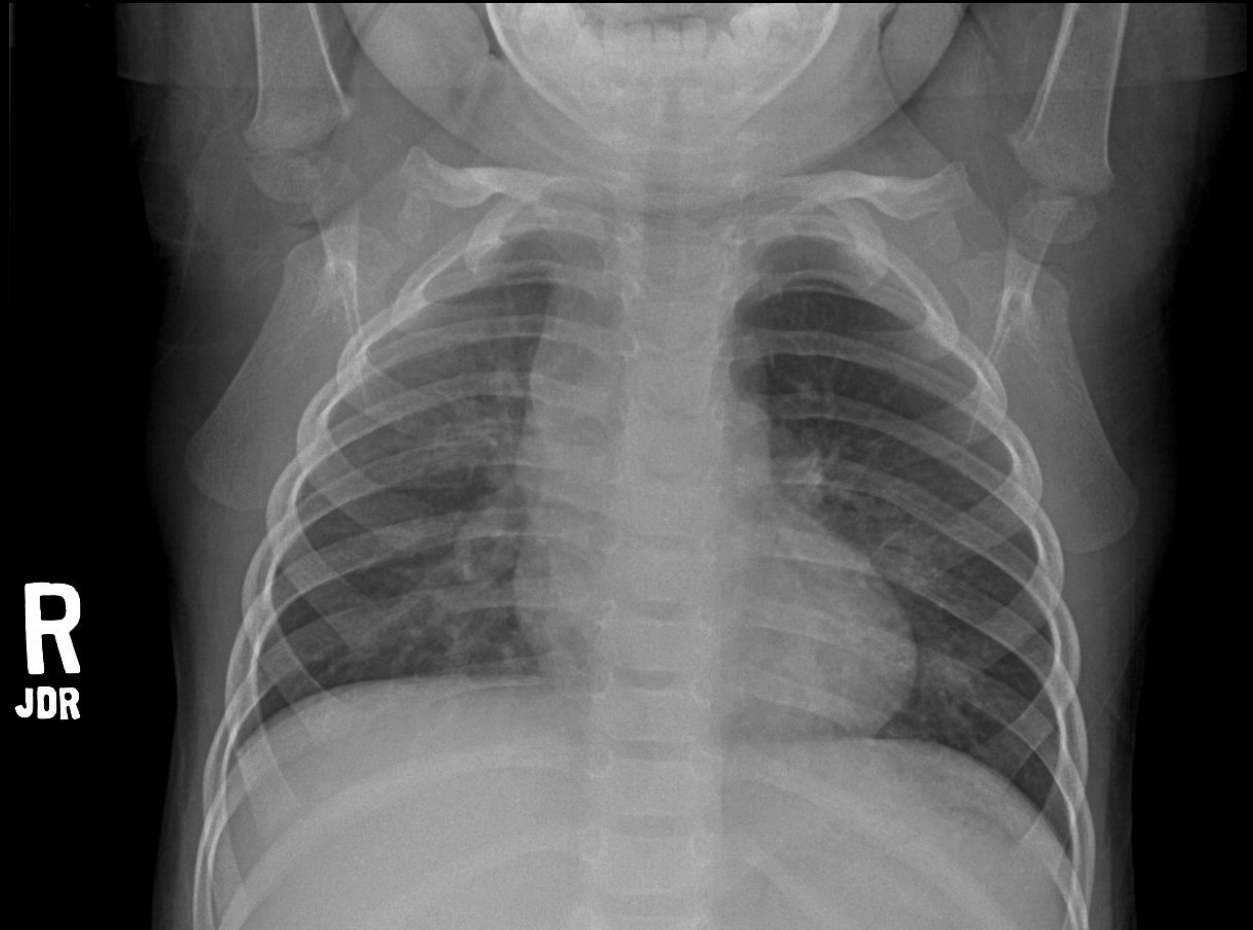
- Occurs when there is progressive accumulation of gas within the pleural cavity. This is usually caused by a ball-valve effect with progressive increase in intrapleural air during each expiration. The thoracic cavity has a relatively fixed volume and therefore, as the volume of gas increases, the pressure rises.
- Radiographically considered a tension pneumothorax when there is mediastinal shift, depression of the ipsilateral diaphragm, and/or asymmetric widening of the intercostal spaces.
- These are medical emergencies and can result in death quickly! The increased intrathoracic pressure decreases the venous return to the heart (preload) and essentially decreases cardiac output and leads to shock. A chest radiograph should not be obtained if clinical suspicion is high. Should proceed to immediate treatment.
- Treatment is with immediate needle decompression. Performed at the second intercostal space in the midclavicular line with 14 or 16-gauge needle. Usually followed by thoracostomy tube placement.

Case 5

Wheezing with possible foreign body aspiration.

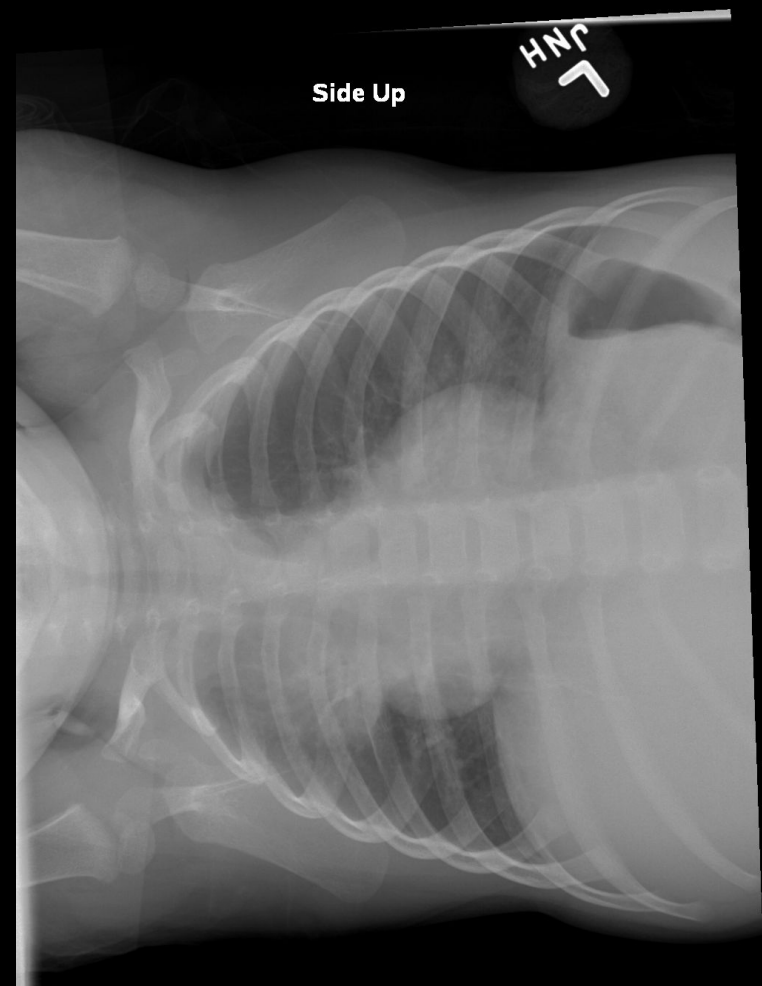
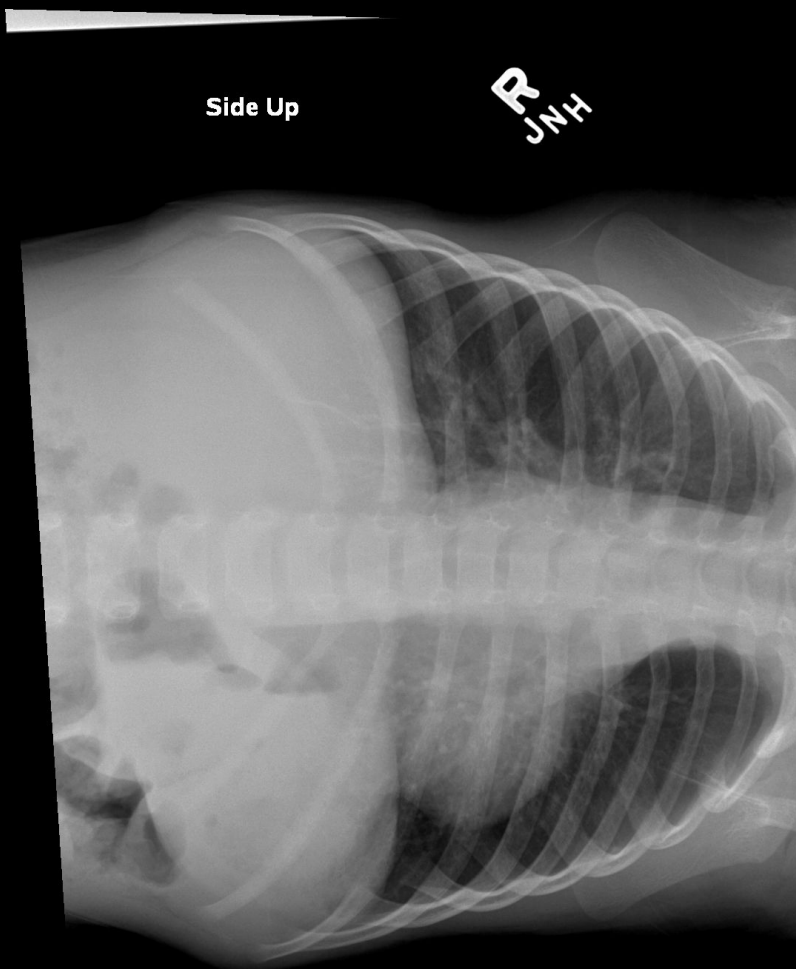
Chest Radiograph

- Findings?
- Next test?



Decubitus imaging

Findings?



Foreign Body Aspiration

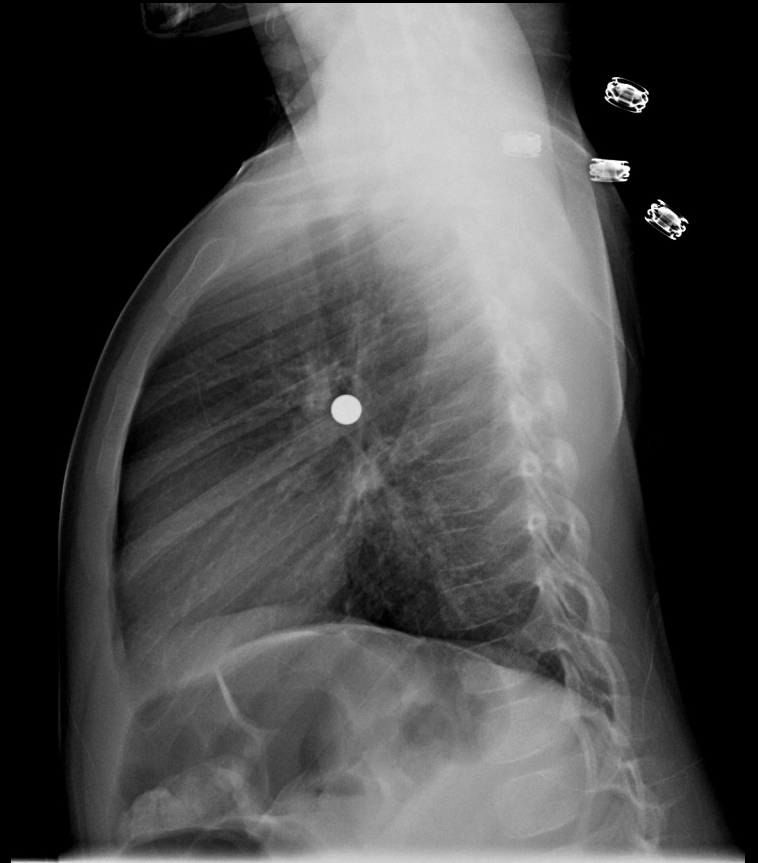
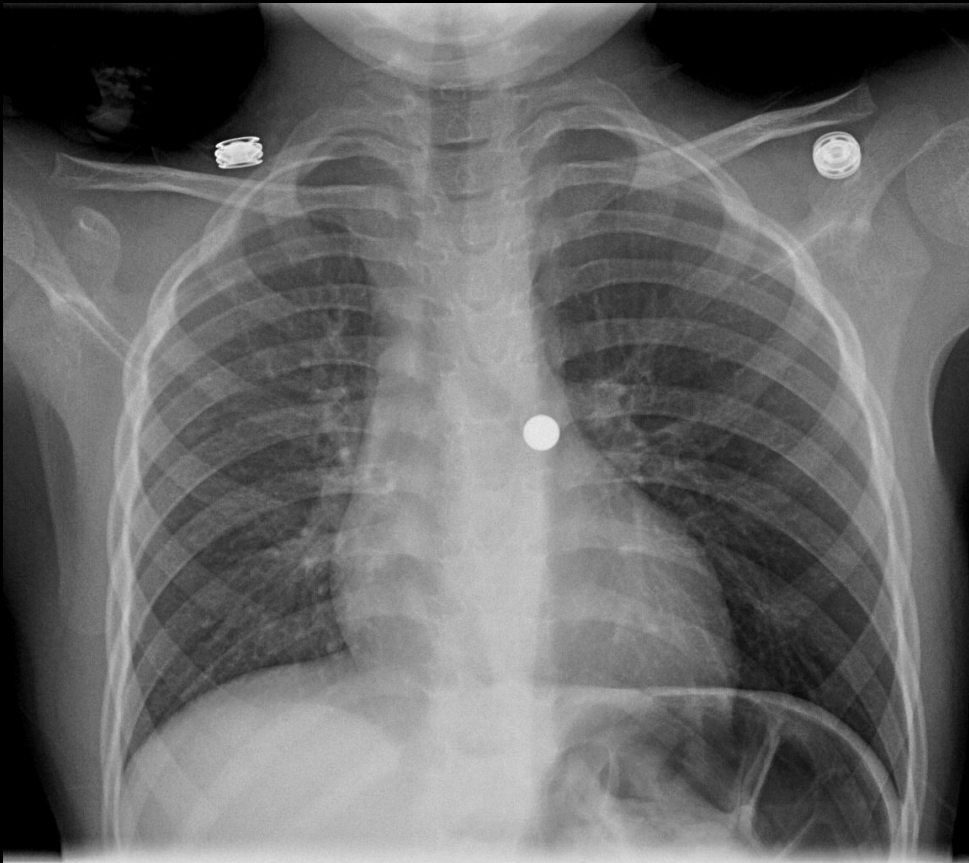
- Most common in children less than 4 years of age.
- Etiology:
 - The most commonly aspirated foreign bodies include seeds and nuts, which are radiolucent by conventional imaging.
 - Additional items include teeth, coins, pins, pens/crayons, etc.
- Radiographic findings:
 - If radiopaque, possible identification of the foreign body within the central airways. If not radiopaque, look for indirect signs.
 - The hallmark of an aspirated foreign body is asymmetric lung volumes/ hyperlucency that do not change during the respiratory cycle. Classically, the affected side will have greater volume and be more lucent. This is due to the check valve mechanism, where air enters the bronchus around the foreign body but cannot exit.
 - This finding of increased air trapping and hyperlucency can be accentuated by decubitus imaging. The dependent lung should naturally become smaller in volume. If an aspirated foreign body is present and obstructing, the dependent lung will continue to show hyperexpansion/hyperlucency.
- Critical point: Keep in mind that the chest radiograph can be normal in 30-40% of patients who truly have an aspirated foreign body. If the clinical suspicion is high, a normal chest radiograph should not preclude further evaluation with bronchoscopy.

Companion Case

5 yo male presenting with concerns of foreign
body aspiration.

Chest Radiograph

- Findings?



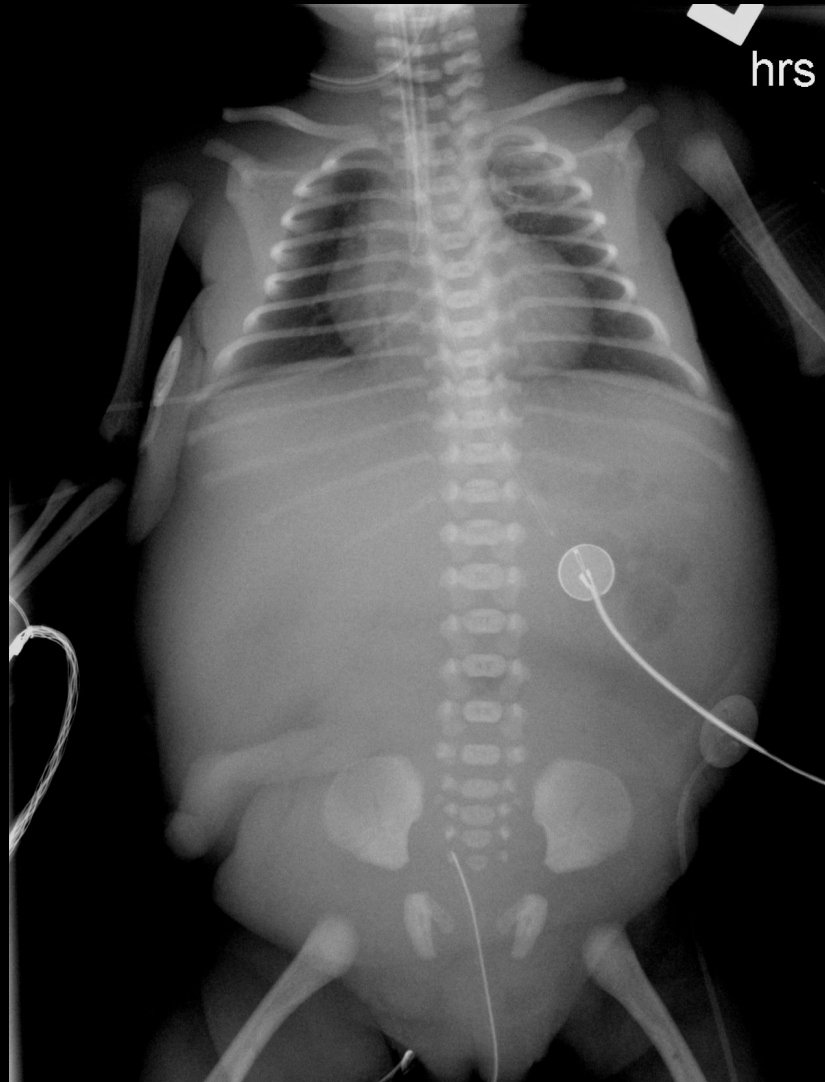
Case 6

1 day old preterm female infant with marked abdominal distention and emesis.

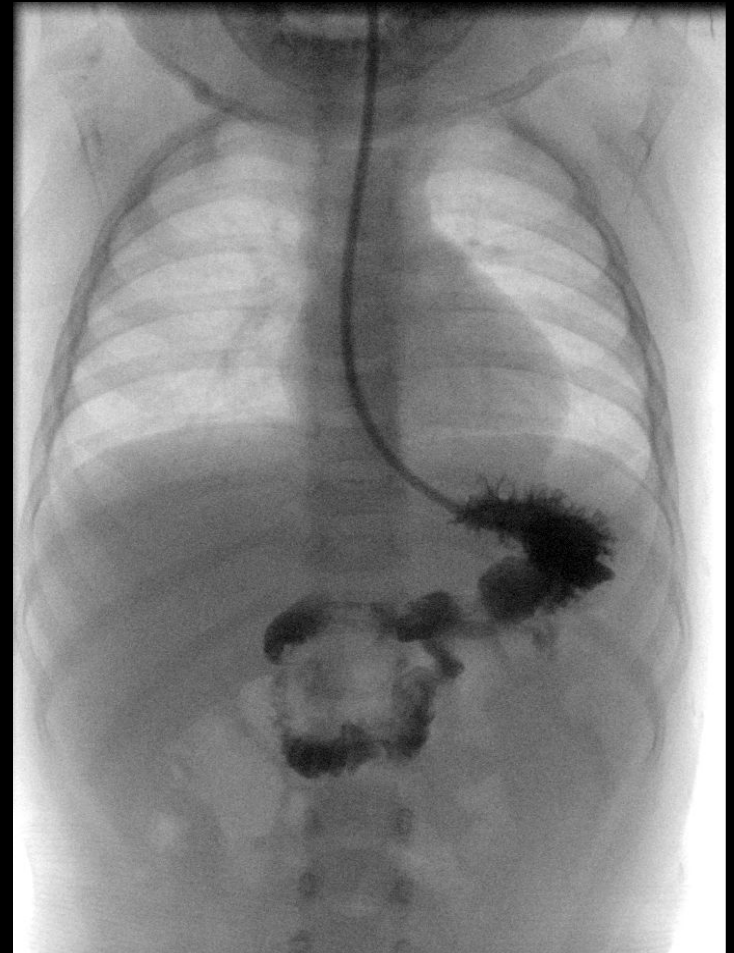
- Differential?
- Next tests?

Abdominal Radiograph

- Findings?
- Next test?



Fluoroscopic UGI



- Potential next test? Why?

Fluoroscopic Contrast Enema



Intestinal Malrotation

- Defined as any abnormal rotation of small or large bowel which occurs due to failure of the normal embryonic 270° counterclockwise rotation of midgut and colon.
- Ladd bands, which are peritoneal fibrous connections, attempt to fix the abnormal duodenal and/or colonic positions and can lead to extrinsic obstruction or volvulus.
- Presentation of intestinal malrotation, but should come to mind if a child is presenting with nonbilious or bilious emesis, recurrent abdominal pain, poor weight gain. Many times children can be asymptomatic if no obstruction.
- The most important complication of intestinal malrotation, especially within the first year of life, is midgut volvulus. Volvulus is the acute twisting of bowel (or stomach) around its mesentery which can compromise mesenteric vasculature and result in ischemia.
- Intestinal malrotation occurs in approximately 1:6,000 live births and is associated with several clinical associations including duodenal and choanal atresia, congenital diaphragmatic hernia, gastroschisis/omphalocele, and heterotaxy.
- Typical imaging workup include abdominal radiographs followed by an UGI study. Barium enema is sometimes performed to evaluate the location of the cecum. Less commonly, cross-sectional imaging such as a CT is performed.
- Management depends on presentation, however, surgical intervention is the definitive management.

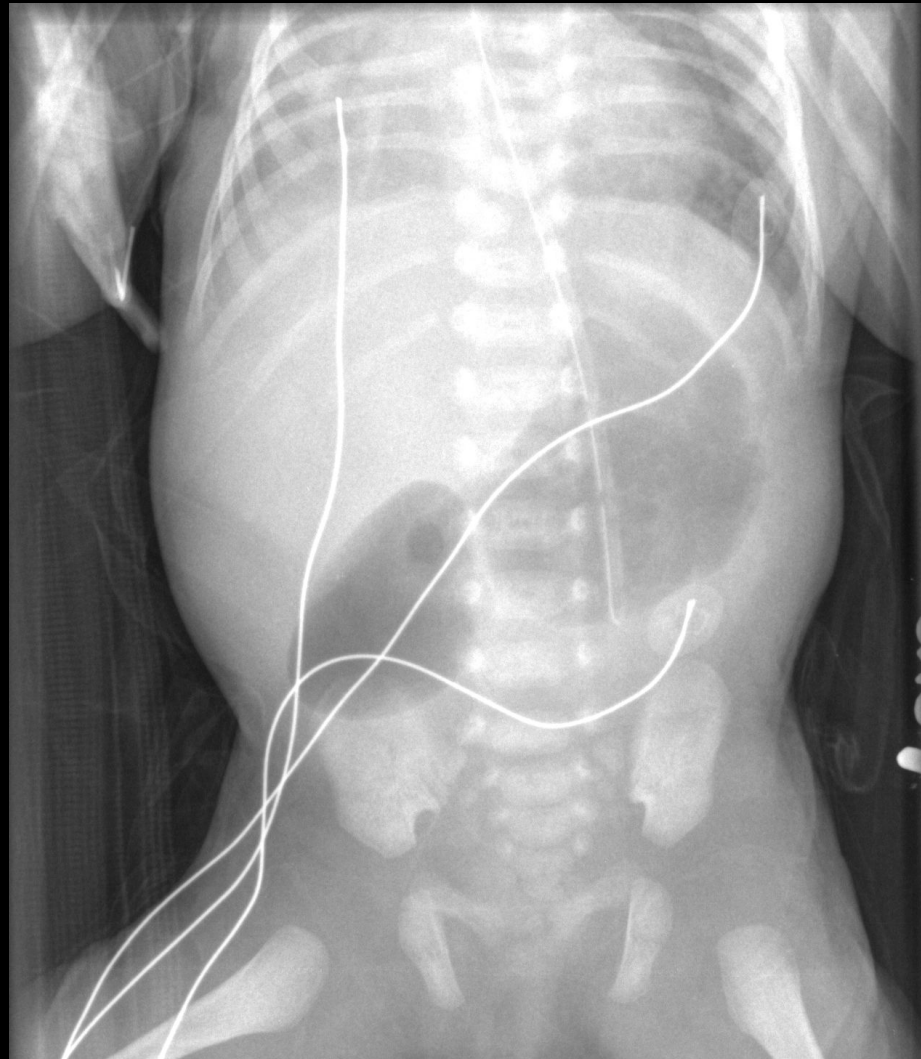
Case 7

1 day old male infant with Down syndrome presents with abdominal distension, bilious emesis, and has not yet had a bowel movement.

- Differential?
- Next tests?

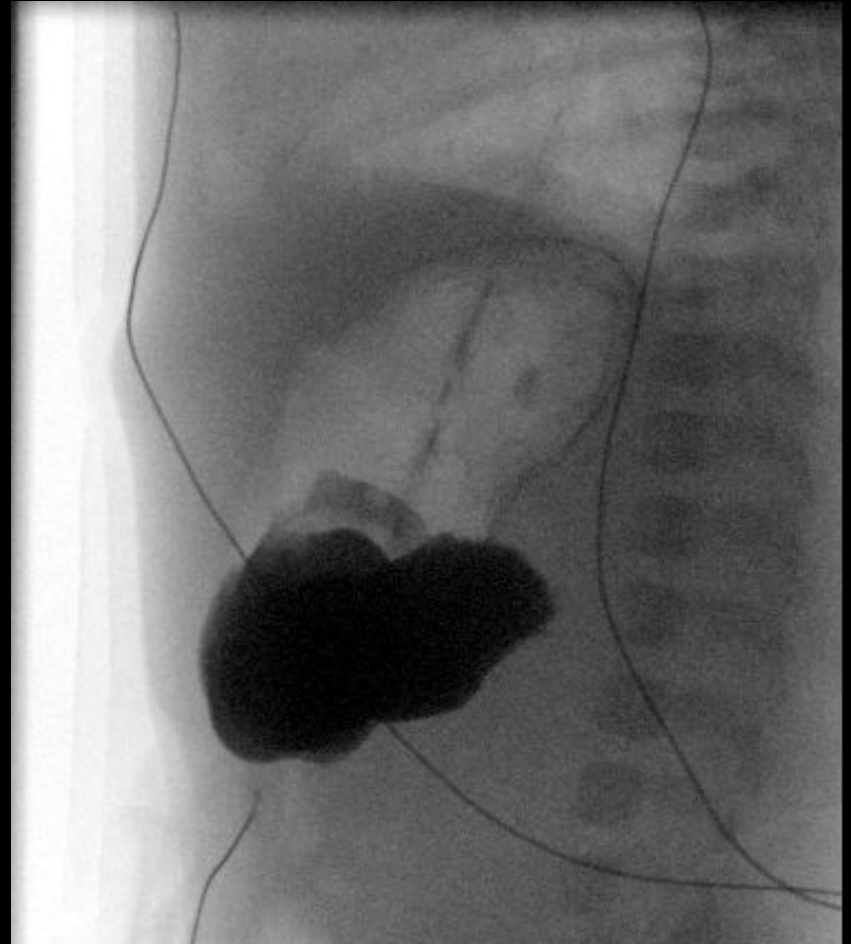
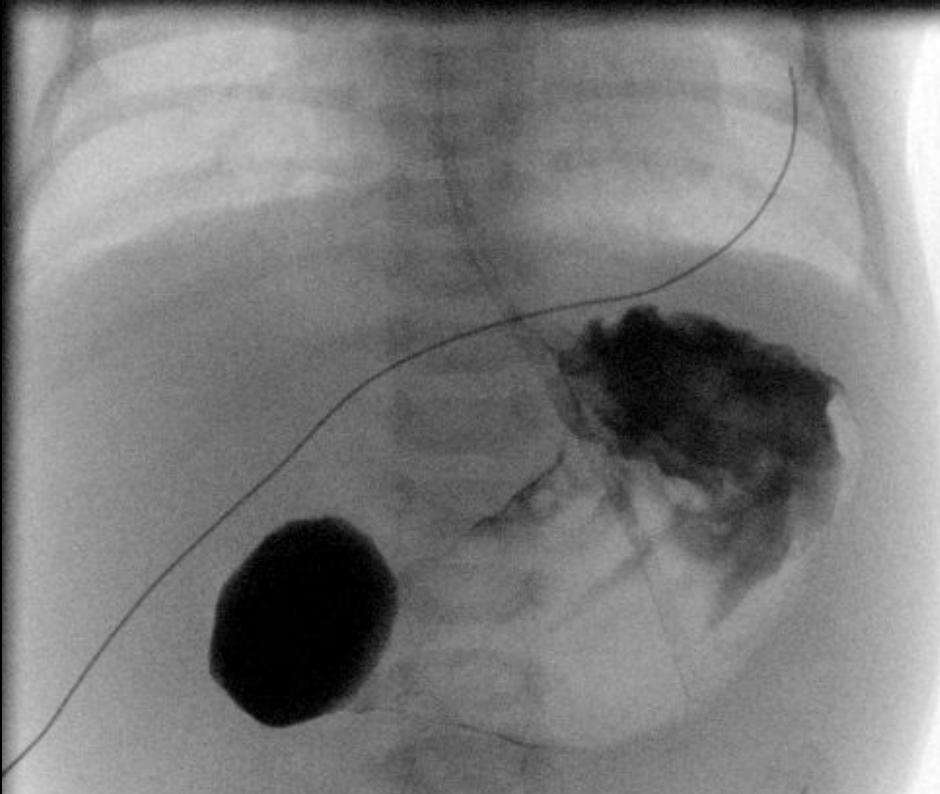
Abdominal Radiograph

- Findings?
- Next test?



Fluoroscopic UGI

- Findings?



Duodenal Atresia

- Duodenal atresia is thought to represent failure of recanalization of the bowel lumen that is a solid tube early in fetal life, possibly due to an ischemic event.
- The classic presentation includes findings of duodenal obstruction with abdominal distension, absent bowel movements, and vomiting.
- No sex associated prevalence, however, there is a strong association with Down syndrome (approximately 30% of duodenal atresia cases are associated with Down syndrome). Additionally, duodenal atresia has associations with VACTERL syndrome, annular pancreas, and other intestinal atresias (jejunal, ileal, anal, etc).
- The initial treatment includes enteric decompression by NG tube, IV fluids, and total parenteral nutrition (TPN). Definitive surgical management is typically achieved by duodenoduodenostomy. Duodenojejunostomy is less commonly performed due to high long term complication rate.
- Initial management includes supportive measures- enteric decompression, IV fluids, and TPN. Surgical intervention is the definitive management.

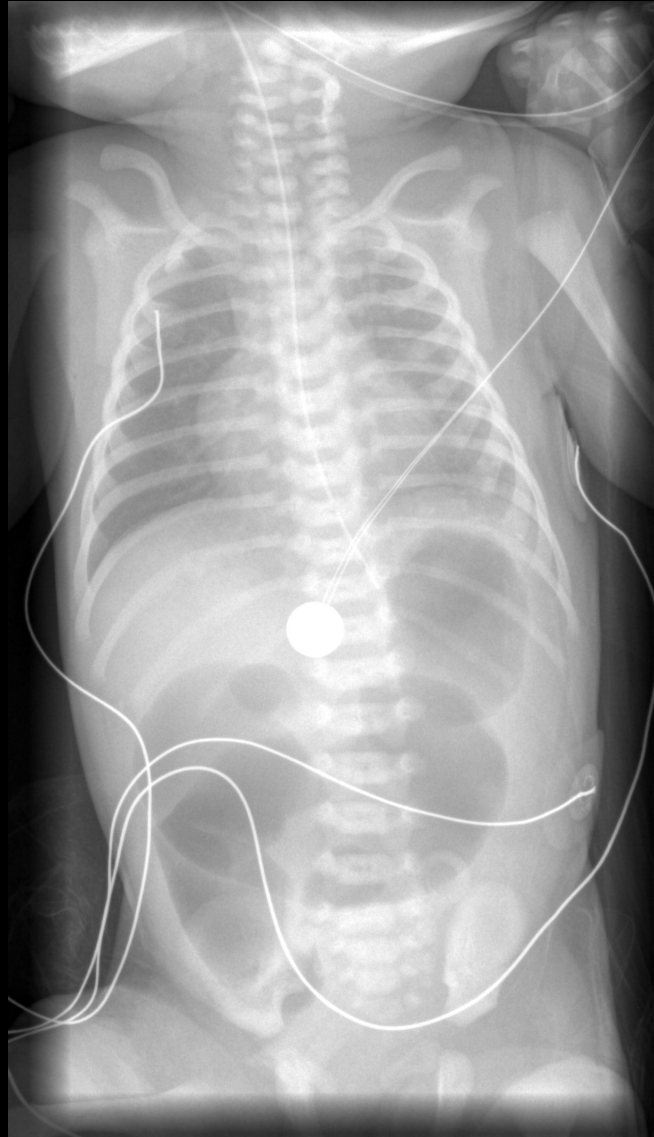
Case 8

1 day old male infant presents with abdominal distension, bilious emesis, and has not yet had a bowel movement.

- Differential?
- Next test?

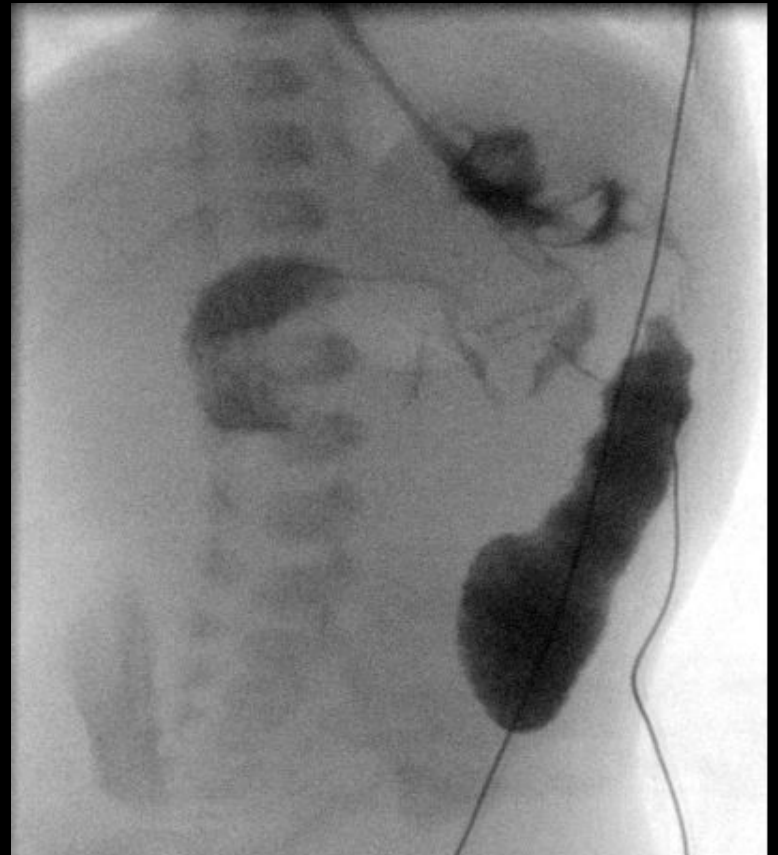
Abdominal Radiograph

- Findings?
- Next test?



Fluoroscopic UGI

- Findings?



Jejunal Atresia

- Jejunal atresia is a congenital anomaly caused by failure of recanalization of the lumen of the jejunum, possibly due to an in utero ischemic event.
- Can occur anywhere from the ligament of Treitz to the jejunoileal junction and there may be more than one atretic segment.
- Jejunal atresia has an incidence of ~ 1:1,000 live births and is more common than duodenal atresia.
- Presentation is nonspecific and includes abdominal distension and bilious emesis within the first day of life.

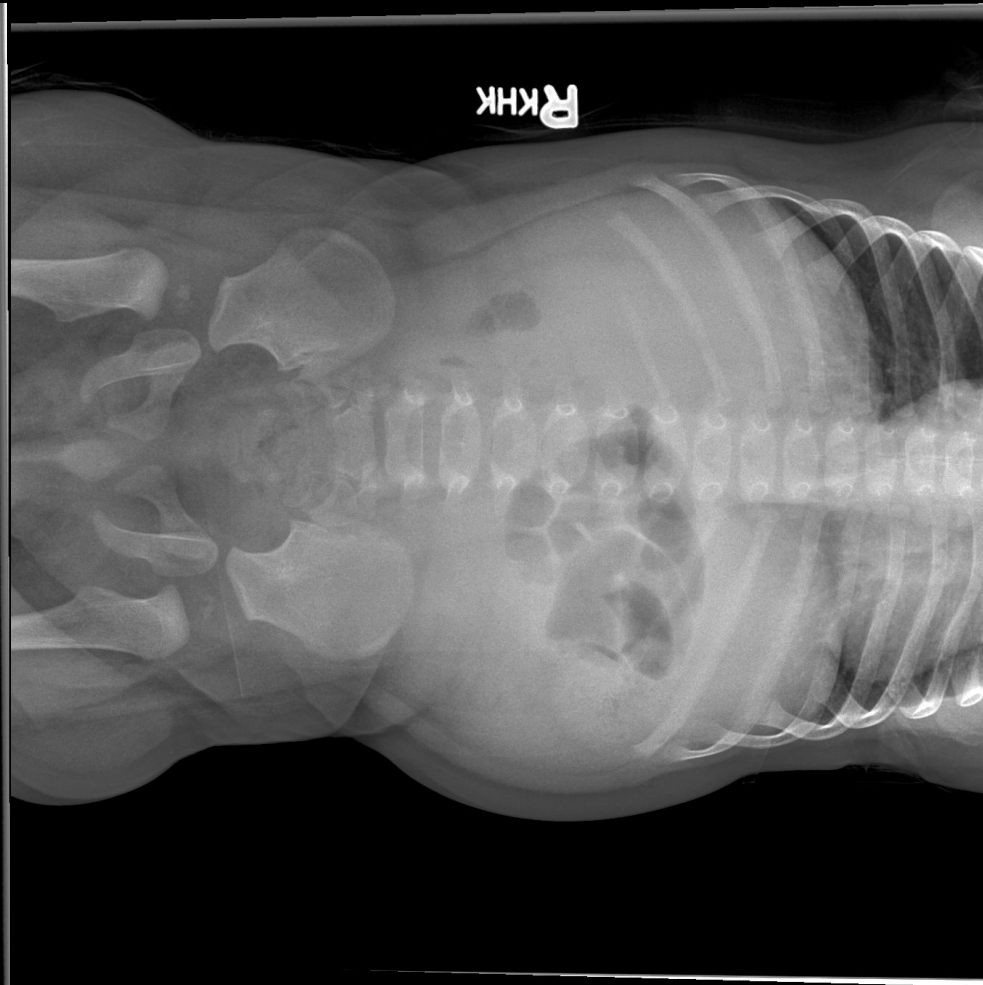
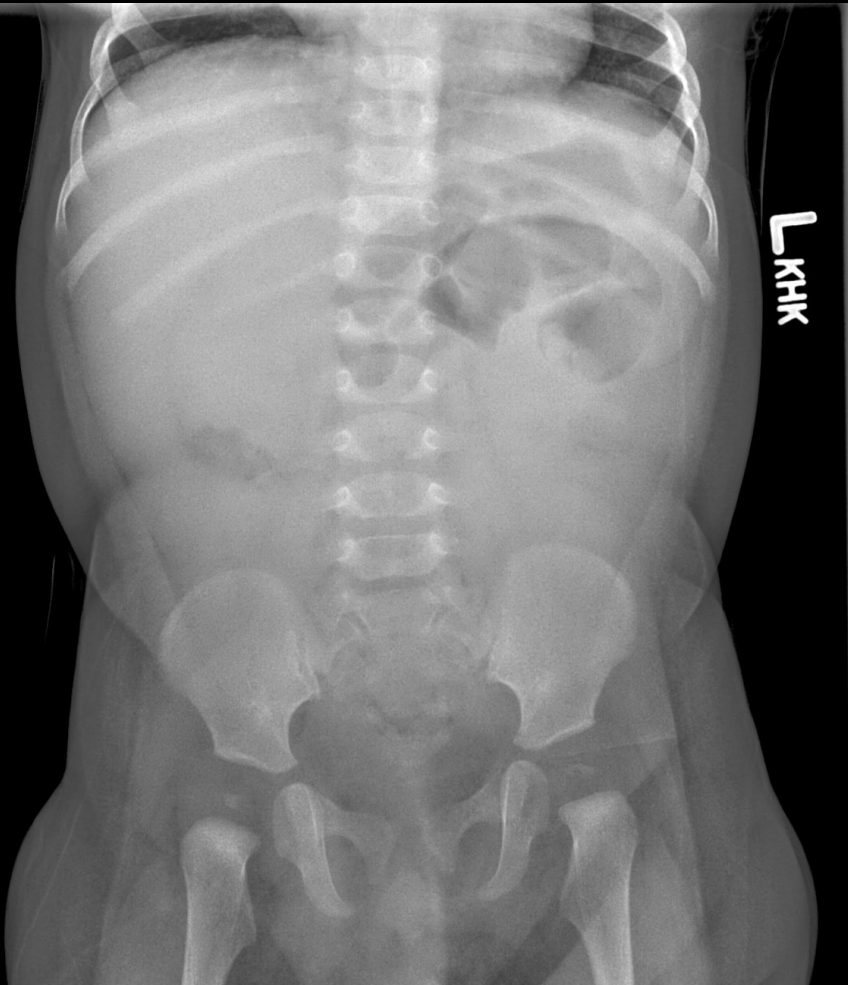
Case 9

1 year old female presents with intermittent abdominal pain, emesis, diarrhea, and red-ish stools for the past 24 hours.

- Differential ?
- Next test ?

Abdominal Radiograph

- Findings?



Abdominal Ultrasound

- Findings?
- Next step in management?

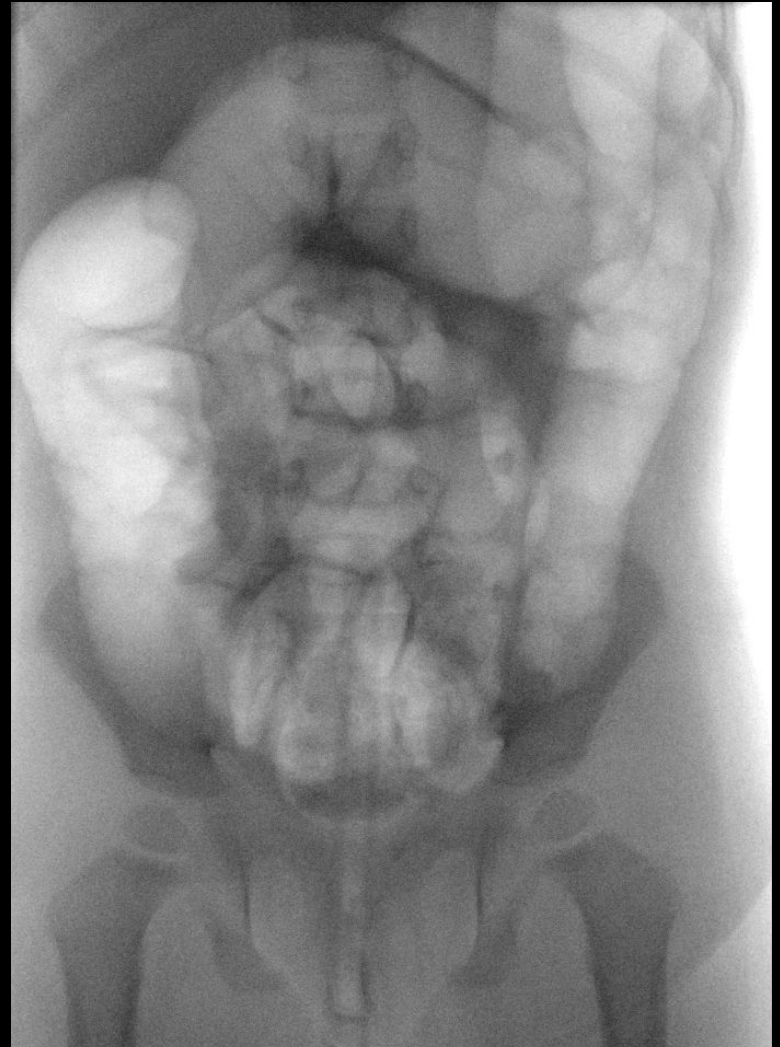


TRANS LLQ



TRANS MID

Air Enema



Ileocolic Intussusception

- Intussusception is the invagination of one portion of bowel into another. In 90% of cases, the distal ileum is pulled into the colon (ileocolic). The result may be bowel obstruction and, if left untreated, perforation, peritonitis, shock, and death.
- The typical presentation includes intermittent/colicky abdominal pain, lethargy, irritability, and currant jelly stools. A right sided palpable mass is suggestive of intussusception in the setting of other symptoms, but is a less common finding.
- The vast majority of clinically relevant intussusceptions occur in children from 3 months to 3 years in age.
- Usually results from a lead point, whether benign or pathologic, being pulled distally by peristalsis. In the majority of cases, no lead point is identified and the cause in these cases is thought to be lymphoid hyperplasia in the setting of viral illness. Additional less common causes include malignant (more common in adults) tumors and Meckel diverticulum.
- Initial attempts at reduction, as in our case, is with air enema which has ~80% success rate. If air enema is unsuccessful, the patient may need surgery for definitive treatment.

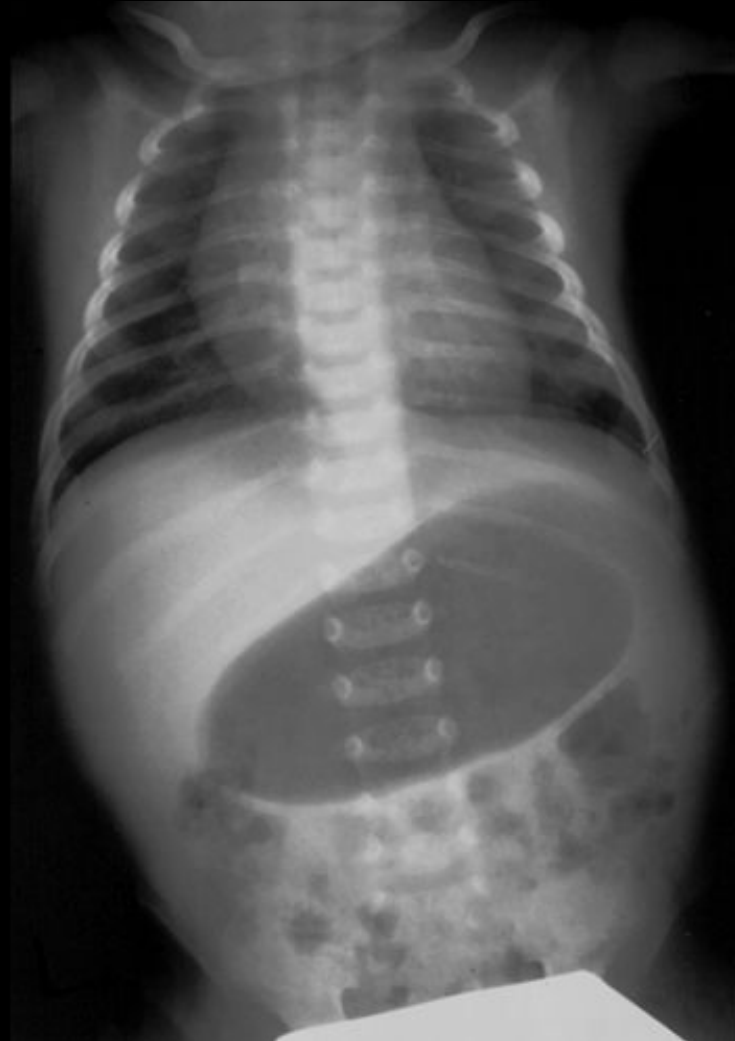
Case 10

4 week old male with protracted nonbilious emesis.

- Differential?
- Next tests?

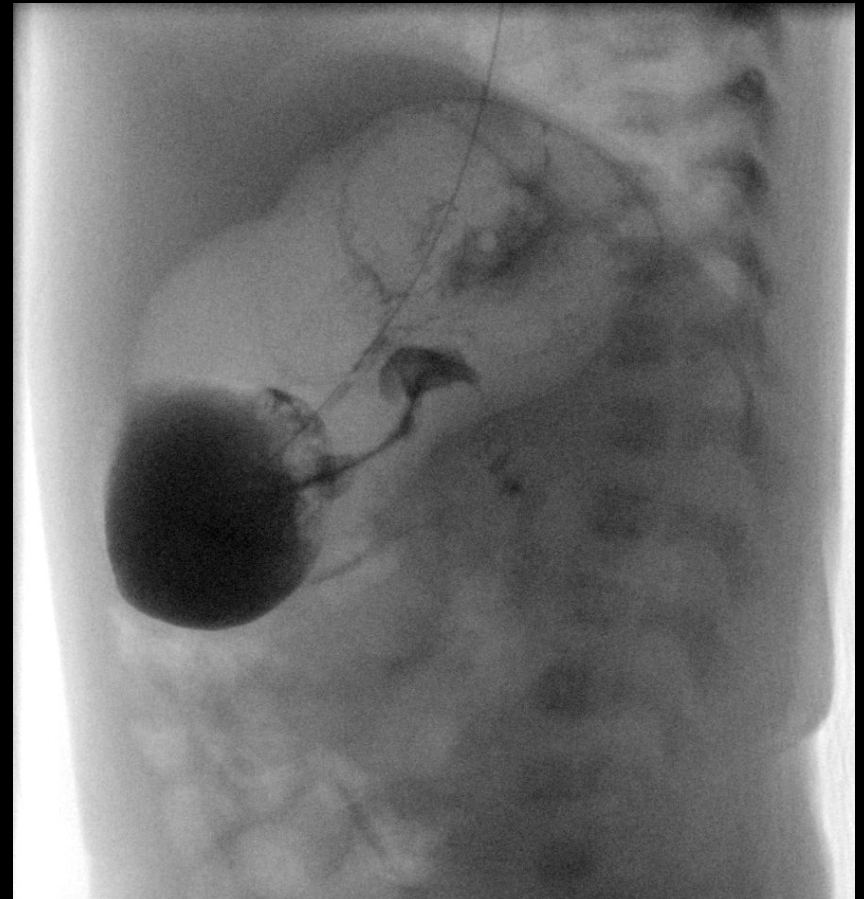
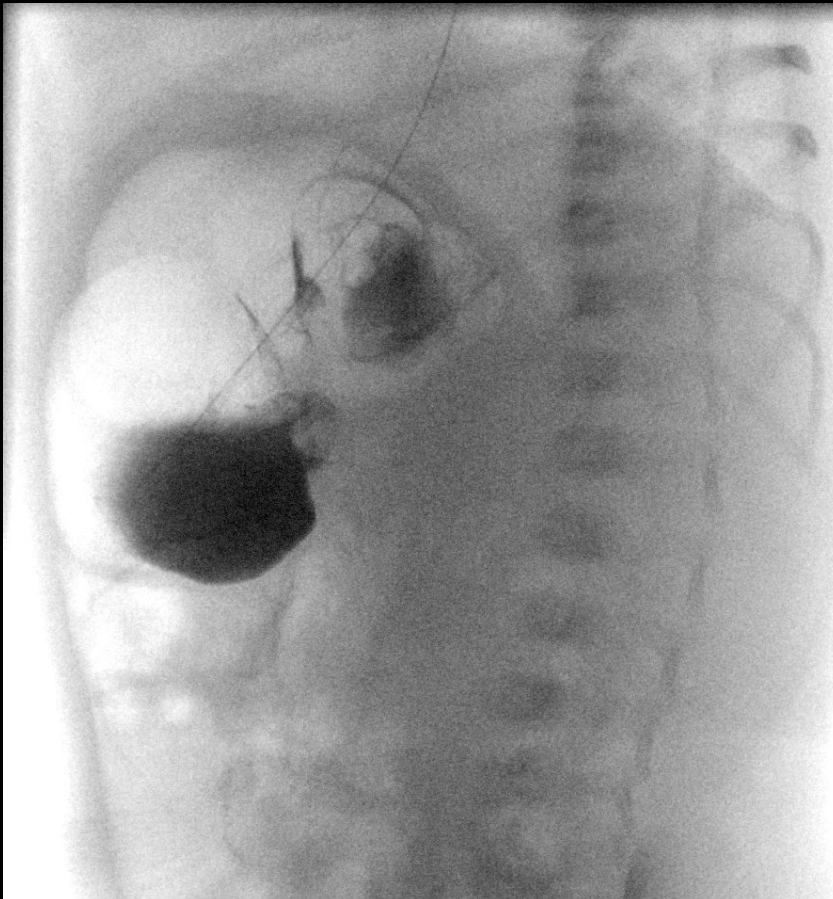
Abdominal Radiograph

- Findings?
- Next test?



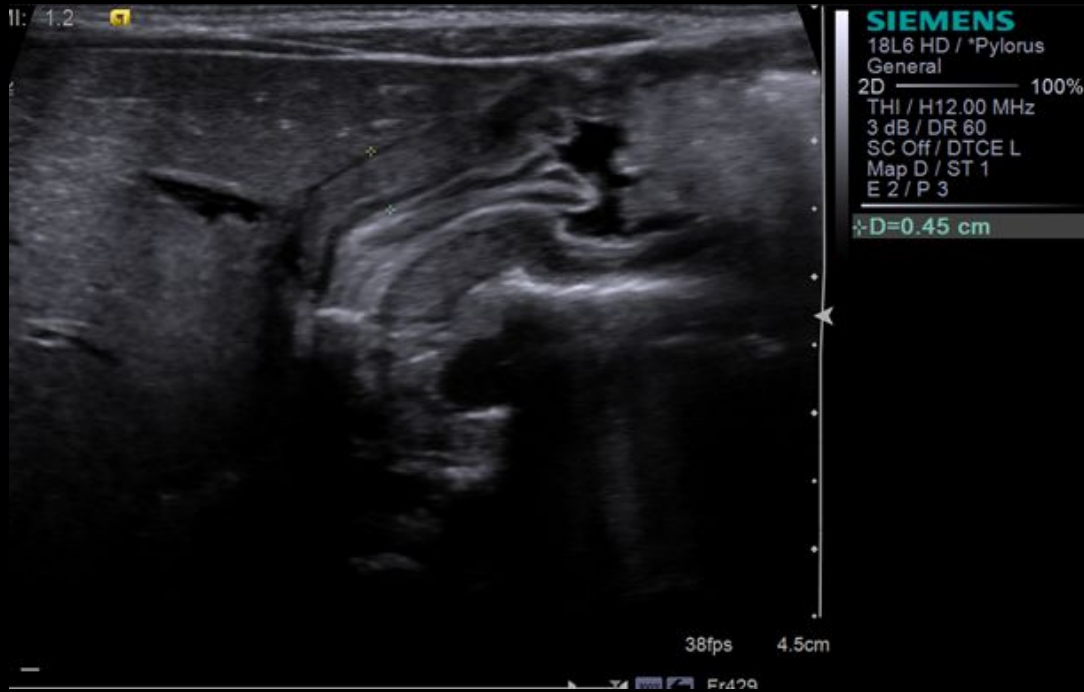
Fluoroscopic UGI

- Findings?



Pyloric Ultrasound

- Findings?



Hypertrophic Pyloric Stenosis

- Hypertrophic pyloric stenosis (HPS) is an acquired disorder of the pylorus due to hypertrophy of the circular musculature of the pylorus. The exact etiology is unknown, but it appears to run in families, inherited as a dominant polygenic trait.
- M:F 4:1, more commonly seen in Caucasians and first born children
- HPS usually presents between 4-12 weeks of life, although it can occur as early as 2 weeks
- Most often present with nonbilious vomiting that progresses from simple regurgitation of food to projectile vomiting. Other manifestations include weight loss, dehydration, and hypochloremic metabolic alkalosis.
- Clinical history and physical examination often suffice to make the diagnosis -->“Palpable olive”. In questionable cases, imaging can be diagnostic. Ultrasound or UGI are the modalities of choice.
- Initial management includes IV hydration and correction of electrolyte abnormalities. Definitive treatment is pyloromyotomy.

** If a repeat study is indicated clinically after surgery, an ultrasound should be performed. The sonographic changes of HPS resolve within 6-8 weeks after successful pyloromyotomy, whereas the findings on upper GI may persist for years.

Case 11

2 year old male with progressive
abdominal distension and decreased
bowel movements

- Differential?
- Next tests?

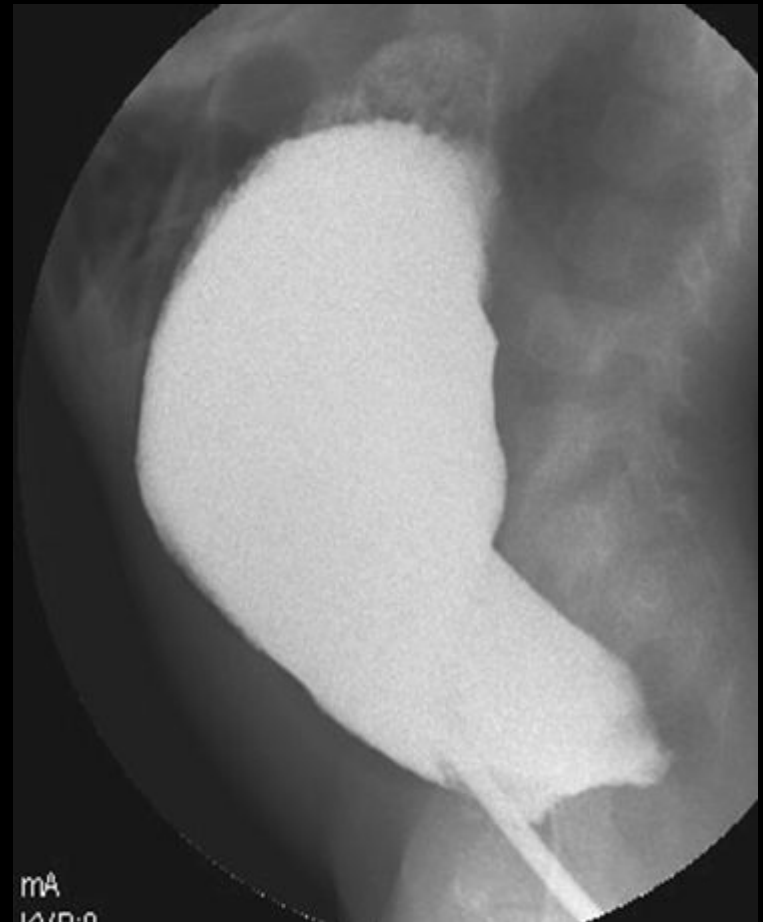
Abdominal Radiograph

- Findings?
- Next test?



Fluoroscopic Contrast Enema

- Findings?
- Next test?



Hirschsprung's Disease

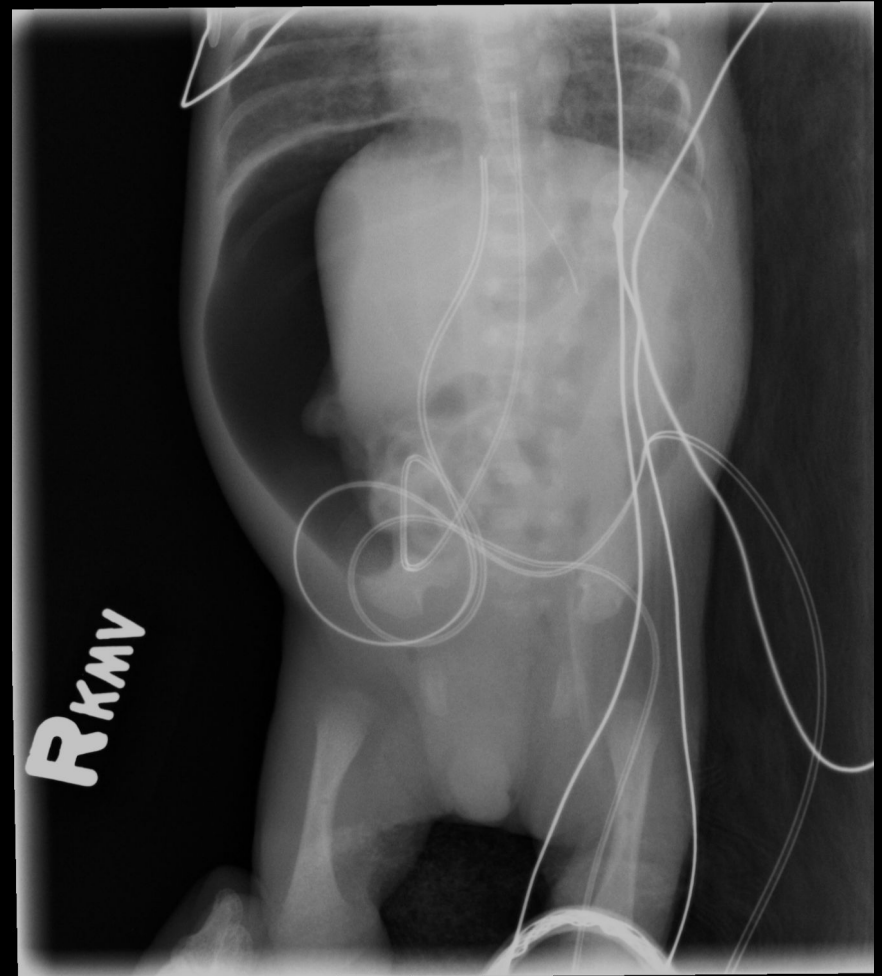
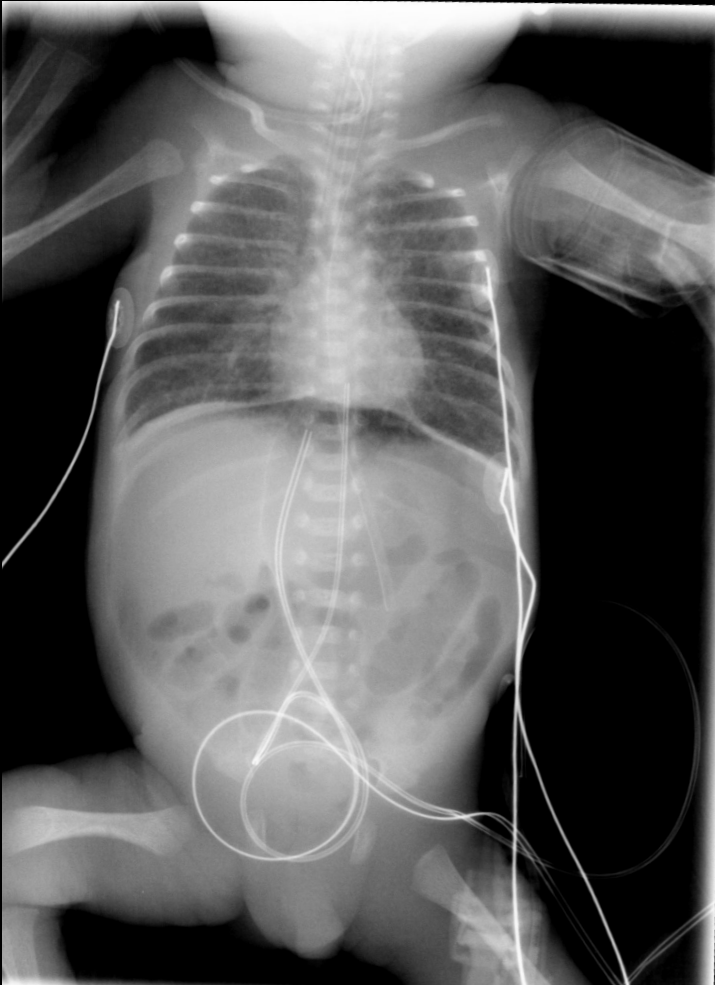
- Occurs secondary to the absence of myenteric ganglia in the smooth muscle layers of the colon.
- Regions affected are highly variable, but most commonly occurs in the rectosigmoid region.
- Males > females.
- Symptoms may range from constipation to signs of obstruction. Most worrisome complication is a potentially fatal enterocolitis. There is a small (3%) association with malrotation.
- Definitive diagnosis requires biopsy but radiologic diagnosis with a contrast enema can be helpful in confirming the clinical suspicion, and in delineating the transition zone.
- A barium enema may demonstrate an abrupt transition from the aganglionic segment to the ganglionic segment. Additionally, an irregular, "saw-toothed" appearance may be seen in the aganglionic segment resulting from the aganglionosis.
- A negative barium enema does not preclude a biopsy when there is high clinical suspicion.

Case 12

Premature infant transferred due to being septic with abnormal abdominal US at outside hospital.

Abdominal Radiograph

- Findings?



Pneumoperitoneum

- The causes of neonatal pneumoperitoneum are slightly different than adult etiologies and include:
 - Perforated bowel due to necrotizing enterocolitis (most common), meconium ileus, Hirschsprung disease
 - Iatrogenic related to intubation/mechanical ventilation, rectal thermometer
- Radiographic features:
 - Because neonates are imaged supine, look for areas of increased lucency over the abdomen.
 - May see air outlining the falciform ligament (football sign).
 - Air beneath the diaphragm will result in a continuous appearance of the diaphragm.
 - May see air outlining both sides of the bowel wall (intraluminal and extraluminal) known as the Rigler sign.
 - If findings are equivocal, decubitus imaging, generally left side down, will allow gas to track over the diaphragm making the findings more conspicuous.
- Treatment:
 - Free air within the abdomen is usually considered a surgical emergency.

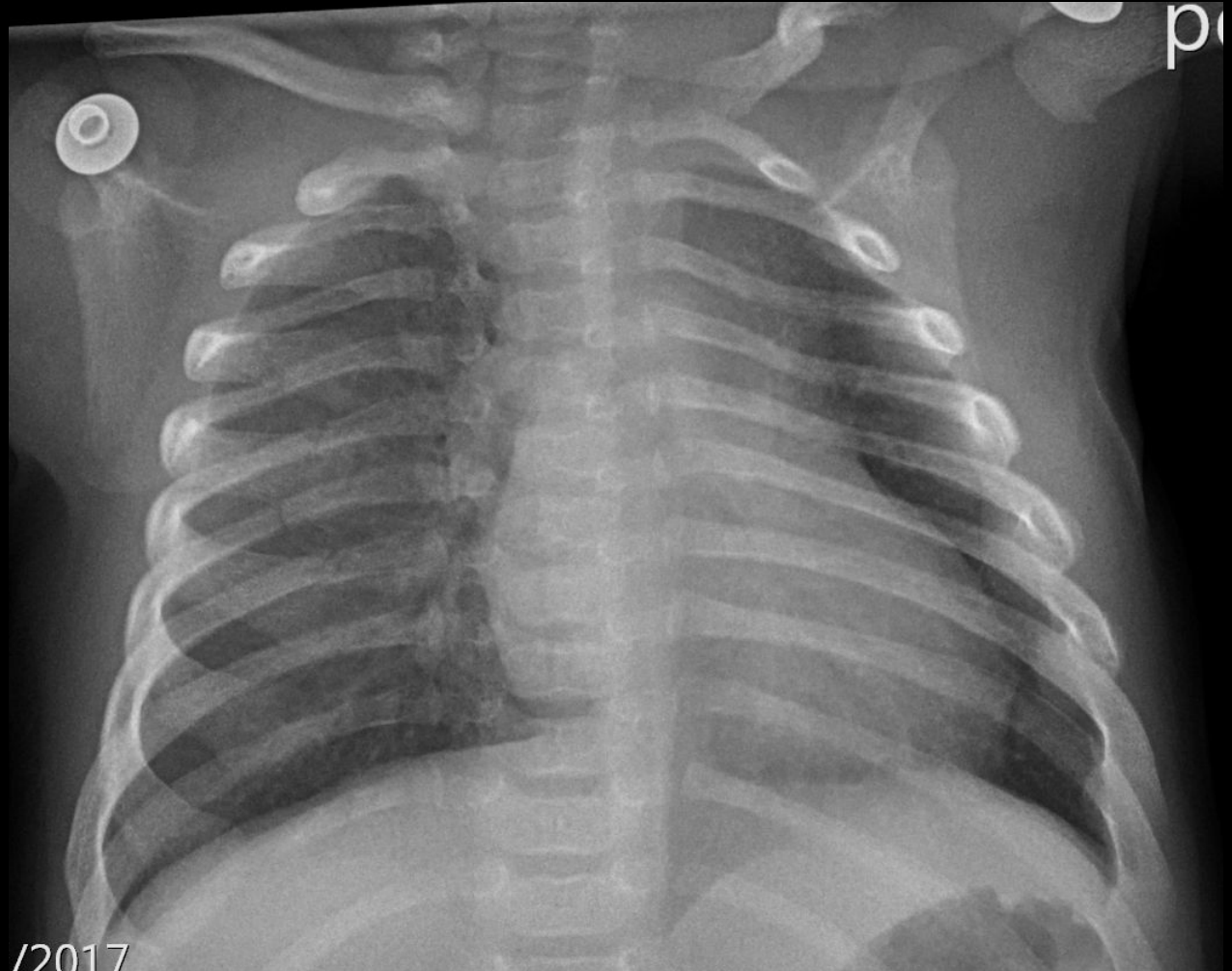
Case 13

1 mo having choking like episodes.

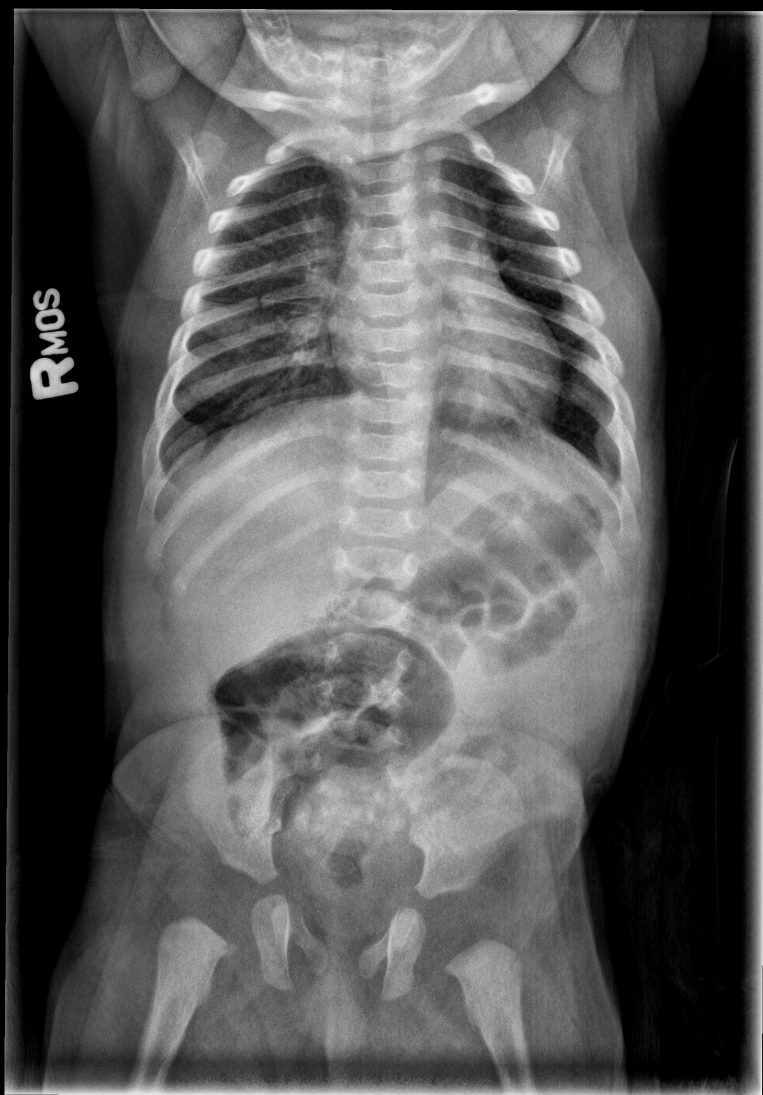
- Differential?
- Next tests?

Chest Radiograph

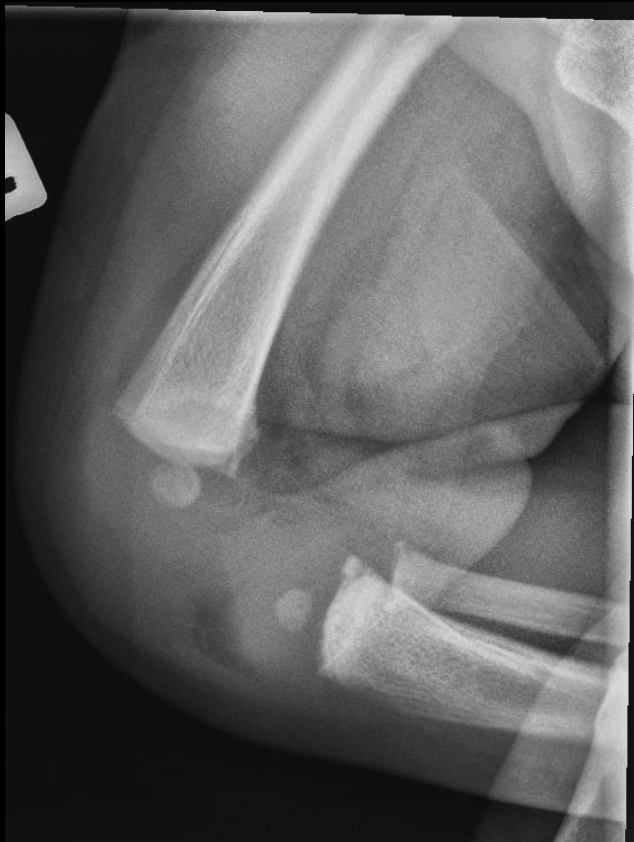
- Findings?
- Next test?



Skeletal Survey



Skeletal Survey



Non-accidental Trauma

- Approximately 10% of children under 5 years of age brought in to the ED with alleged accidents have actually suffered nonaccidental trauma.
- When is a Fracture Suspicious for Child Abuse?
 - No hx of injury
 - History not plausible
 - Inconsistent histories
 - Frx in nonambulatory child
 - Delay in seeking care for injury
- What constitutes an appropriate radiologic workup?
 - NOT a babygram!!
 - Appropriate radiographic skeletal survey is necessary and includes:
 - Chest AP and lateral
 - Skull (lateral)
 - Upper arms
 - Forearms
 - Hands
 - Pelvis
 - Upper legs (femurs)
 - Lower legs
 - Ankles
 - Feet
- Fractures with high specificity for child abuse include:
 - Bucket handle or Corner fractures
 - Rib fractures of different ages of healing
 - Acromion fracture
 - Spinous process fractures
 - Sternal fracture
 - Occipital impression fractures
- Fractures that are commonly seen but not as specific for NAT
 - Long bone diaphyseal fractures
 - Clavicular fractures
 - Digital fractures
- Differential diagnosis to consider:
 - Osteogenesis imperfecta
 - Rickets (Vit D deficiency)
 - Scurvy
 - Menkes Disease

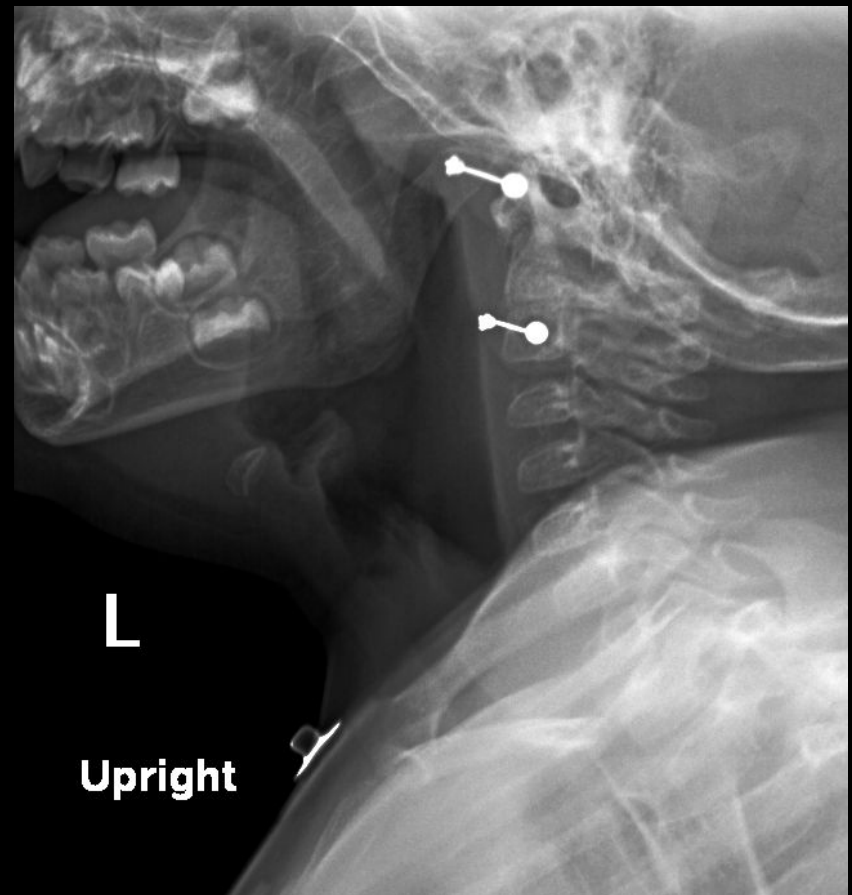
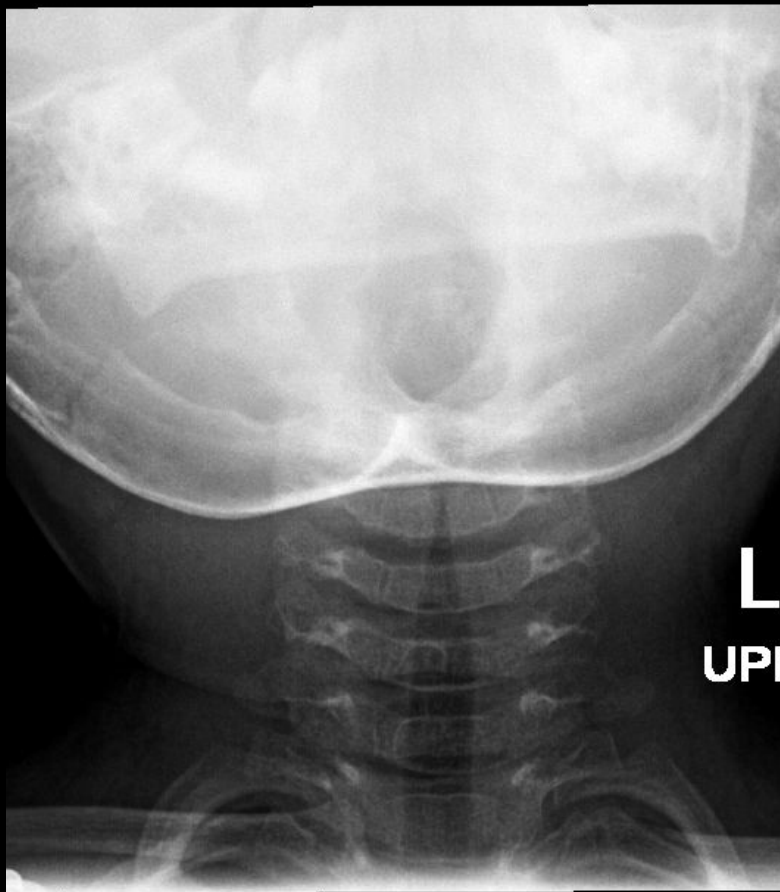
Case 14

3 year old female presenting with fevers, sore throat, barking cough, and inspiratory stridor.

- Differential?
- Next tests?

AP and lateral neck radiographs

- Findings?



Croup

- Generally due to a viral infection of the upper airway. Common etiologies include parainfluenza virus or RSV.
- Commonly affects children between 6 months to 3 years of age with peak at 18 months.
- Has seasonal predominance in the late fall and early winter.
- Radiographic findings:
 - Steeple sign: seen on AP radiograph of the neck by uniform narrowing of the subglottic airway.
 - Can see distention of the hypopharynx
- Treatment:
 - Usually self-limiting with good prognosis.
 - Supportive care including O2 and nebulized epinephrine.