Read Films Like a Radiologist:
An Expert's Guide to Pediatric CXR and AXR Interpretation

Mark Bittman, MD

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Pediatric Radiologist

Financial Disclosures

- None

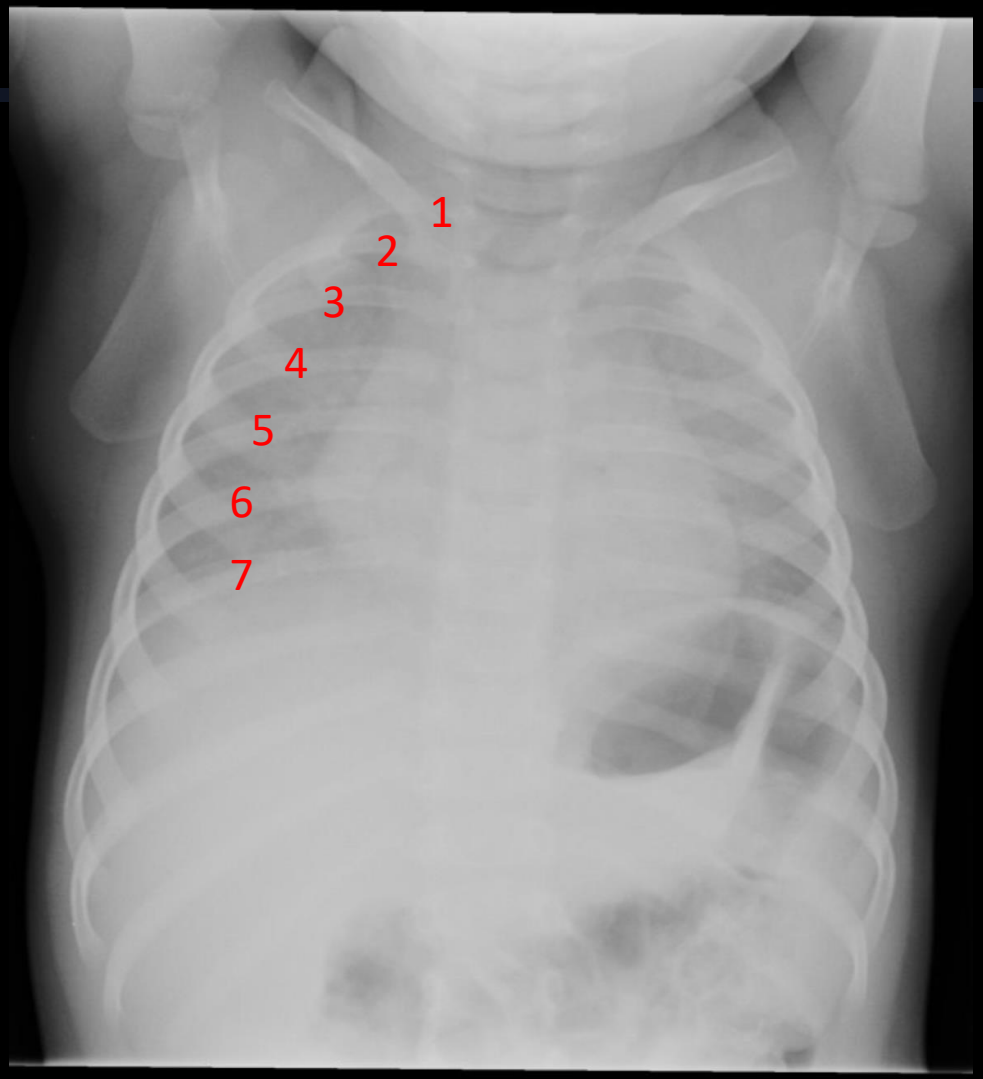
Learning Objectives

- **Differentiate different types of Pediatric Pneumonia**
- **Identify critical findings on CXR in the UC setting**
- **Learn the Ddx for bowel obstruction in children and identify specific imaging findings to narrow the DDx.**
- **Be aware of organic causes of Constipation**
- **Recognize Foreign Body Indicators on CXR and AXR**
- **Case based format**

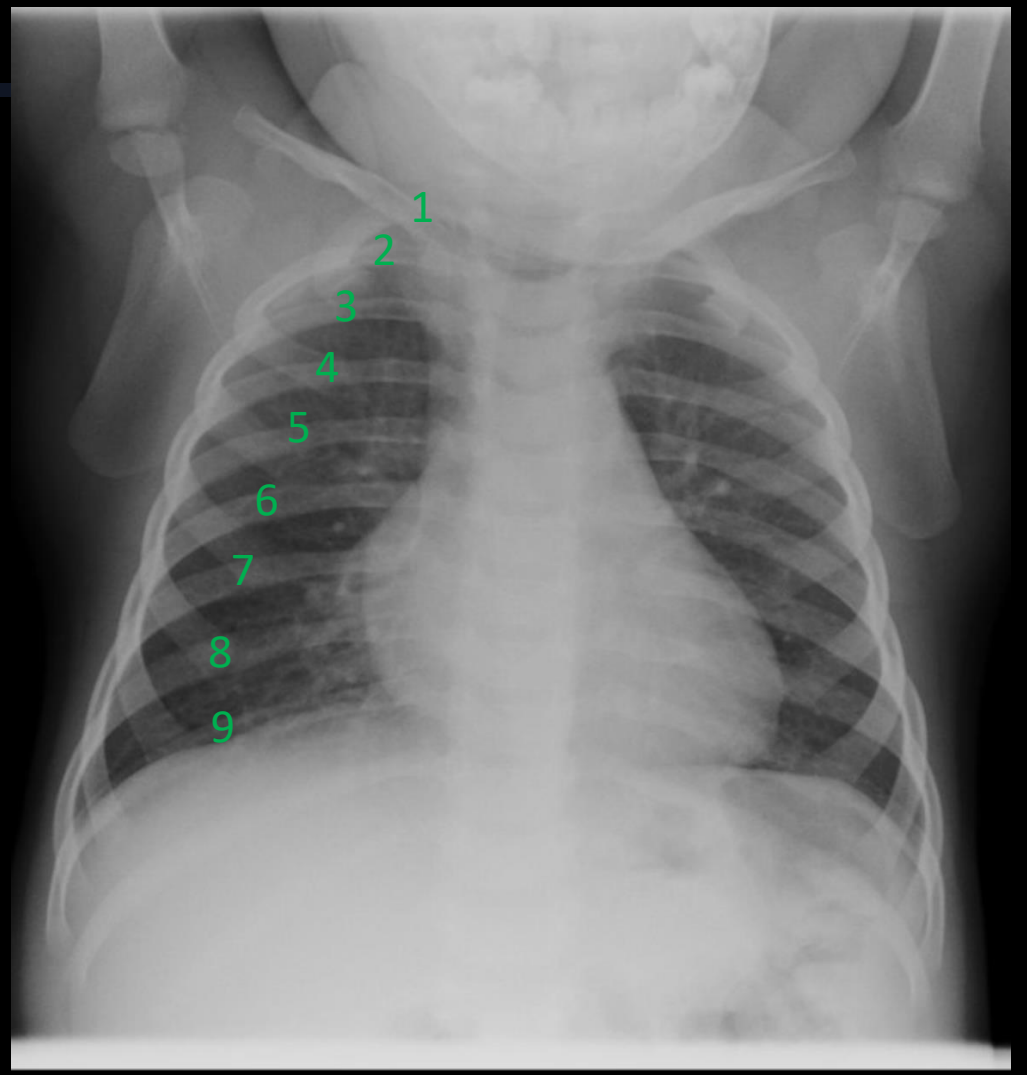
1 yo with dyspnea

Viral/RAD?
Bacterial PNA?
Cardiomegaly, pulmonary edema?
Normal?

Low lung volumes



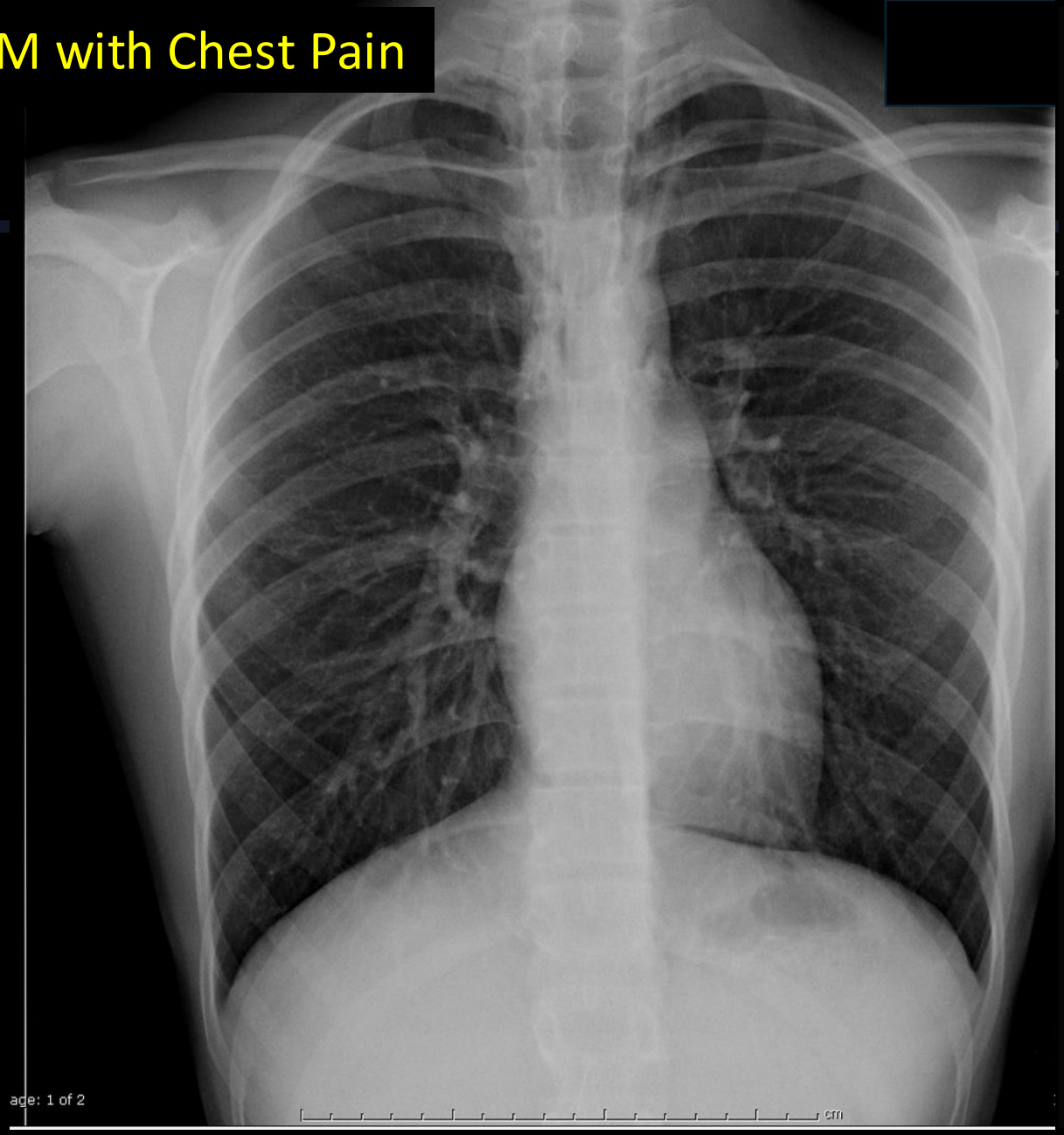
Repeated with improved inspiratory effort



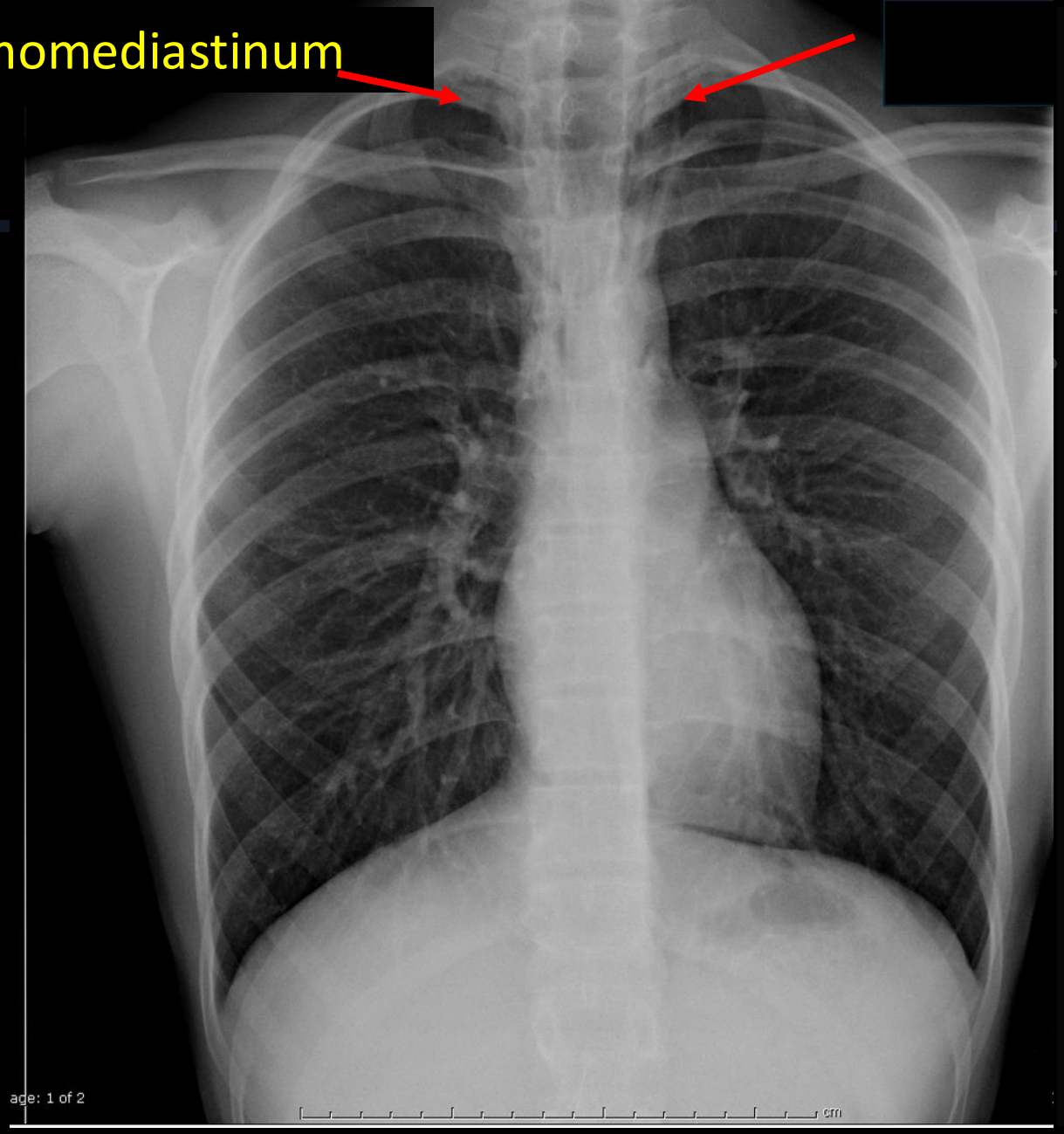
Inspiration vs. Expiration: Avoiding Diagnostic Pitfalls

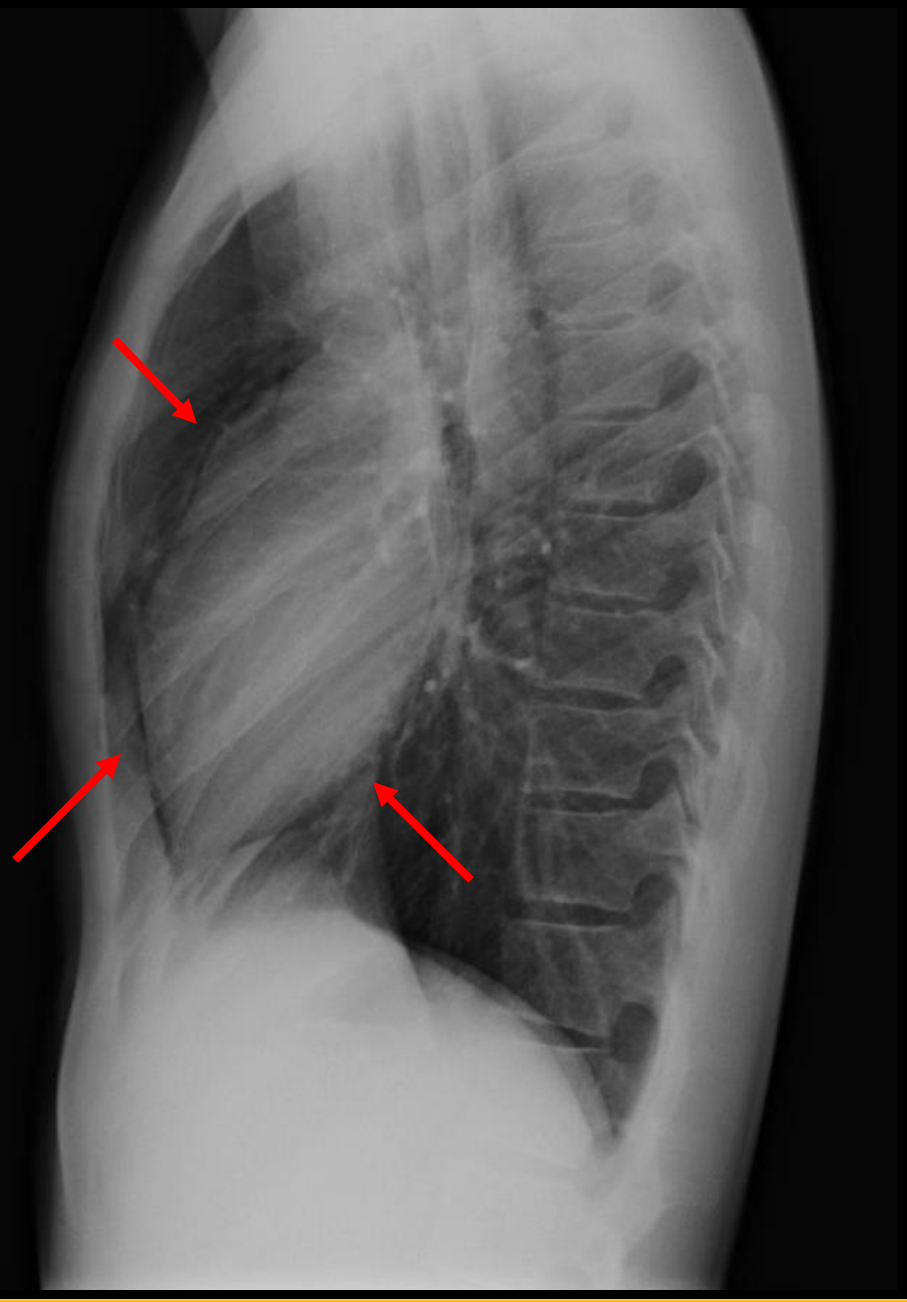
- **Cardiac Silhouette:** Expiration causes "apparent" cardiomegaly; the heart appears wider as the diaphragm rises.
- **Lung Opacity:** Reduced aeration in expiration mimics bilateral hazy opacities or pneumonia.
- **Vascular Crowding:** Expiratory films compress pulmonary vessels, often mistaken for pulmonary edema or venous congestion.
- **Anatomical Landmark:** Aim for **8–9 posterior ribs** to confirm an adequate inspiratory film in children.
- **"Thymic Sail": Poor inspiration can cause the thymus to appear enlarged or distorted, masquerading as a mediastinal mass or pna.**

15 yo M with Chest Pain



Pneumomediastinum

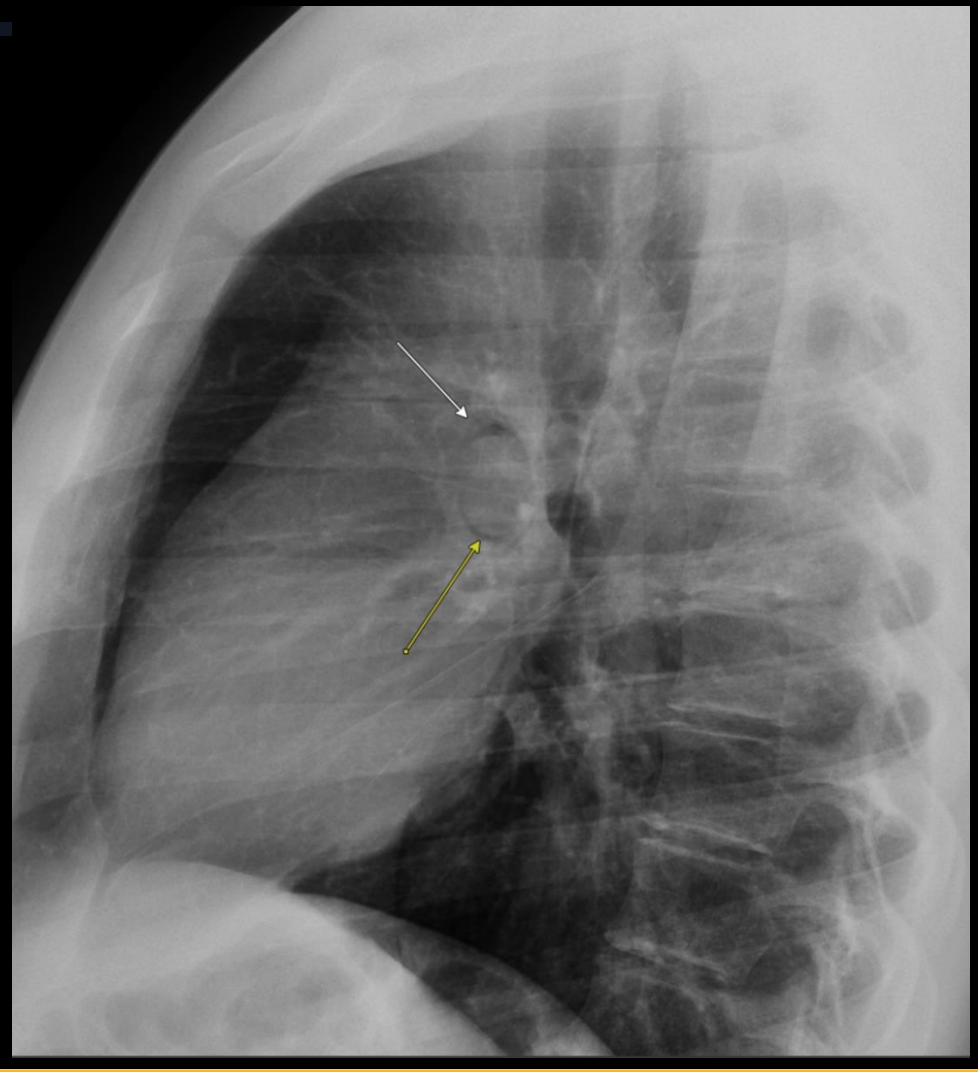




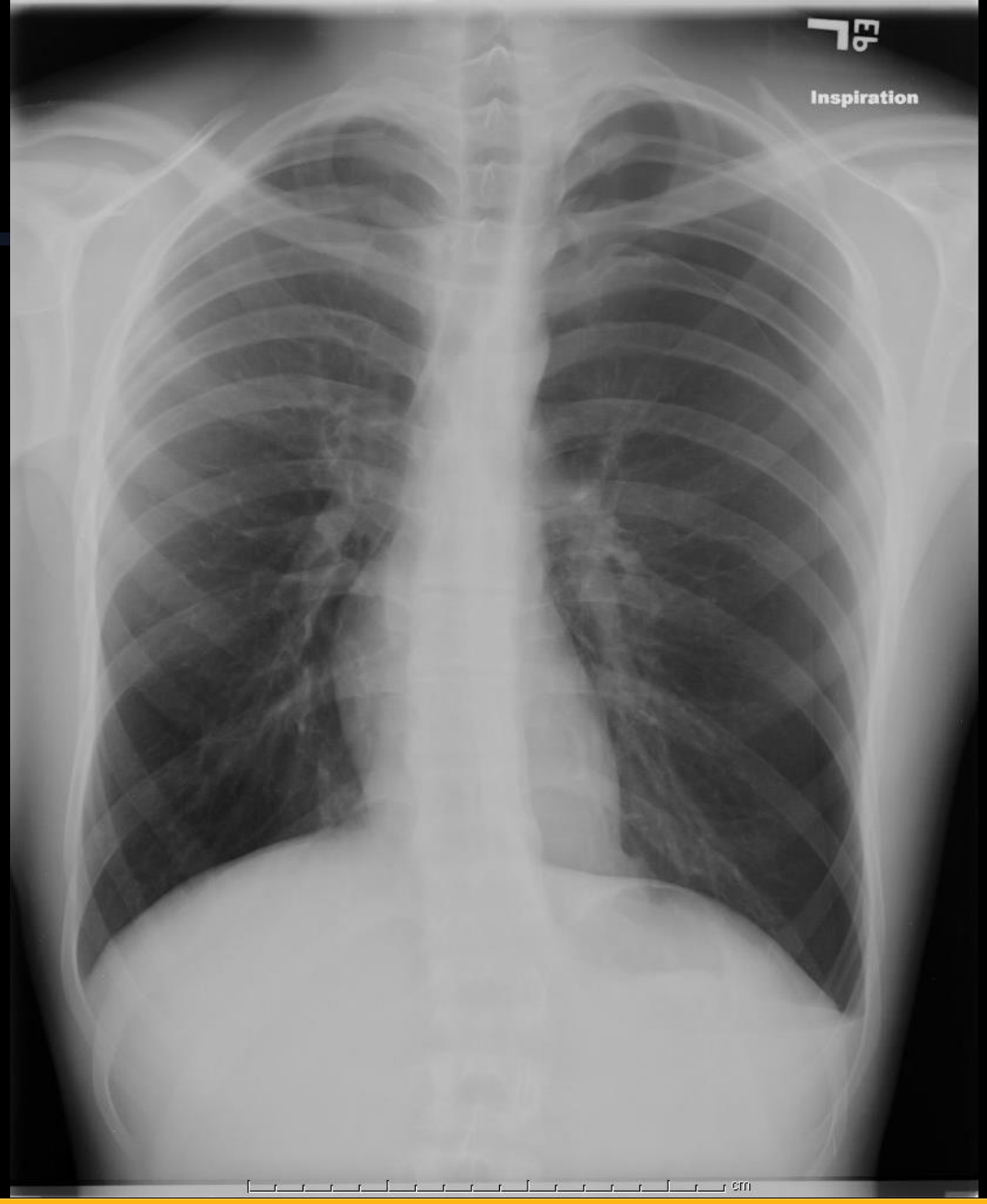
Pneumomediastinum

- Lateral View: Many subtle cases are best seen on the lateral X-ray.
- Look for the "retrosternal air" or air outlining the great vessels
  - Ring around the artery sign
- AP view note the streaky lucency tracking into the neck soft tissues
- Pediatric Specifics: In older kids (teens), the most common trigger is an asthma exacerbation or the Valsalva maneuver (e.g., weightlifting or forceful vomiting).
- Clinical Pearl: Often benign and self-limiting (e.g., from asthma or forceful coughing), but must rule out esophageal rupture if the patient is toxic or febrile.

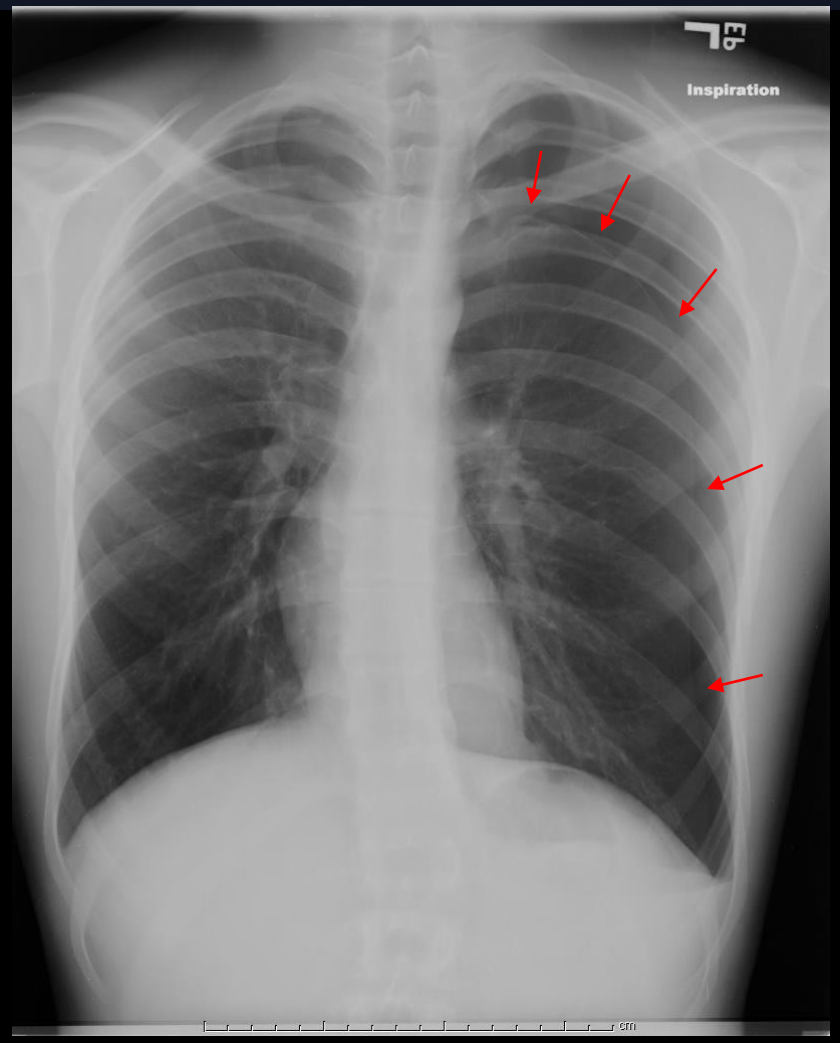
"ring around the artery" sign of pneumomediastinum

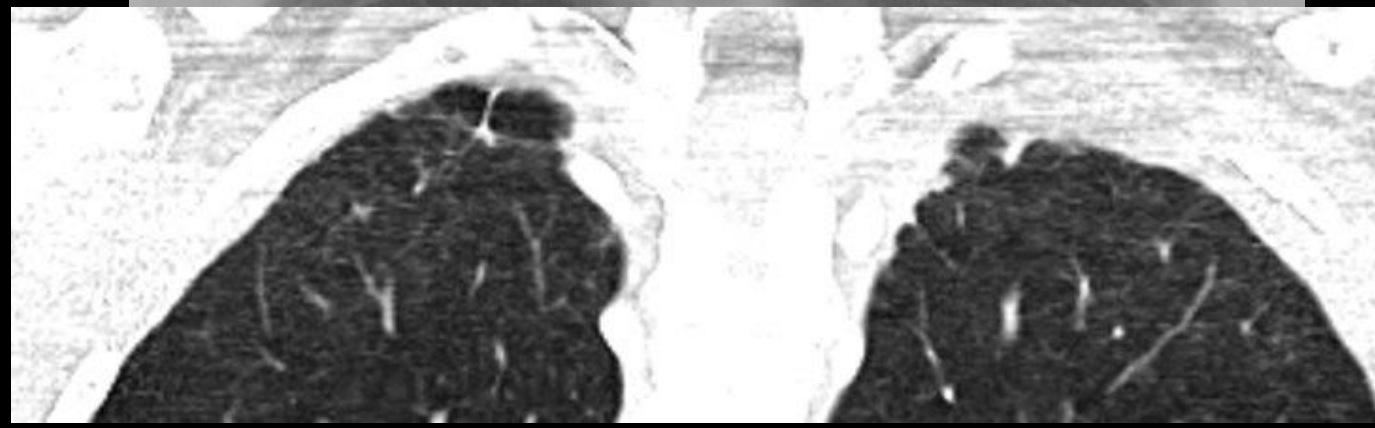


Chest Pain



Chest Pain - Pneumothorax

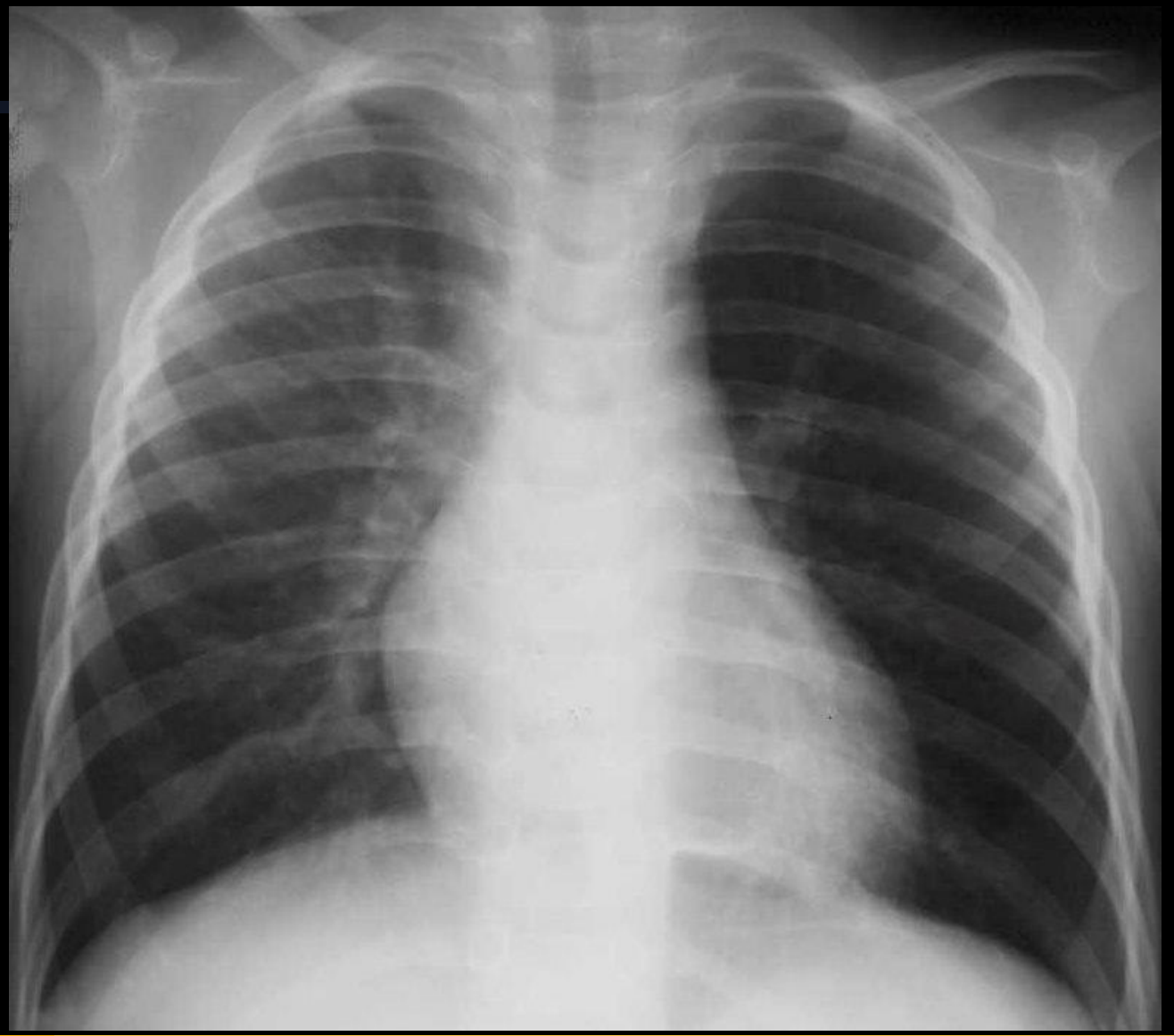




Spontaneous pneumothorax

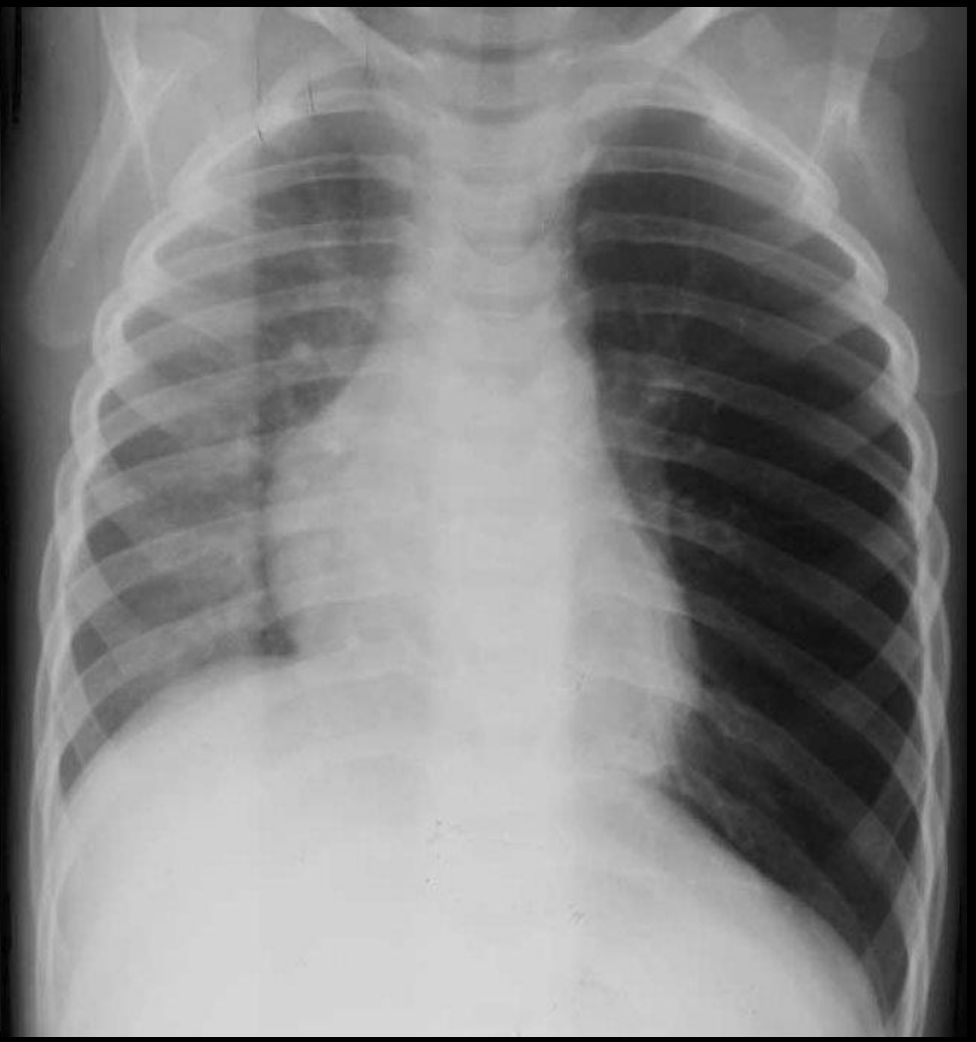
- **Primary (PSP):** Occurs in healthy individuals without overt lung disease; typically results from subpleural bleb or bulla rupture in the lung apex.
- **Secondary (SSP):** Arises from underlying lung pathology (e.g., COPD, CF, or Marfan syndrome); carries a higher risk of morbidity and recurrence.
- **Pathophysiology:** Air enters the pleural space, disrupting the negative intrapleural pressure required for lung expansion.
- **Radiographic Hallmark:** Identification of the **visceral pleural line** with a peripheral absence of lung markings; often best seen in upright films.
- Look for XR signs of **Tension Pneumothorax**
  - **Mediastinal deviation (tracheal deviation)**
  - **Depression/flattening of the diaphragm**
  - **Deep sulcus sign**
  - **Widening of the intercostal spaces**

Choking episode

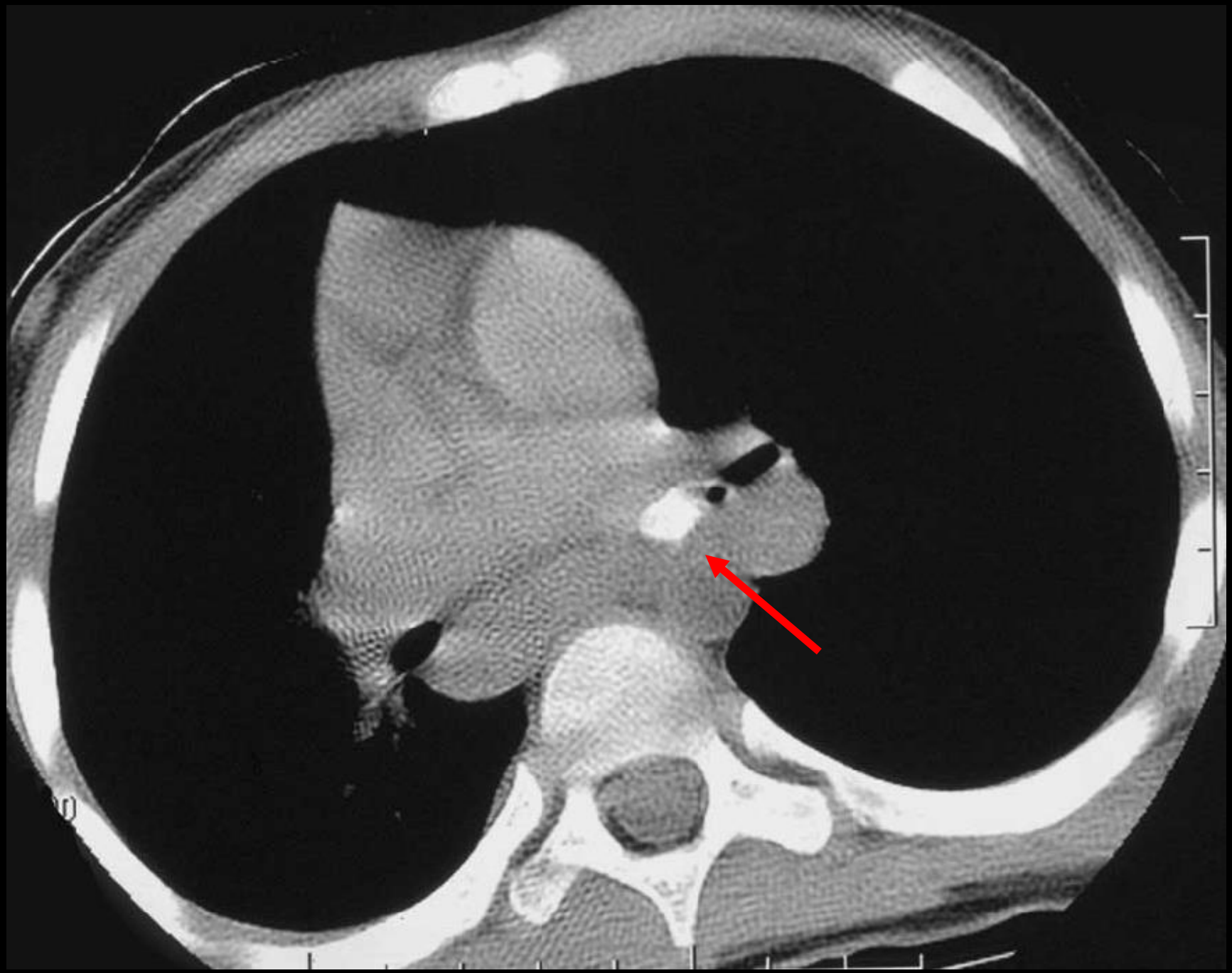


Left lung air trapping

left side down decub



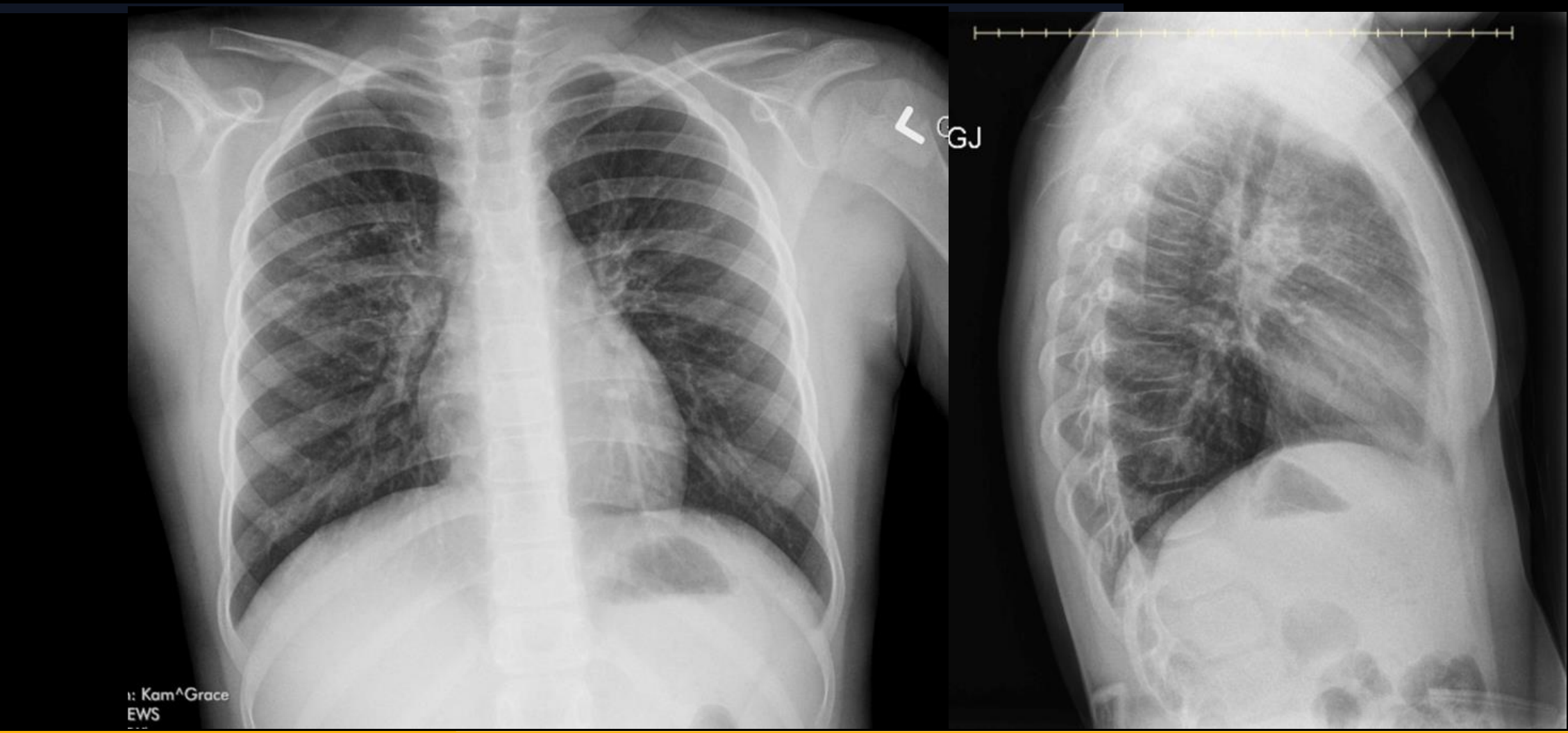
right side down decub



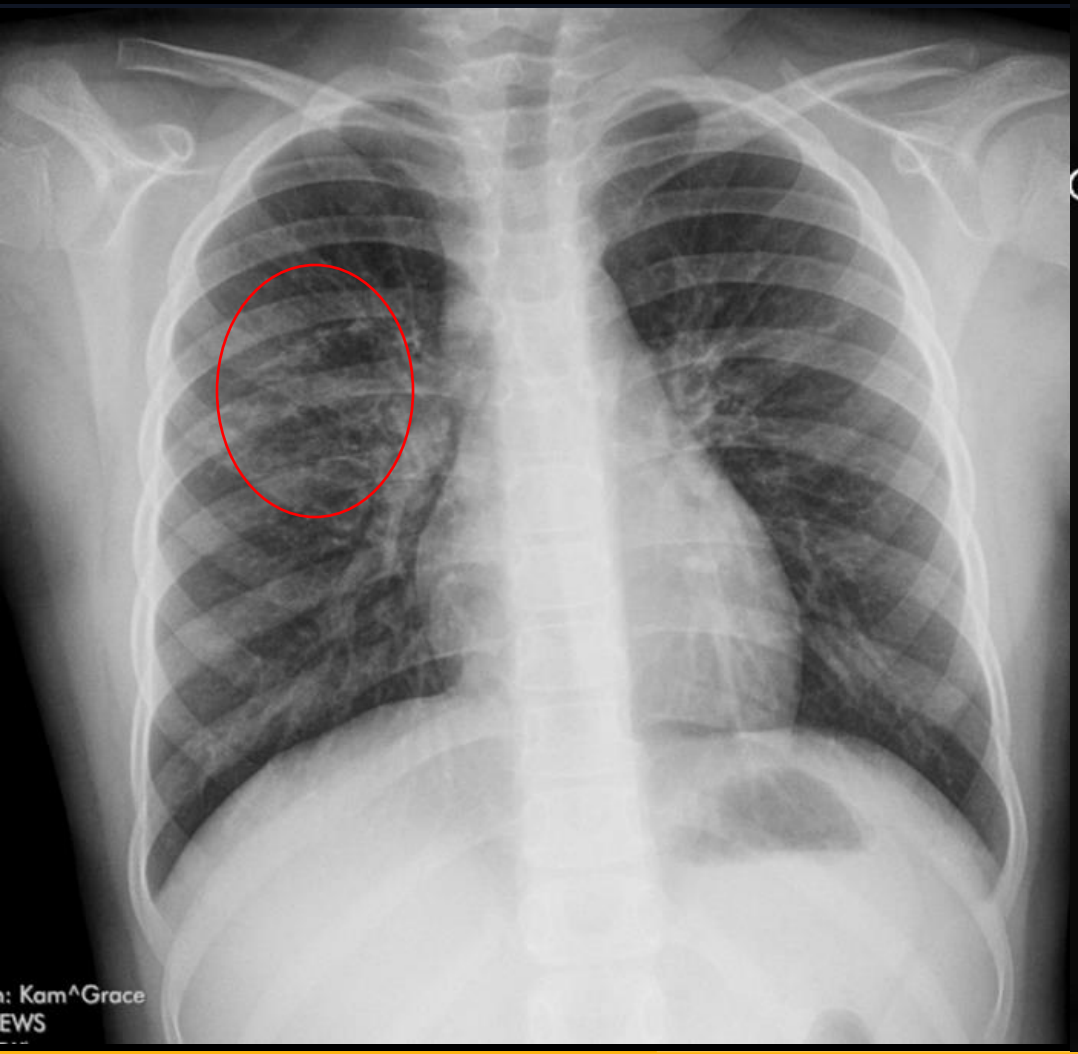
Aspirated foreign body

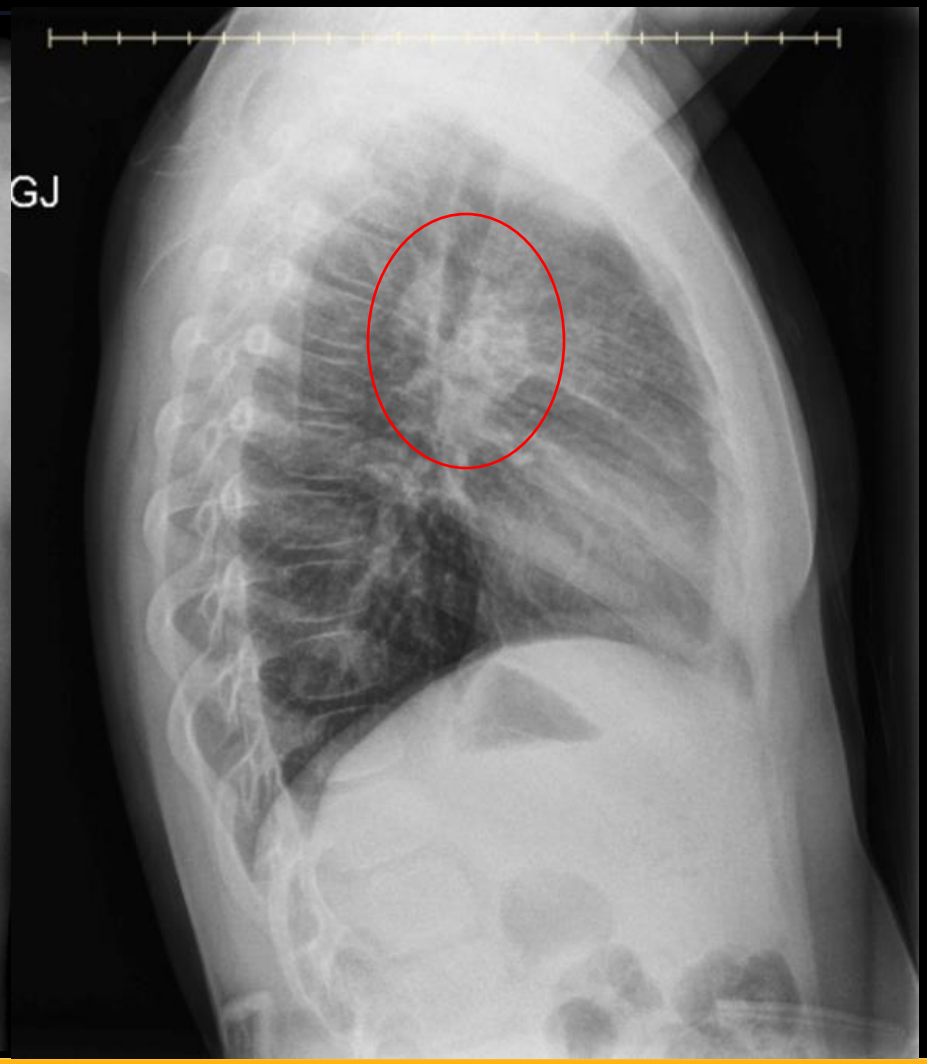
- Usually children < 3 years
- Hyperlucent lung
  - Air trapping - "ball-valve" effect
  - Decreased vascularity (vasoconstriction b/c ↓ pO2)
- Location Bias: Right mainstem bronchus is the most common site due to its more vertical orientation and wider diameter.
- Warning Label: "Negative imaging does NOT exclude a foreign body."
- Up to 25% of patients with confirmed aspiration have a normal initial chest X-ray.
- Most objects (nuts, plastic) are not radio-opaque.
- Gold Standard: Proceed to Rigid Bronchoscopy if history is suggestive, regardless of imaging; delay increases risk of post-obstructive pneumonia.

HX: Two weeks of cough and nasal congestion, previously febrile, now afebrile.



RUL, atypical infection.





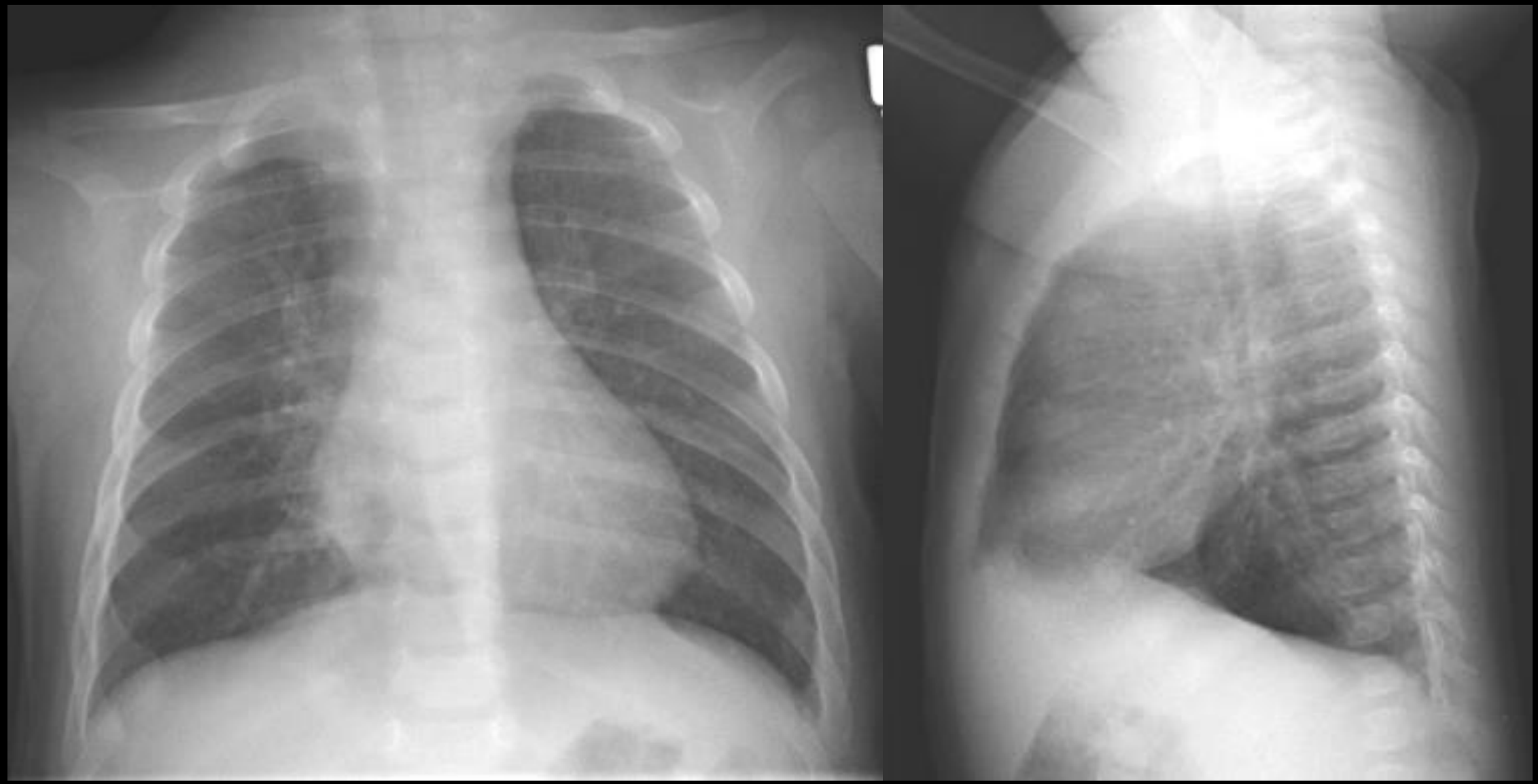
Tips:

- Reticulonodular opacity – lines and nodular pattern
- Interstitial infiltrate
- Ddx includes atypical infection, mycoplasma

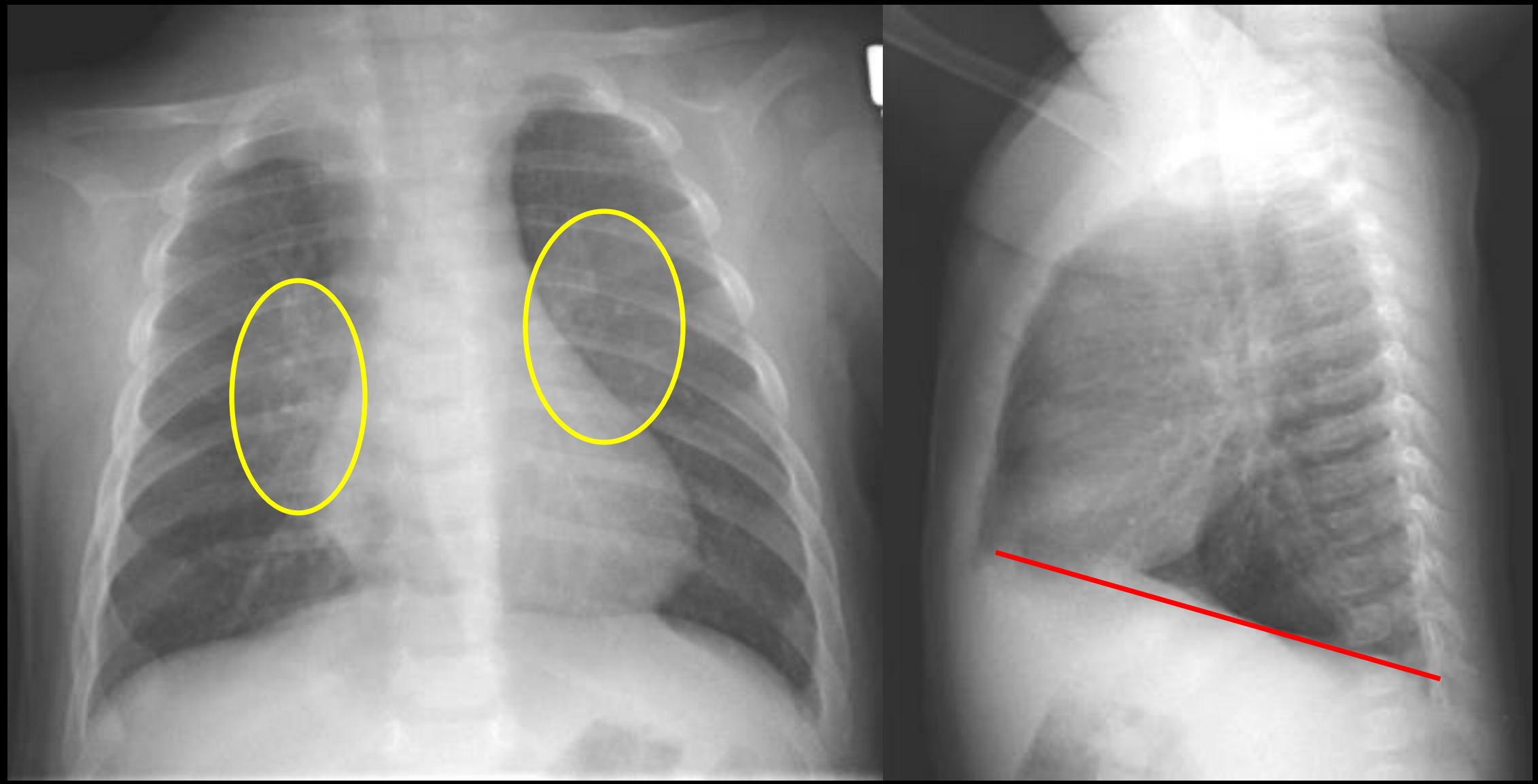
Atypical pneumonia

- **Clinical-Radiographic Dissociation:** Characteristically "dirty" or "busy" X-rays in patients with relatively mild symptoms (low-grade fever, dry cough).
- **Reticulonodular Pattern:** Often presents with patchy, or interstitial infiltrates rather than dense lobar consolidation. Unilateral or bilateral. Effusions less common.
- **Perihilar Prominence:** Frequent involvement of the hilar regions with "streaky" opacities radiating outward.
- **Common Pathogens:** Primarily *Mycoplasma pneumoniae*, *Chlamydophila pneumoniae*, and *Legionella*.

Fever and cough



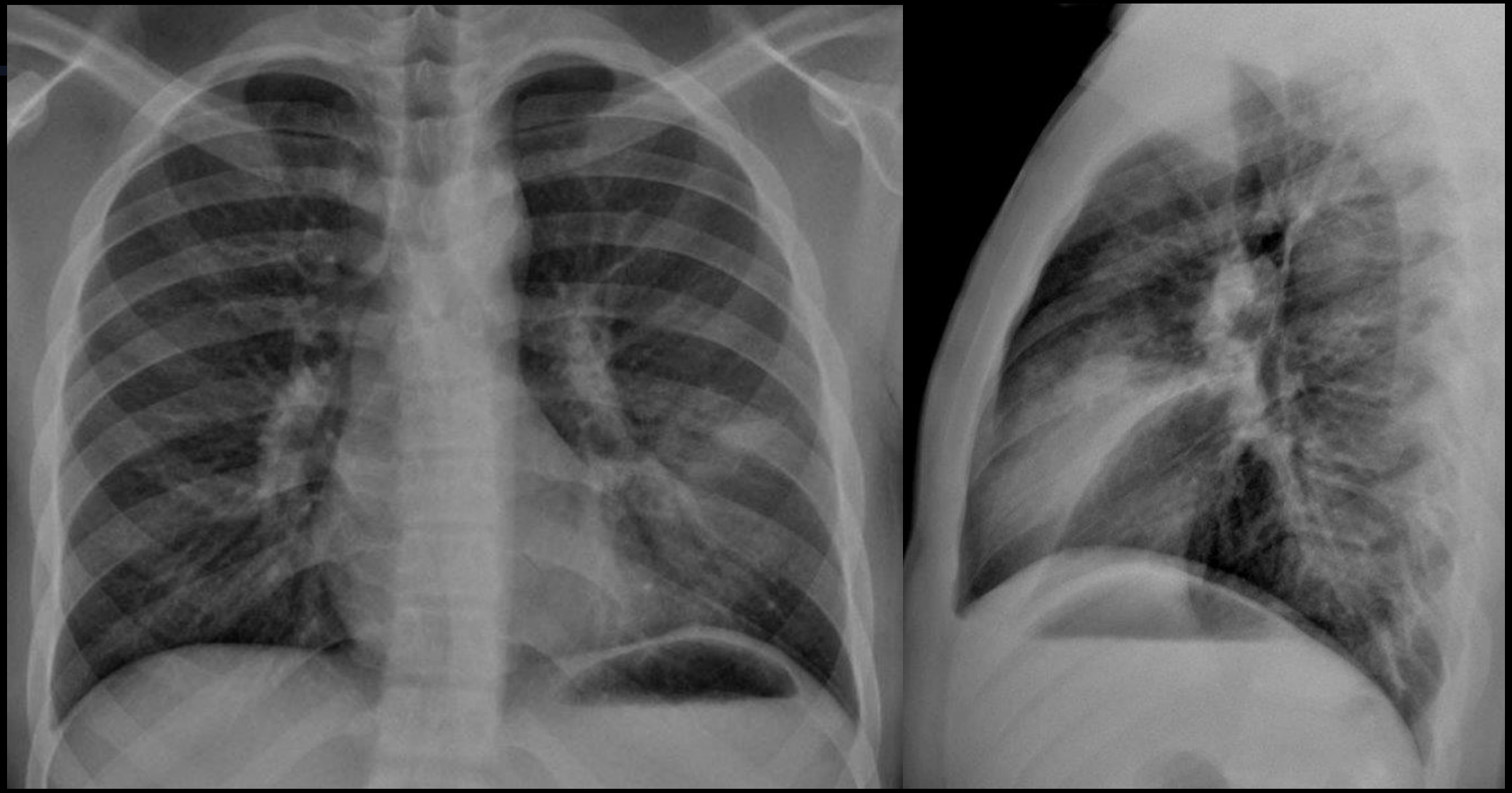
Viral or RAD



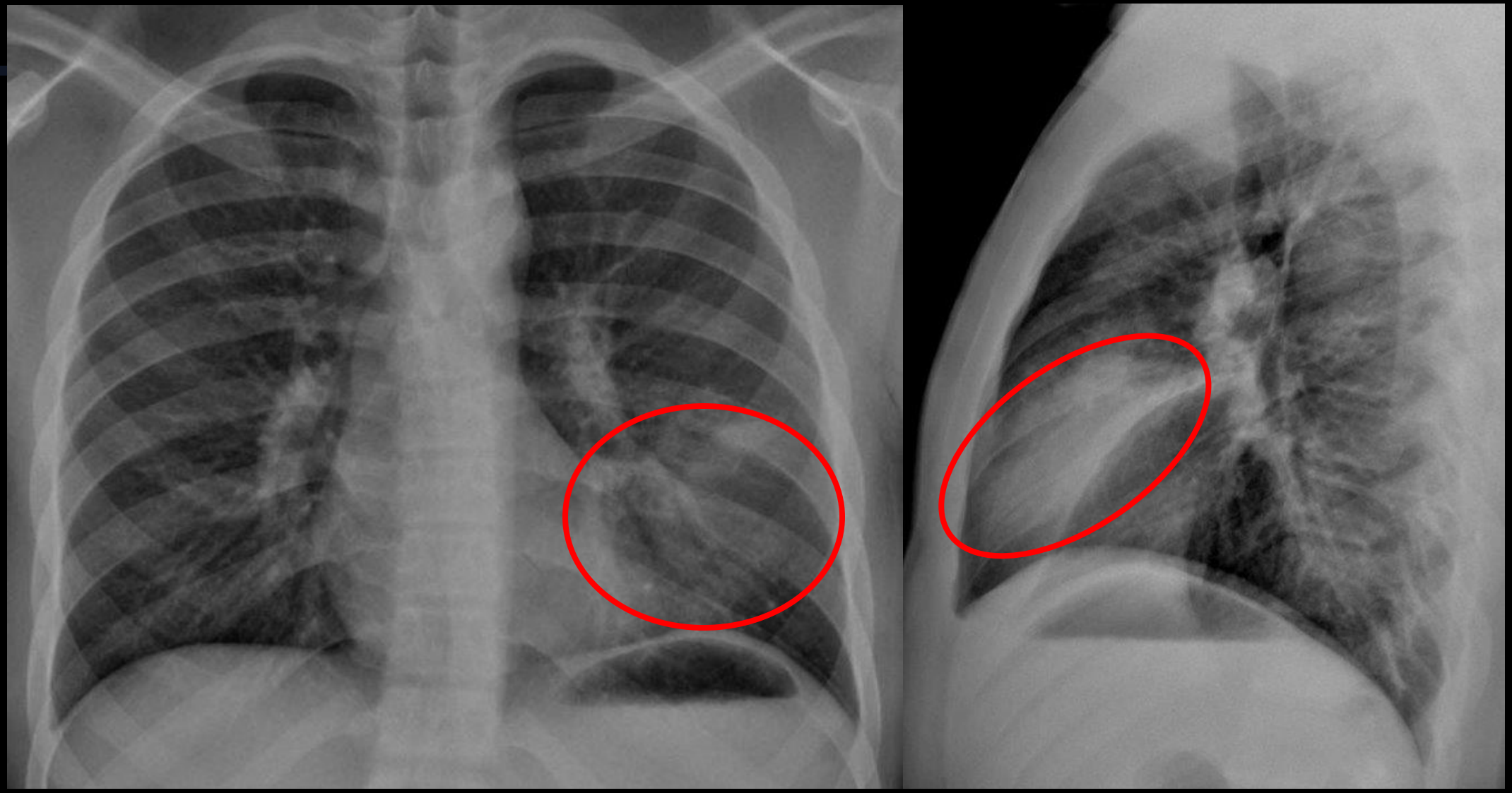
Bronchiolitis

- Infectious small airways inflammation in children < 3 years old
- Edema/peribronchiolar inflammation narrows airway lumen causing air trapping
  - Hyperinflation
  - “Tram-tracking” of airways seen side-on
  - “Donuts” in airways seen end-on
  - **Atelectasis vs. Infiltrate:** Focal opacities (especially in the Right Middle Lobe) are often **mucus plugging** and volume loss rather than true bacterial infection.

Fever and cough



Lingular pneumonia



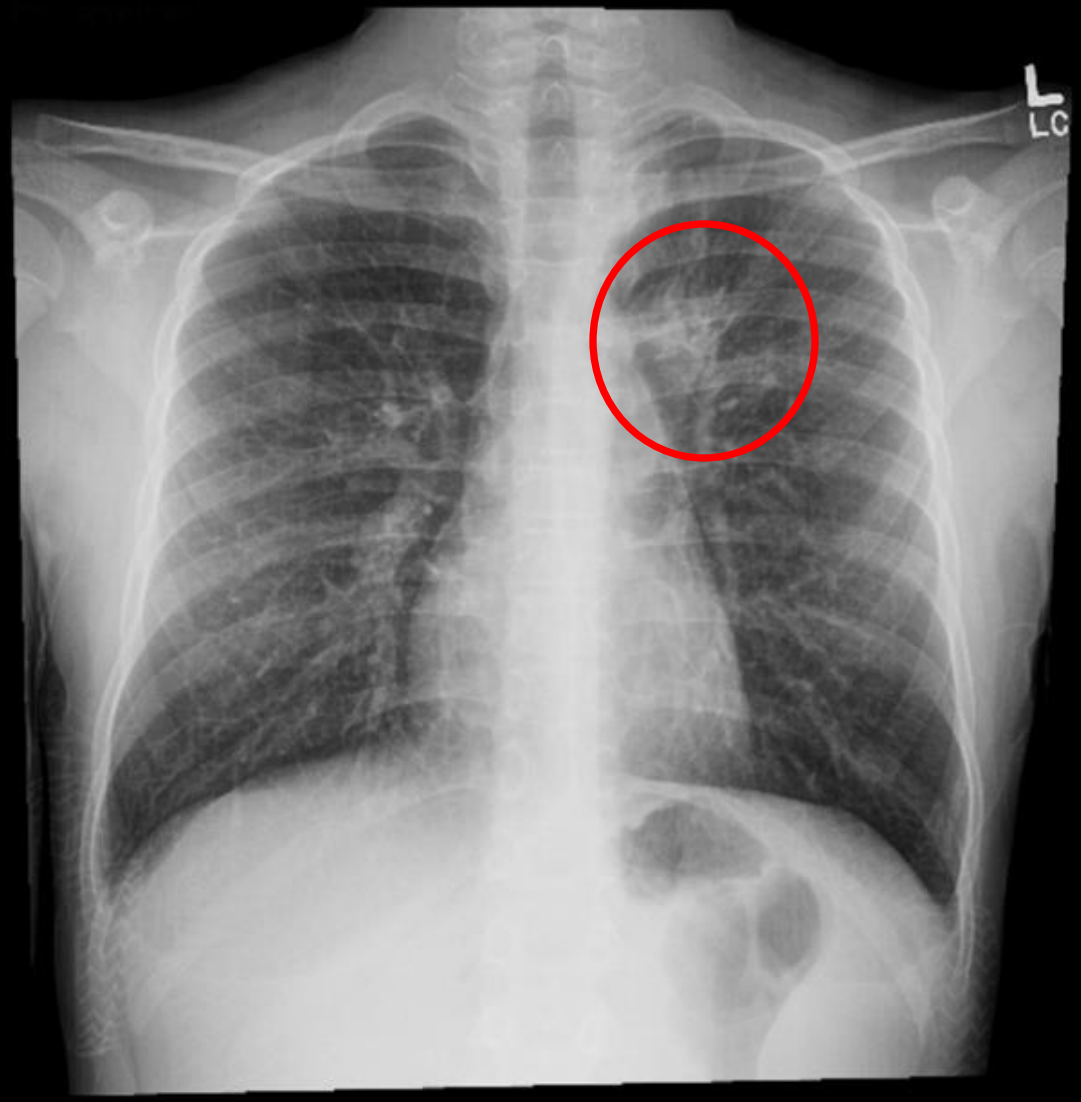
Lingular pneumonia

- **Lobar Opacification:** Homogeneous opacity of a single lobe or segment with sharply defined borders where it meets an interlobar fissure.
- **Air Bronchograms:** Lucent, air-filled bronchi visible within the dense consolidation—a classic sign of alveolar filling.
- **Silhouette Sign:** Loss of the normal interface between the lung and adjacent structures (e.g., the heart border or diaphragm), acting as a "map" to the infection's location.
- **Bulging Fissure Sign:** Uncommon but suggestive of high-volume exudate (classically associated with *Klebsiella pneumoniae*) causing the fissure to displace outward.
- **Complications to Screen:** Evaluate for associated parapneumonic effusions (seen in up to 60% of cases), empyema, or the development of a lung abscess or necrotizing infection (lucecny in the consolidated lung).

Fever and cough

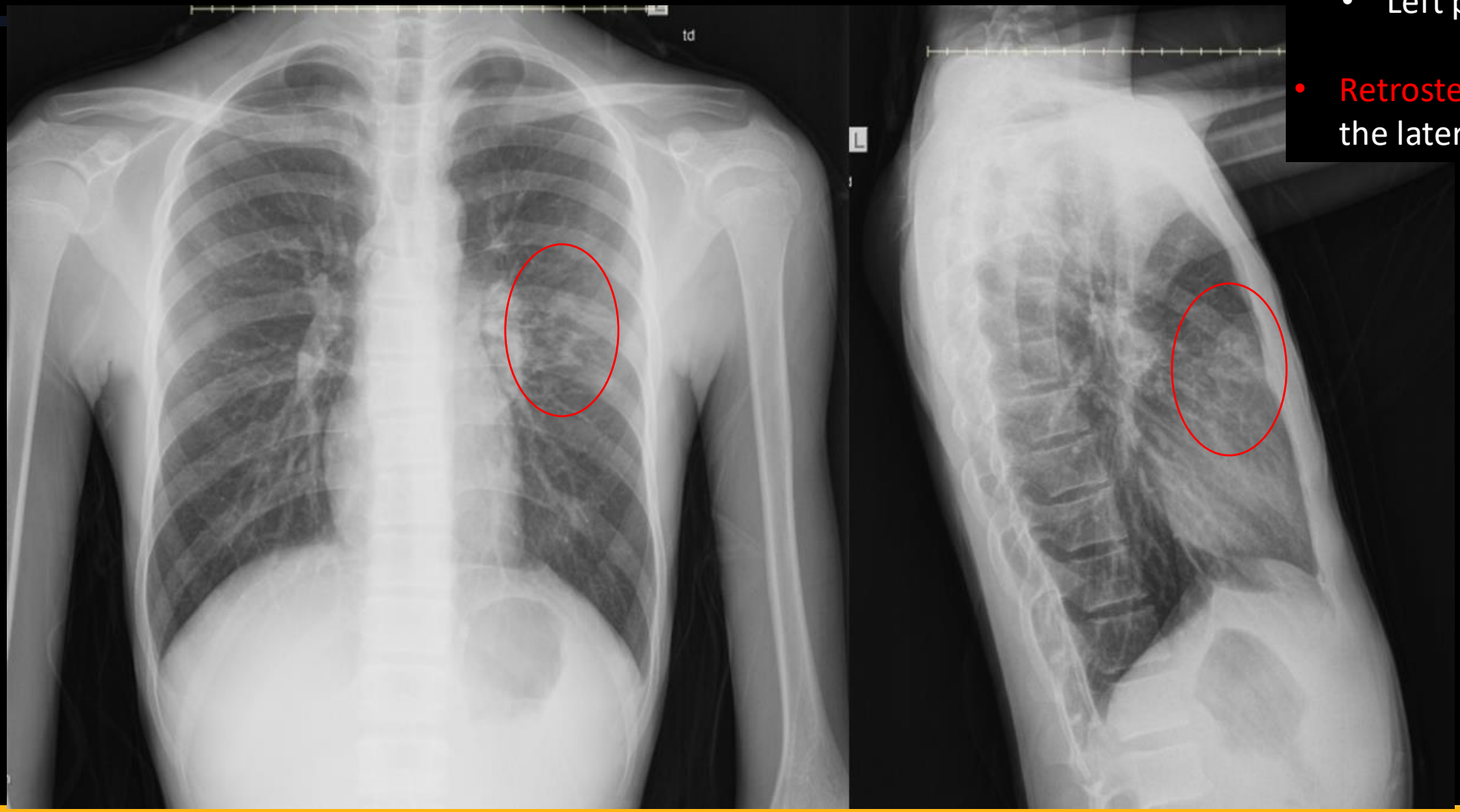
LUL Pneumonia

Retrotracheal clear space is opacified



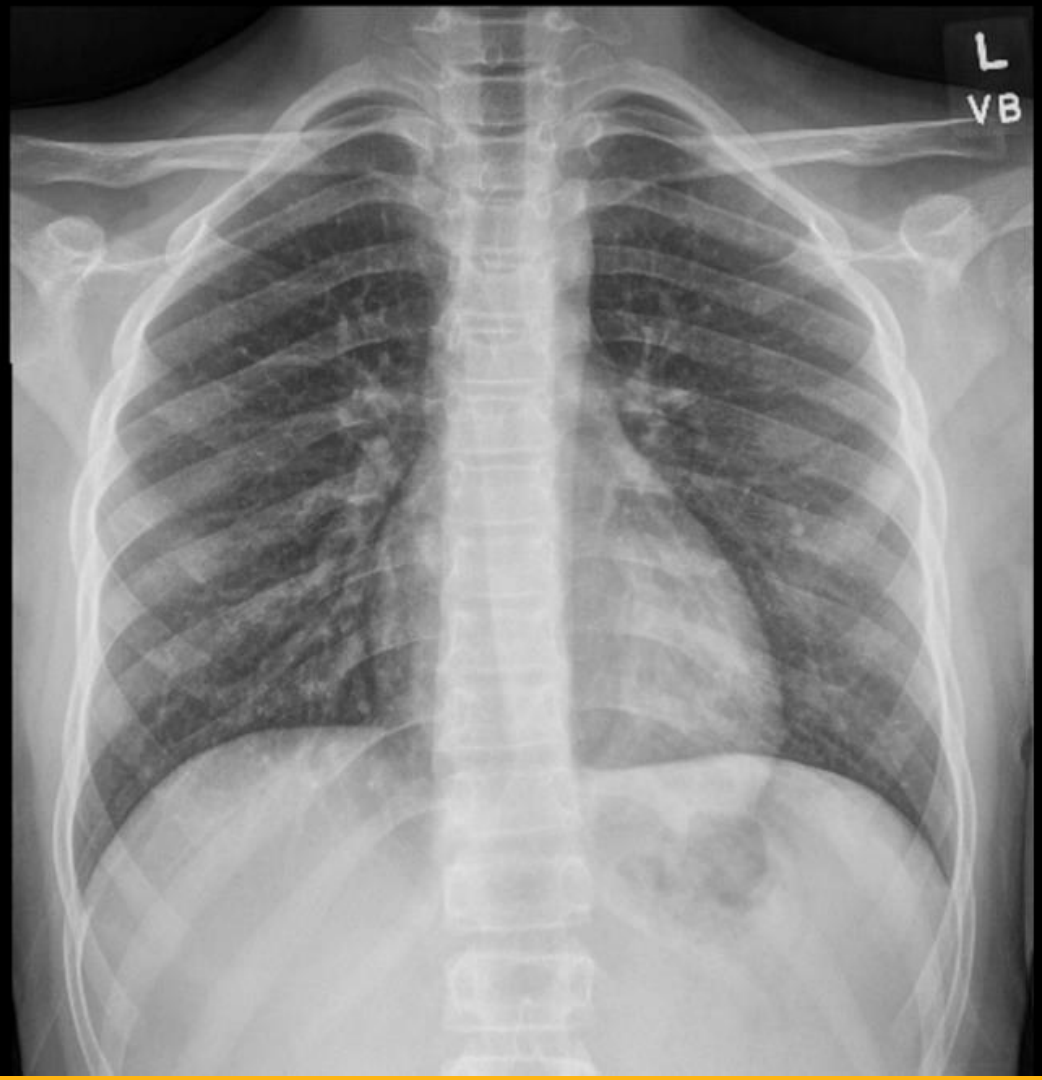
Fever and cough

Left upper lobe pneumonia

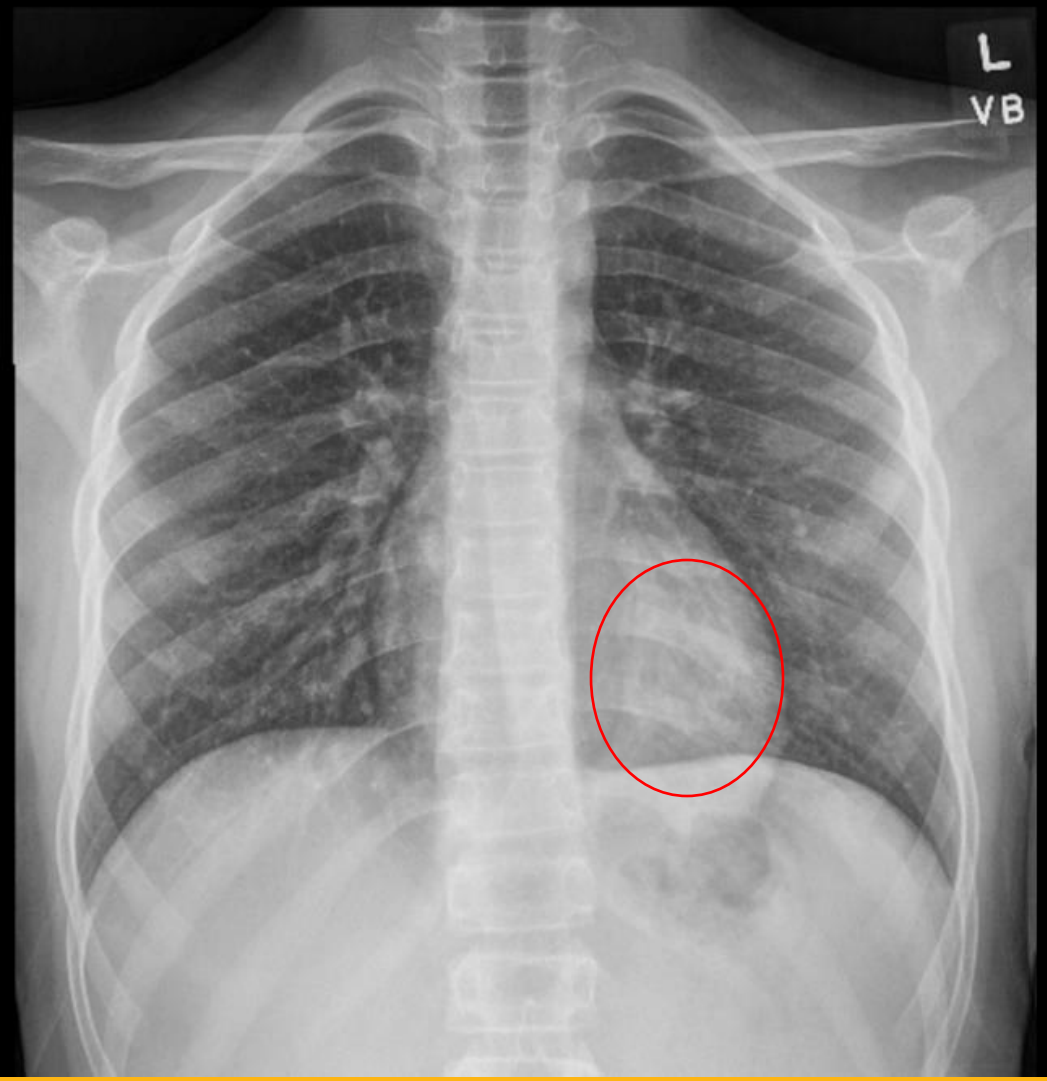


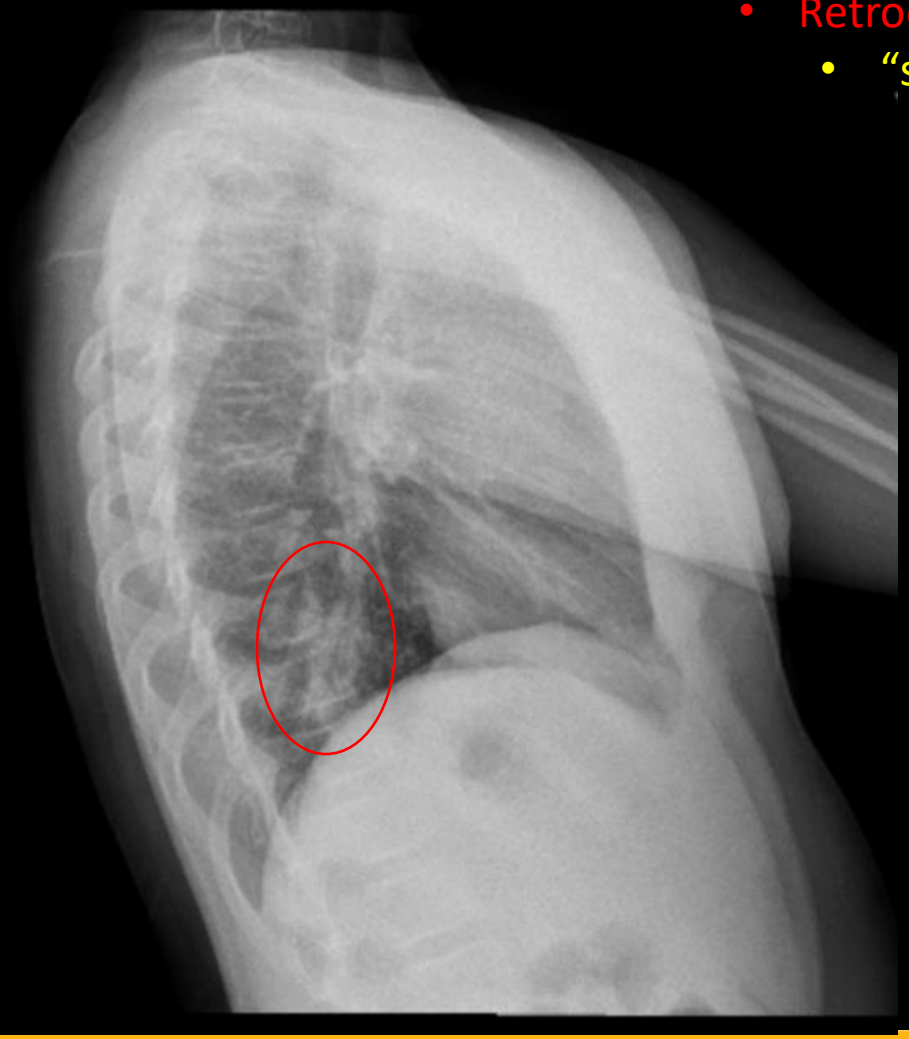
- Left perihilar opacity.
- Retrosternal clear space on the lateral view.

Fever and Cough



LLL Pneumonia





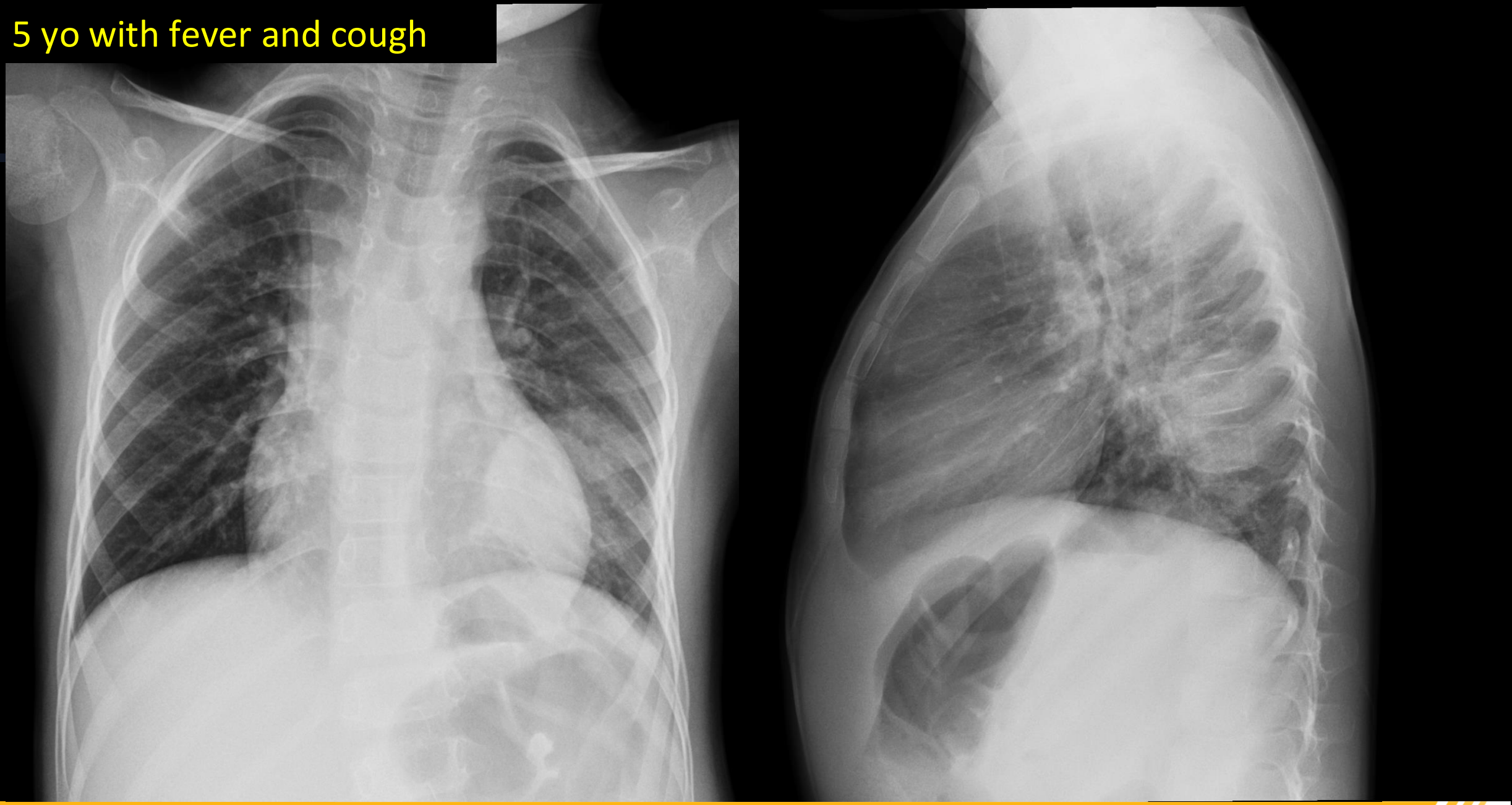
Tips:

- Retrocadiac opacity
  - “spine sign"

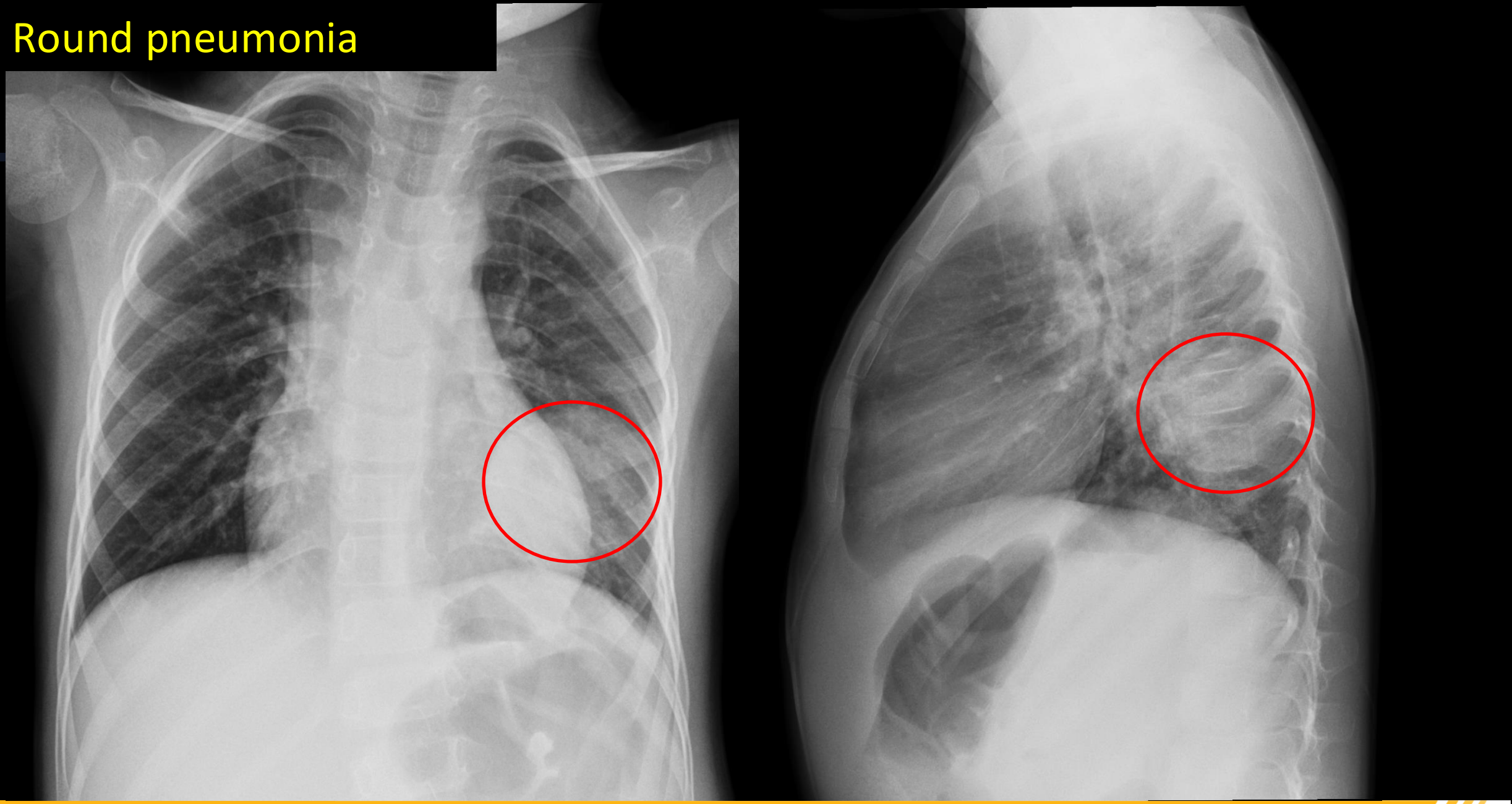
Take Home Point: Clear Spaces on the Lateral View

- Retrosternal
- Retrotracheal
- Retrocardiac

5 yo with fever and cough



Round pneumonia



Round Pneumonia

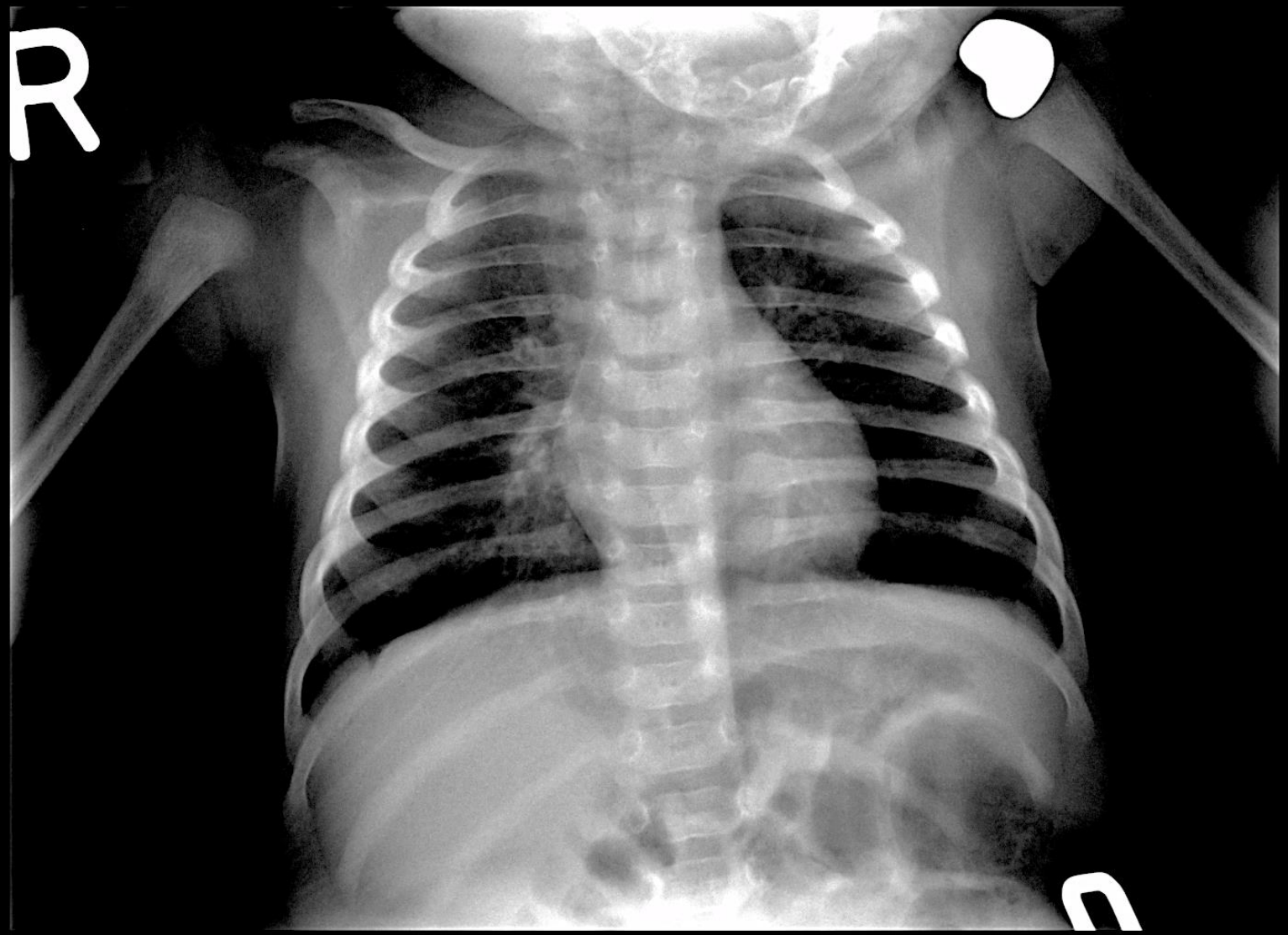
- **Population:** Primarily children **<8 years old** (mean age ~5 years).
- **Presentation:** Fever, cough, tachypnea, and generalized malaise.
- **Atypical Presentation:** Can present with **abdominal pain** or vomiting, mimicking an acute abdomen.
- **Etiology:** Most commonly **Streptococcus pneumoniae** (~90%).

- **Pathophysiology**
- **Immature Anatomy:** Young children have underdeveloped collateral ventilation pathways, specifically the **Pores of Kohn** and **Channels of Lambert**.
- **Centrifugal Spread:** Lack of these channels prevents the lateral spread of infection throughout the lobe. Instead, the infection spreads radially from a central focus, creating a **spherical consolidation**.
- **Resolution:** As children age and these pathways mature, pneumonia typically takes on the more familiar lobar appearance.

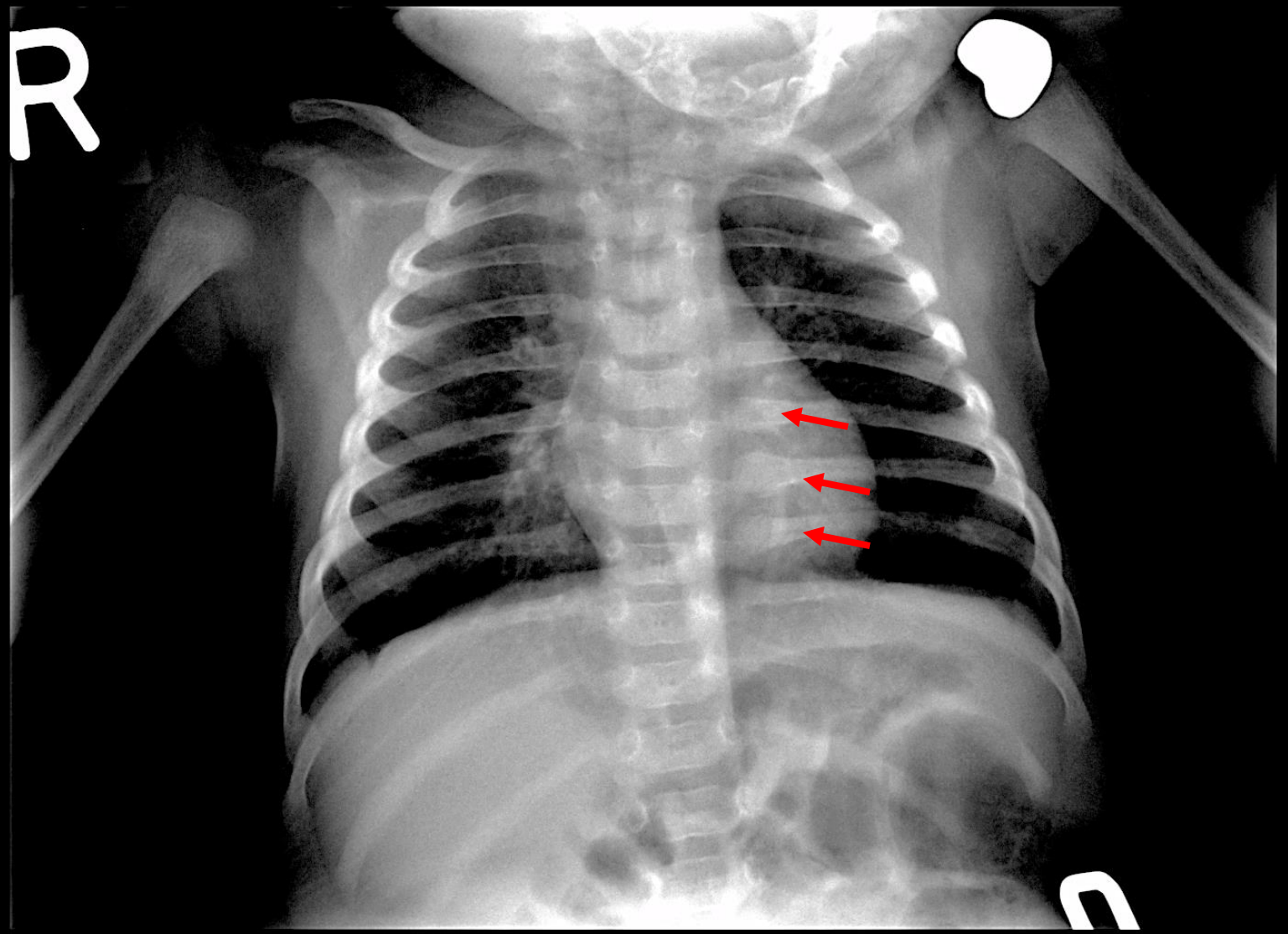
- **Imaging Hallmarks (CXR)**
- **Morphology:** Solitary, well-circumscribed, homogeneous round or oval opacity.
- **Location:** Predilection for **posterior segments of the lower lobes** (likely gravity-dependent).
- **Positive Signs: Air bronchograms** are present in ~20% of cases, helping to confirm a parenchymal process rather than a solid mass.
- **Negative Signs:** Characteristically **lacks** cavitation, calcification, or associated pleural effusion.

Follow-up 4 weeks later, after antibiotics

6 month old with fever and cough



Healing posterior rib fractures



American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: Suspected Physical Abuse — Child

Variant 1: Child 24 months of age or younger, no focal neurologic signs or symptoms.

Radiologic Procedure	Rating	Comments	RRL*
X-ray skeletal survey	9		☢☢☢
CT head without contrast	7	Particularly for patients who are at "high risk" (eg, with rib fractures, multiple fractures, or facial injury, or less than 6 months of age).	☢☢☢
MRI head without contrast	5	If further evaluation is indicated after CT examination.	O
MRI head without and with contrast	5	If further evaluation is indicated after CT examination. Administration of contrast is suggested if indicated due to prior CT findings or findings on noncontrast portion of MRI. See statement regarding contrast in text under "Anticipated Exceptions."	O
Tc-99m bone scan whole body	4	If skeletal survey is negative and high clinical suspicion remains.	☢☢☢
CT head without and with contrast	1		☢☢☢☢
CT head with contrast	1		☢☢☢

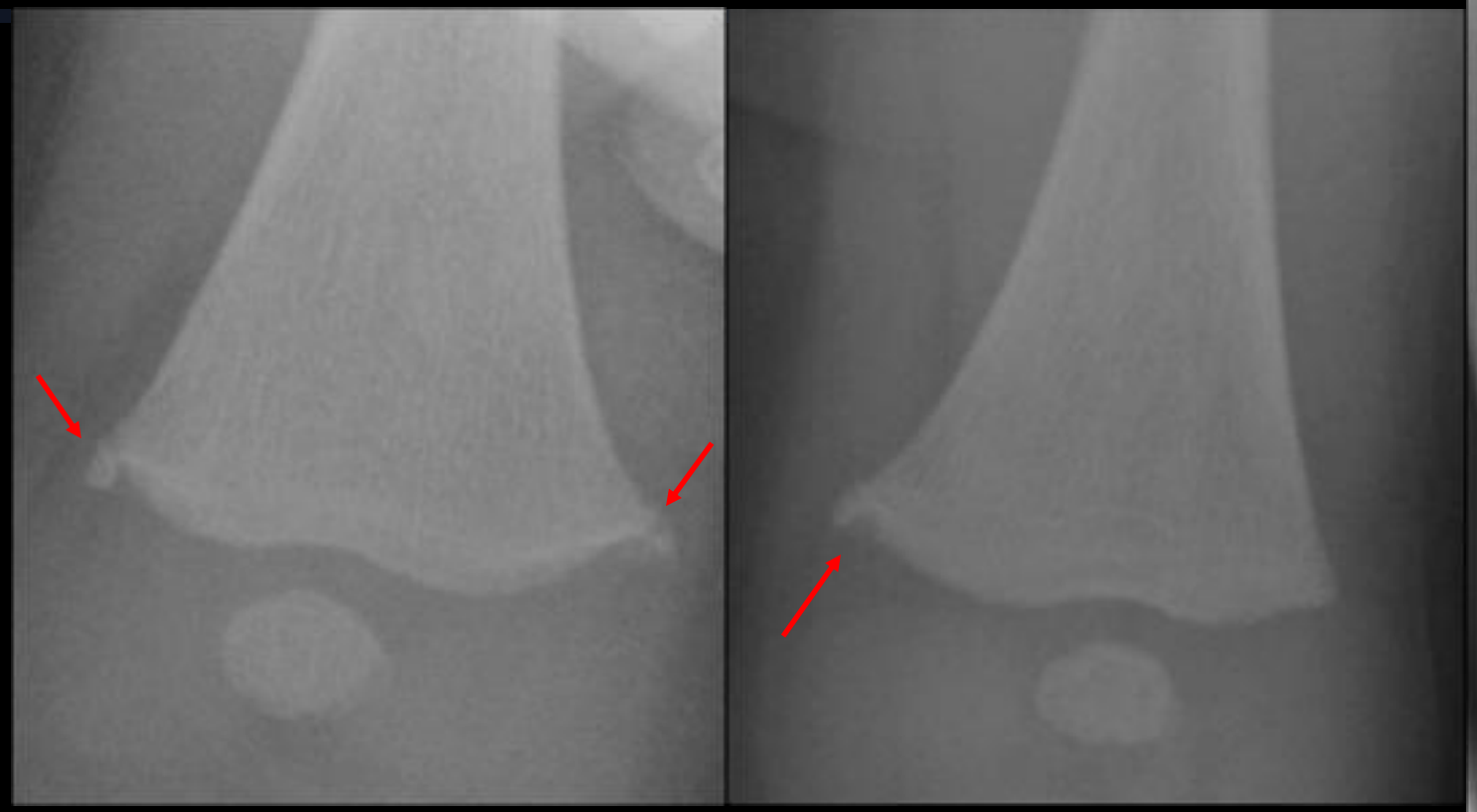
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

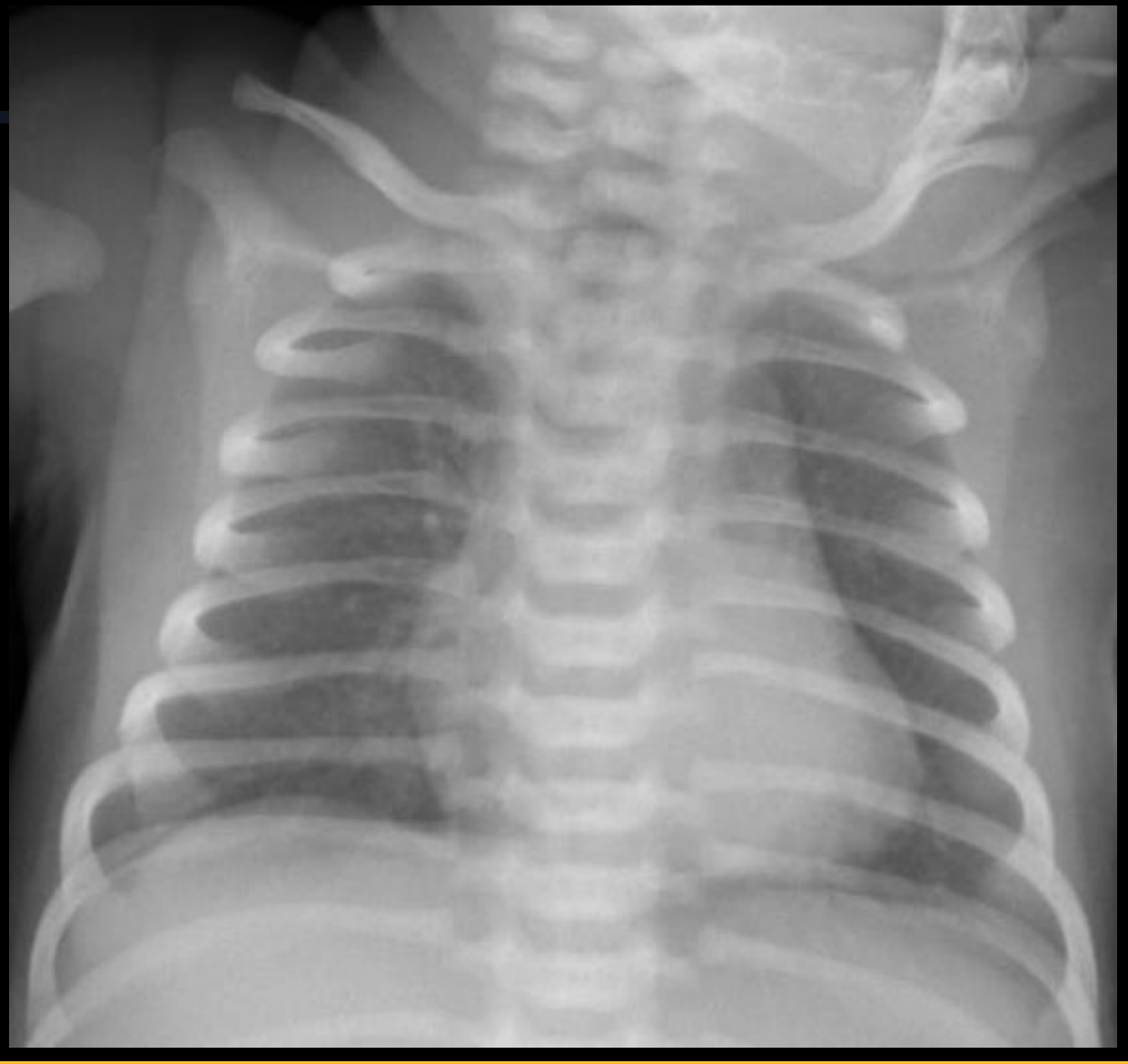
Posterior Rib Fractures: A Red Flag for Non-Accidental Trauma (NAT)

- **High Specificity:** Posterior rib fractures—specifically near the costovertebral articulation—have a PPV for abuse as high as **95%** in children under 3.
- **Mechanism of Injury:** Typically caused by **manual thoracic compression** (e.g., squeezing the chest) rather than direct impact or CPR.
- **The CPR Myth: While vigorous CPR can cause anterior or lateral rib fractures, it is extremely rare for it to cause posterior fractures.**
- **Radiographic Challenge:** Acute fractures are often **occult** on initial frontal X-rays; they are frequently only identified once callus formation (healing) appears 7–14 days later.
- **Next Steps:** If a posterior rib fracture is identified, a full **skeletal survey** and evaluation by a child abuse pediatrician are mandatory.

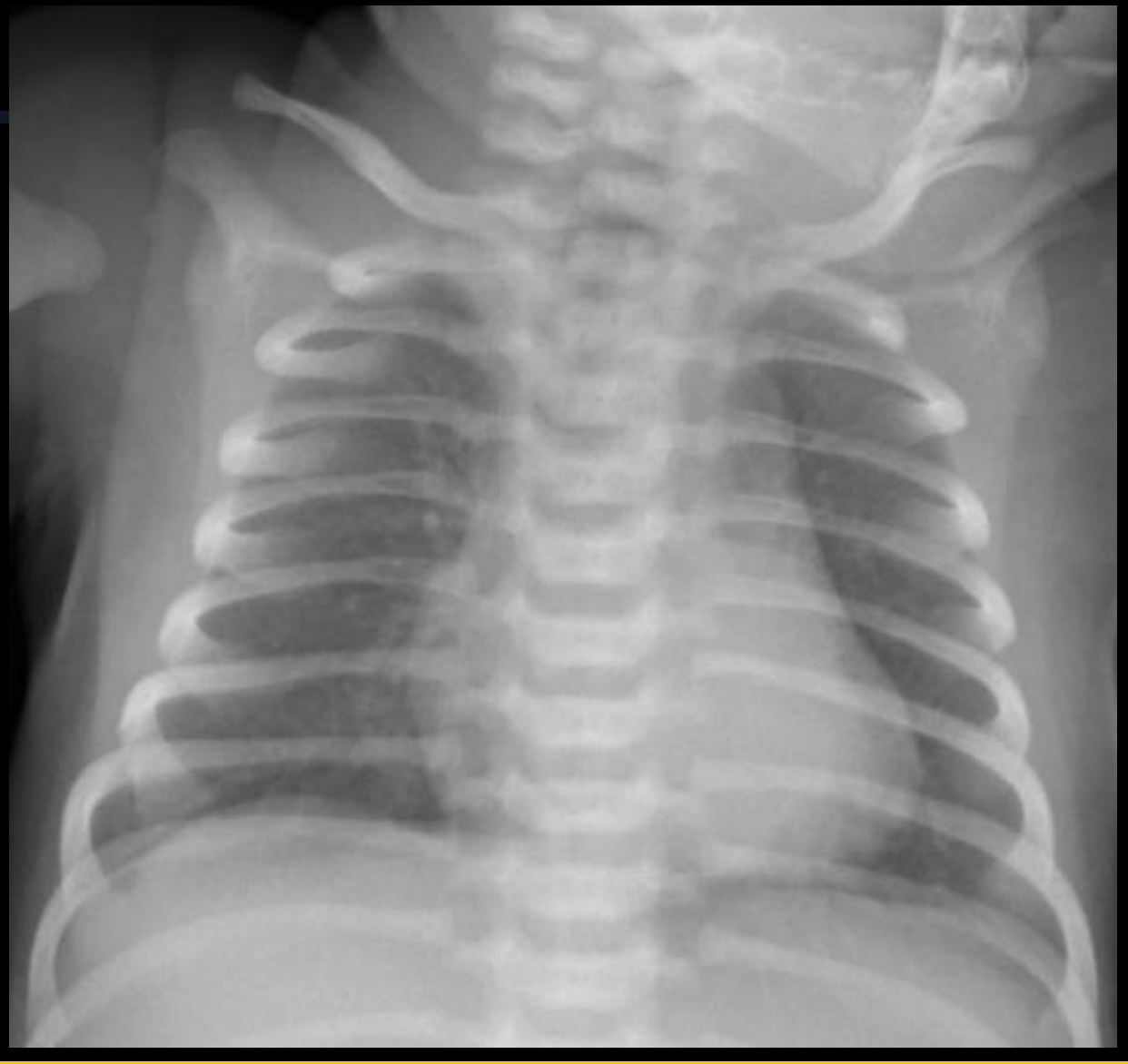
Bucket handle or corner fracture
“classic metaphyseal lesion” fractures



1 yo with fever and cough



? Bronchiolitis with LLL atelectasis or pneumonia



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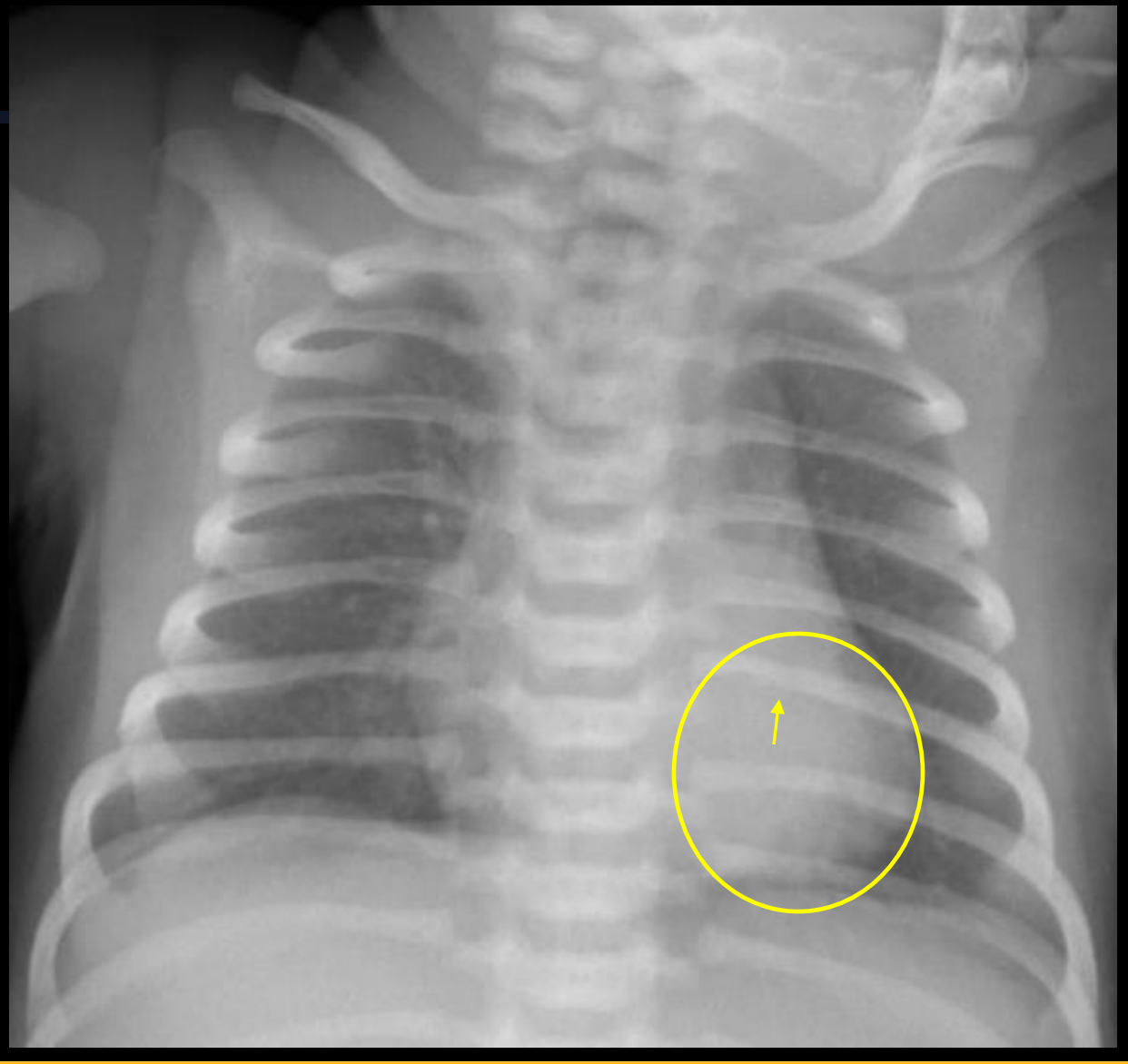
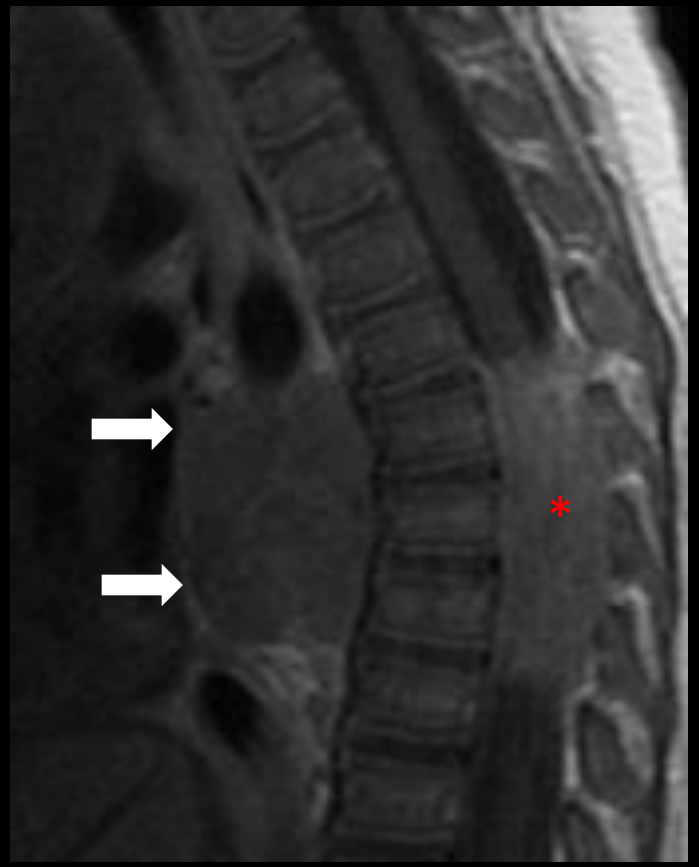
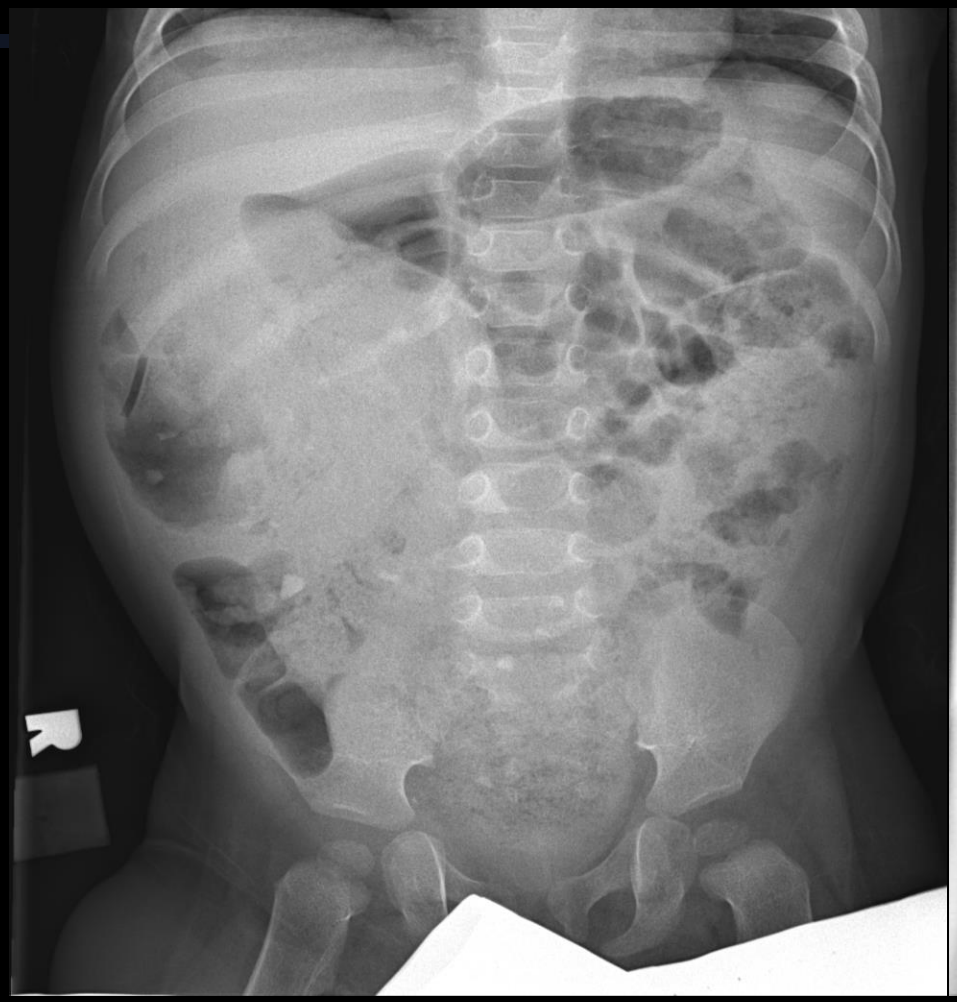


3 months later presents with signs of spinal cord compression

Thoracic neuroblastoma with intraspinal extension (*)

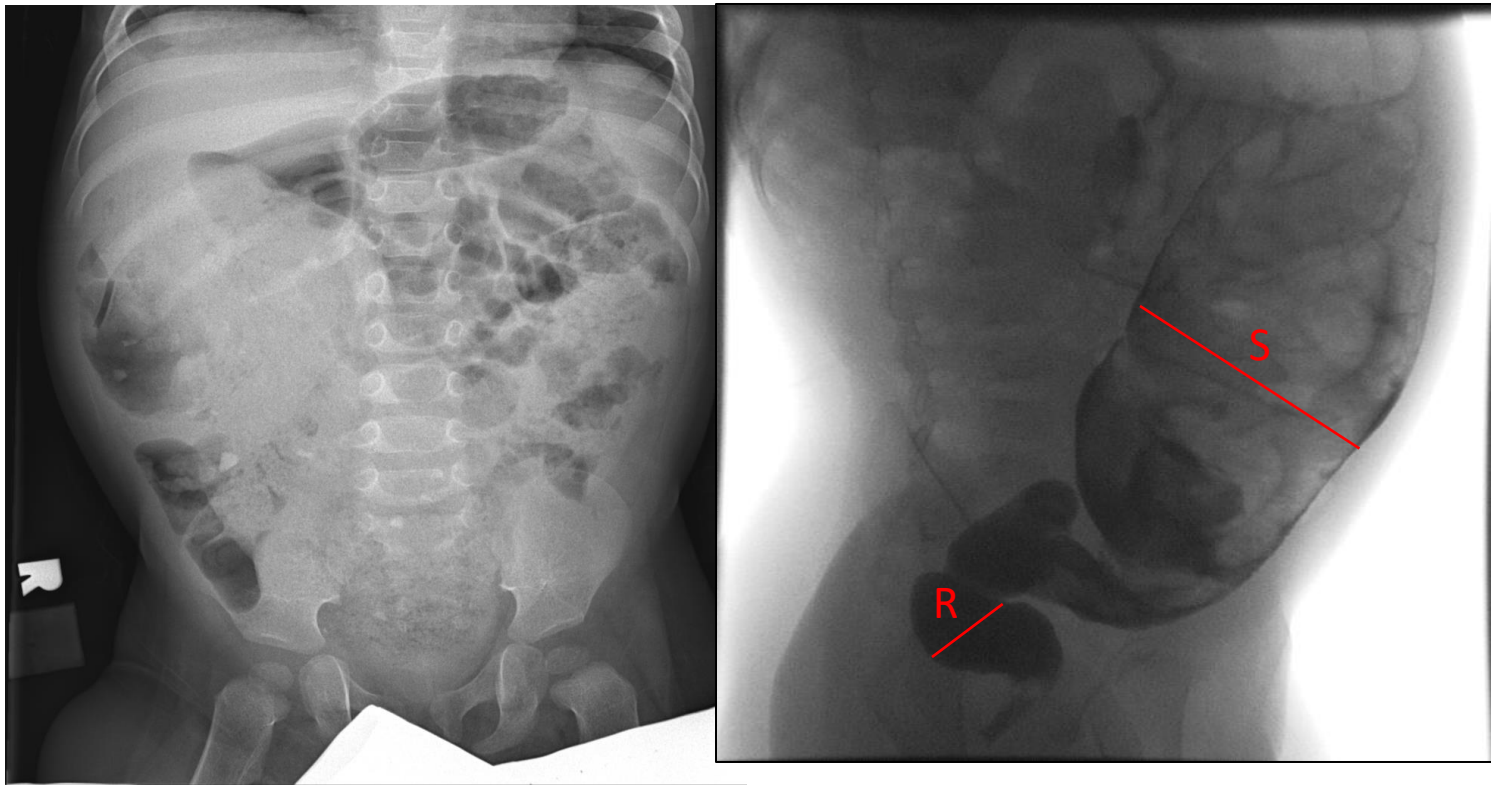


2 yo presenting to the UC with abdominal distension



Constipation in Children

- **Common**
  - 3-5% of sick visits to pediatrician
  - Up to 48% of ED visits for abd pain*
  - 1/3 of children ages 6-12
- **95% cases functional**
  - Behavioral
  - Diet
  - Early toilet training
- **Organic causes**
  - Hirschsprung's dz
  - Anatomic abnormality
    - Anorectal malformations
    - Mass
  - Metabolic d/o
  - Cystic fibrosis



Abnl Rectosigmoid Index >1

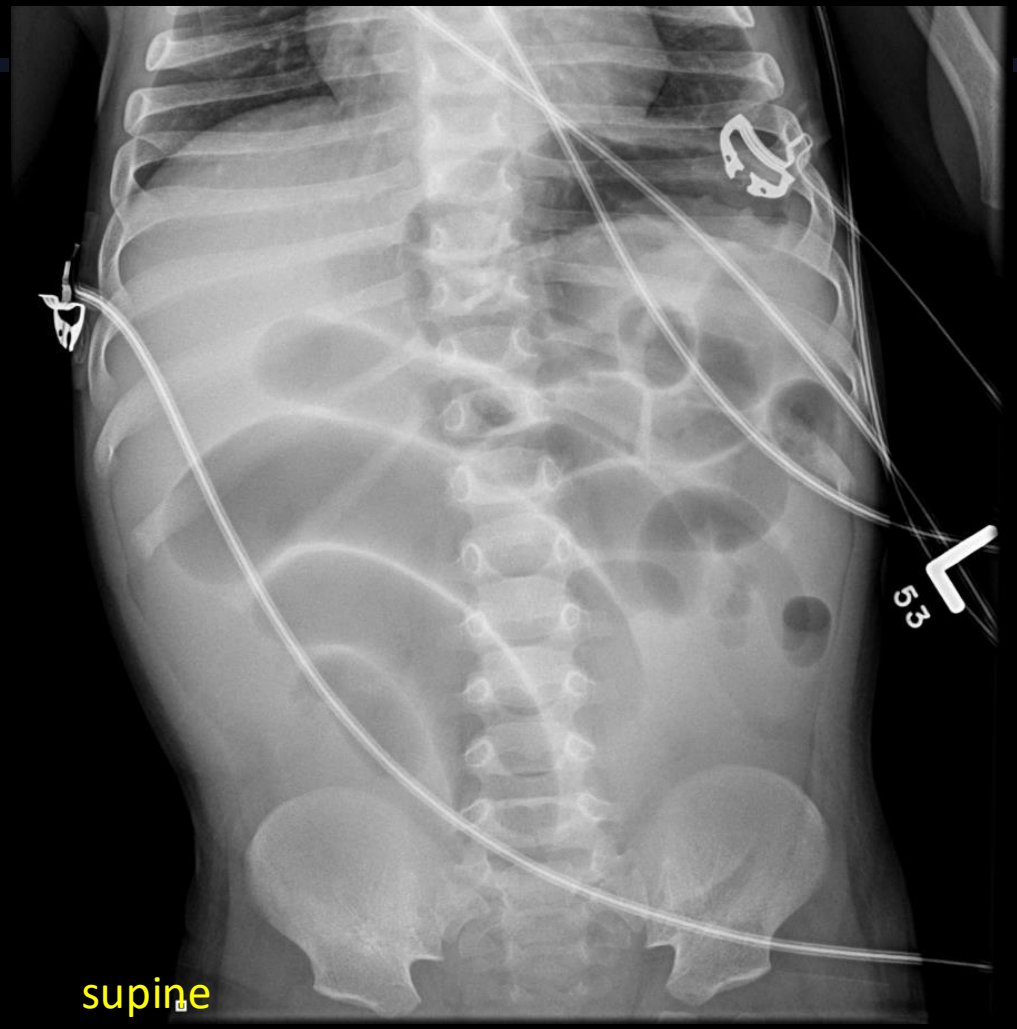
* Loenin-Baucke, V. Constipation as Cause of Acute Abdominal Pain in Children. *J Pediatr 2008; 151:666-9*

8 year old with constipation

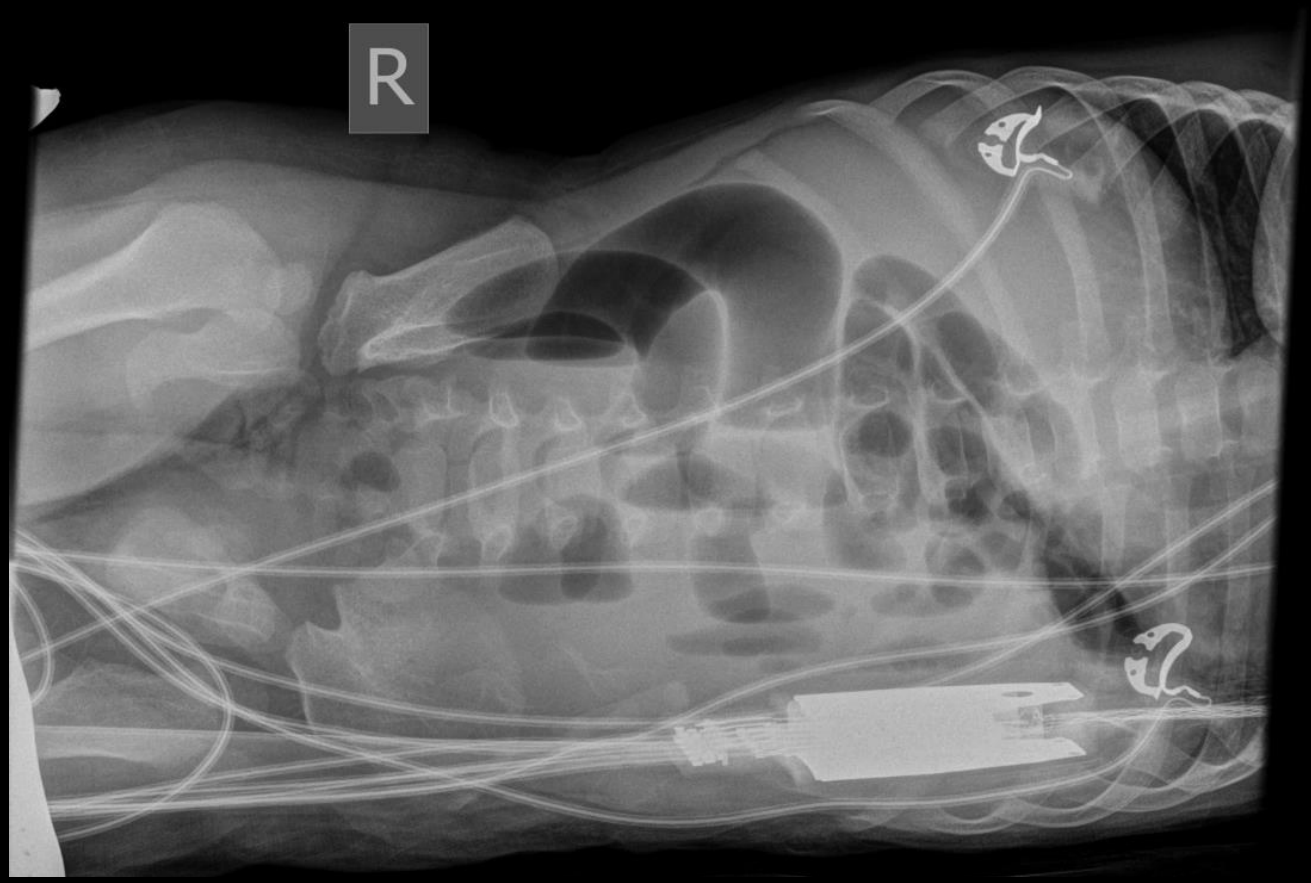
Paucity of bowel gas, little stool

Uterine Embryonal Rhabdomyosarcoma

1 yo with emesis, and abdominal pain

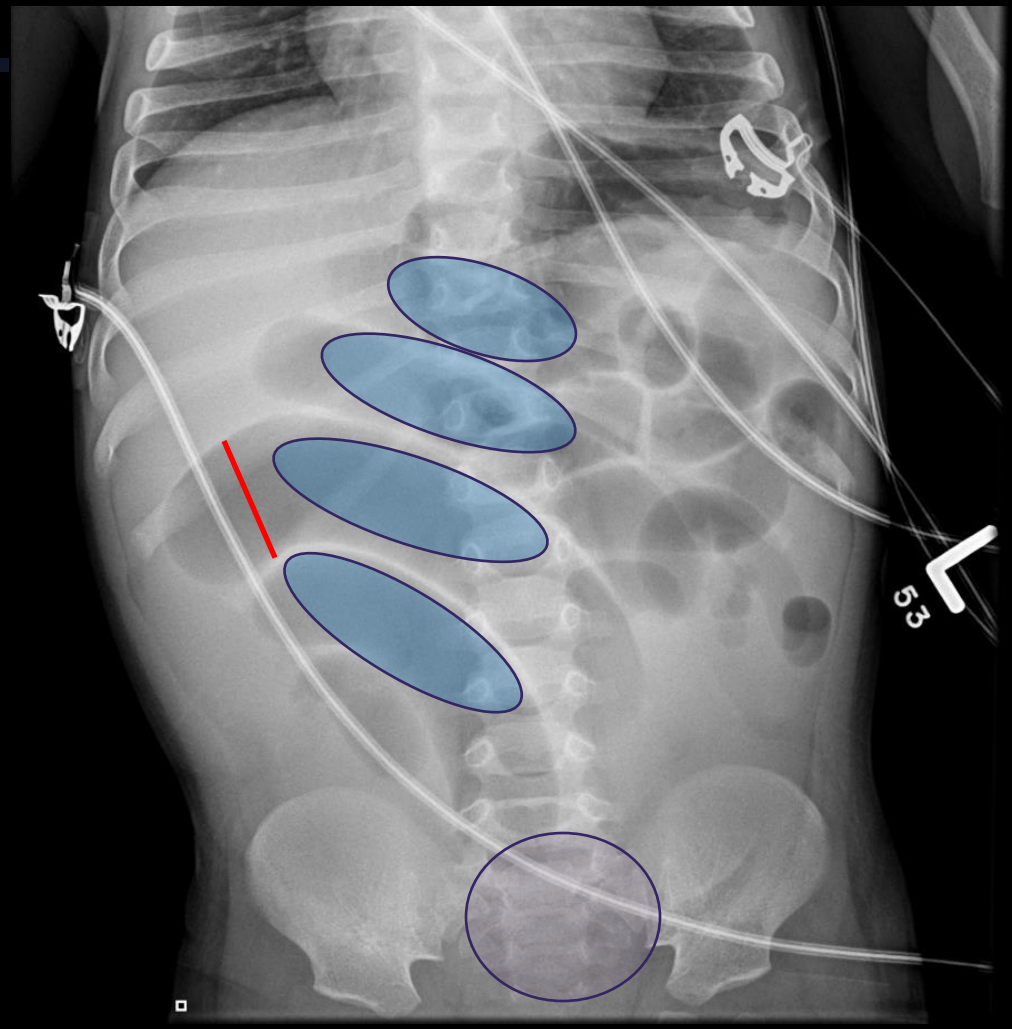


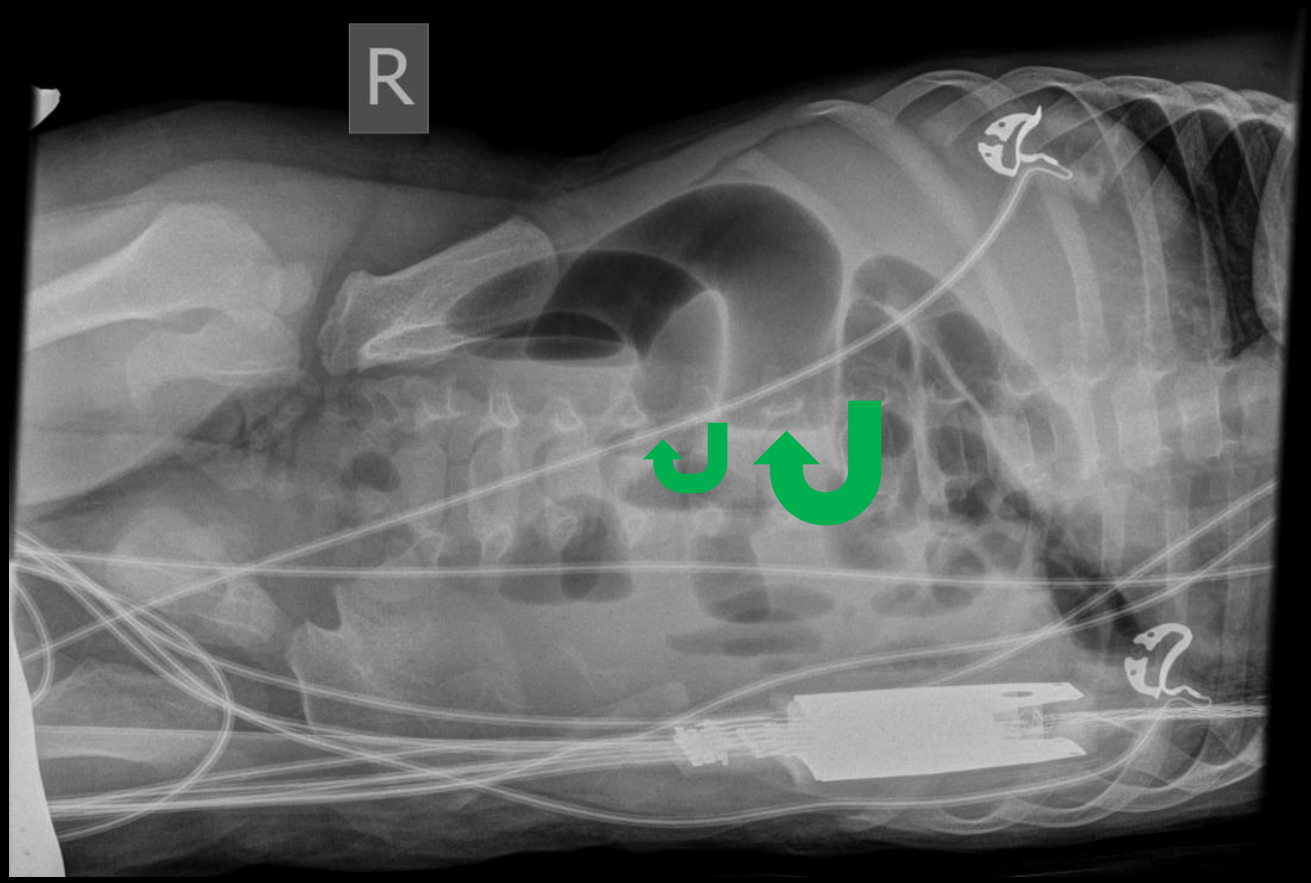
supine



decubitus

1 yo with Small Bowel Obstruction: dilated bowel, stacked configuration, air-fluid levels, lack of distal colonic gas





Pediatric Small Bowel Obstruction: A Diagnostic Framework

- **The "AAIIMM" Mnemonic (Older Children):**
  - **A:** Adhesions
  - **A:** Appendicitis
  - **I:** Intussusception (most common)
  - **I**: Inguinal hernia
  - **M:** Meckel diverticulum
  - **M:** Malrotation with midgut volvulus

Intussusception

- **90% “idiopathic” (hypertrophied lymphoid tissue)**
- **3 months to 3 years**
- **Post-viral**
- **Winter/Spring**

Intussusception: Clinical Presentation

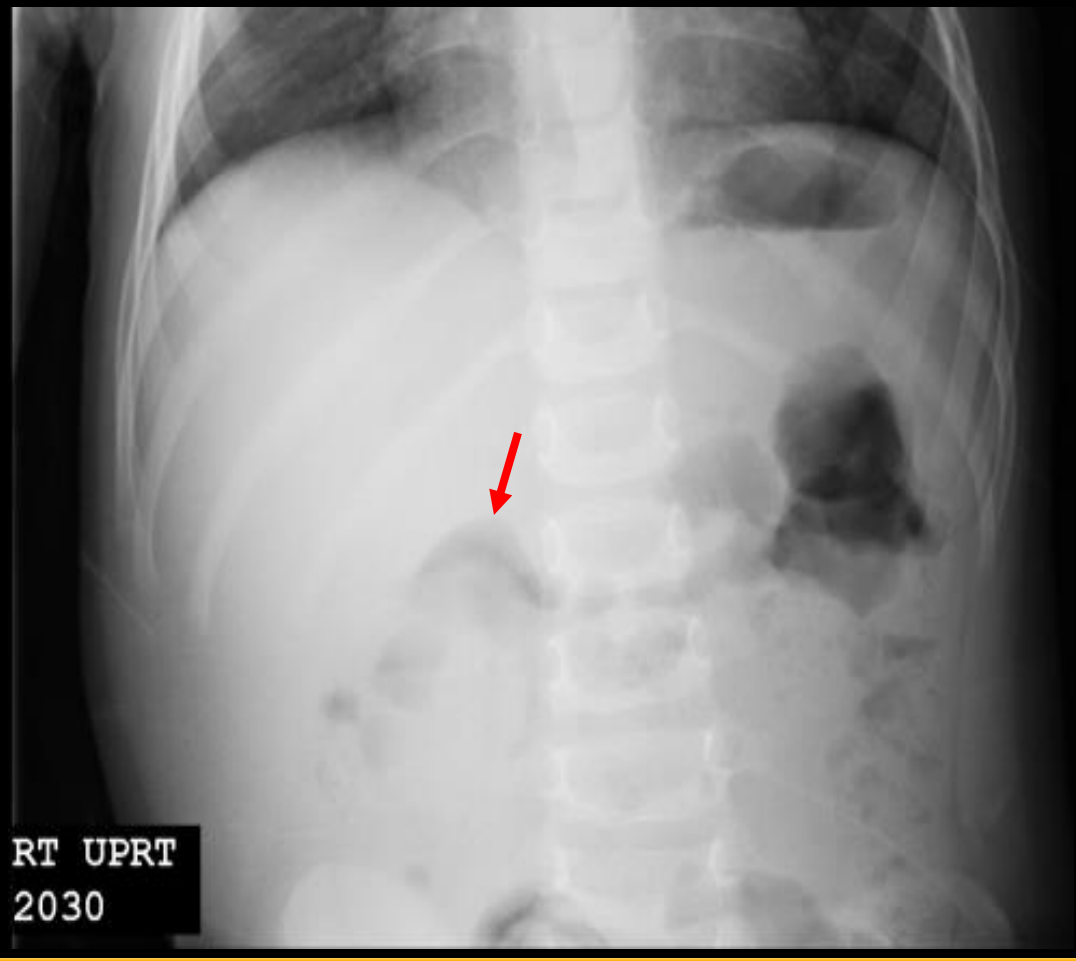
- **Abdominal pain, intermittent**
- **Bloody stool**
- **Abdominal mass**
- **Lethargy**

Classic triad < 50%

Plain film findings: intussusception

Target Sign

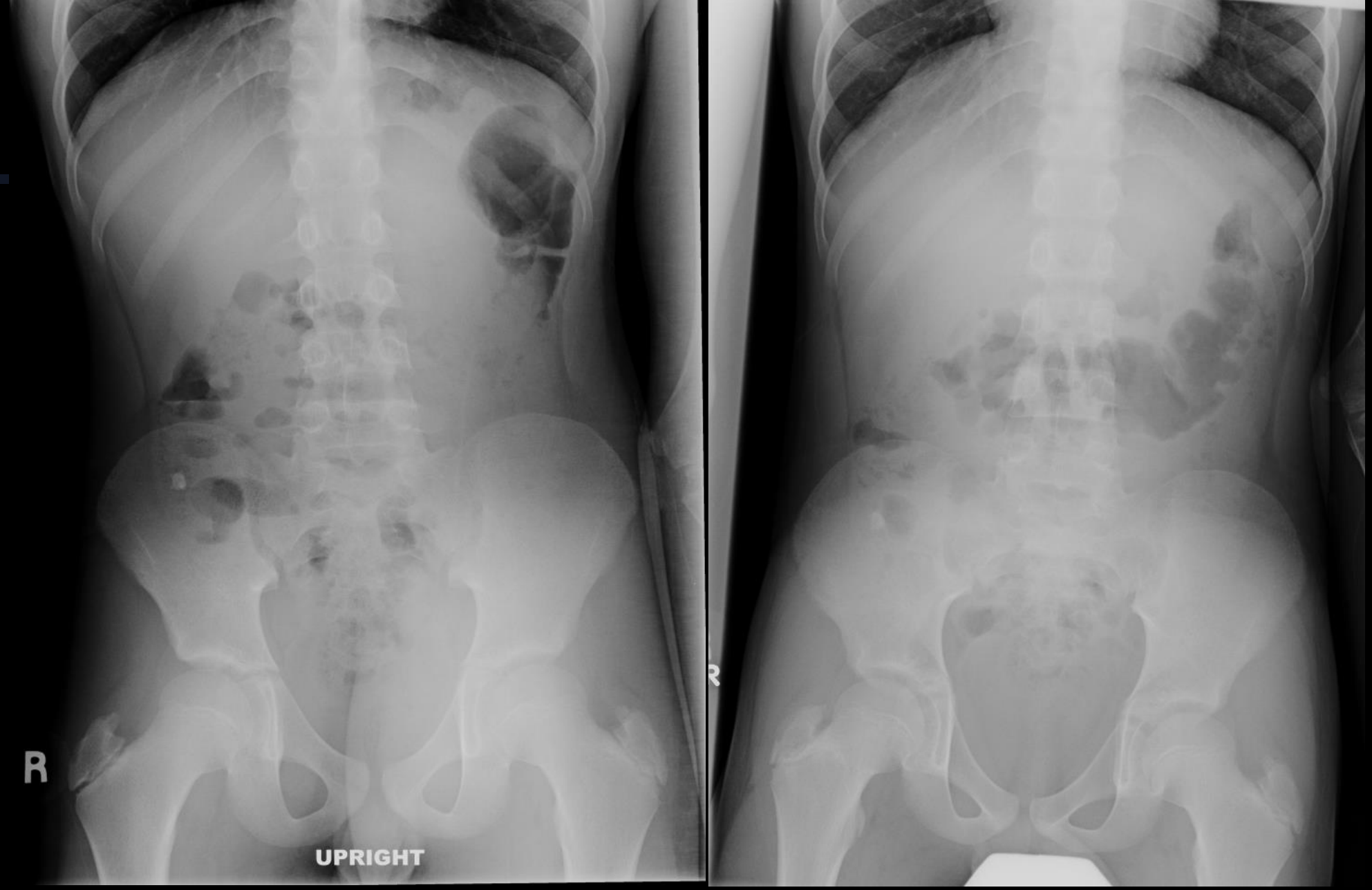
Crescent Sign



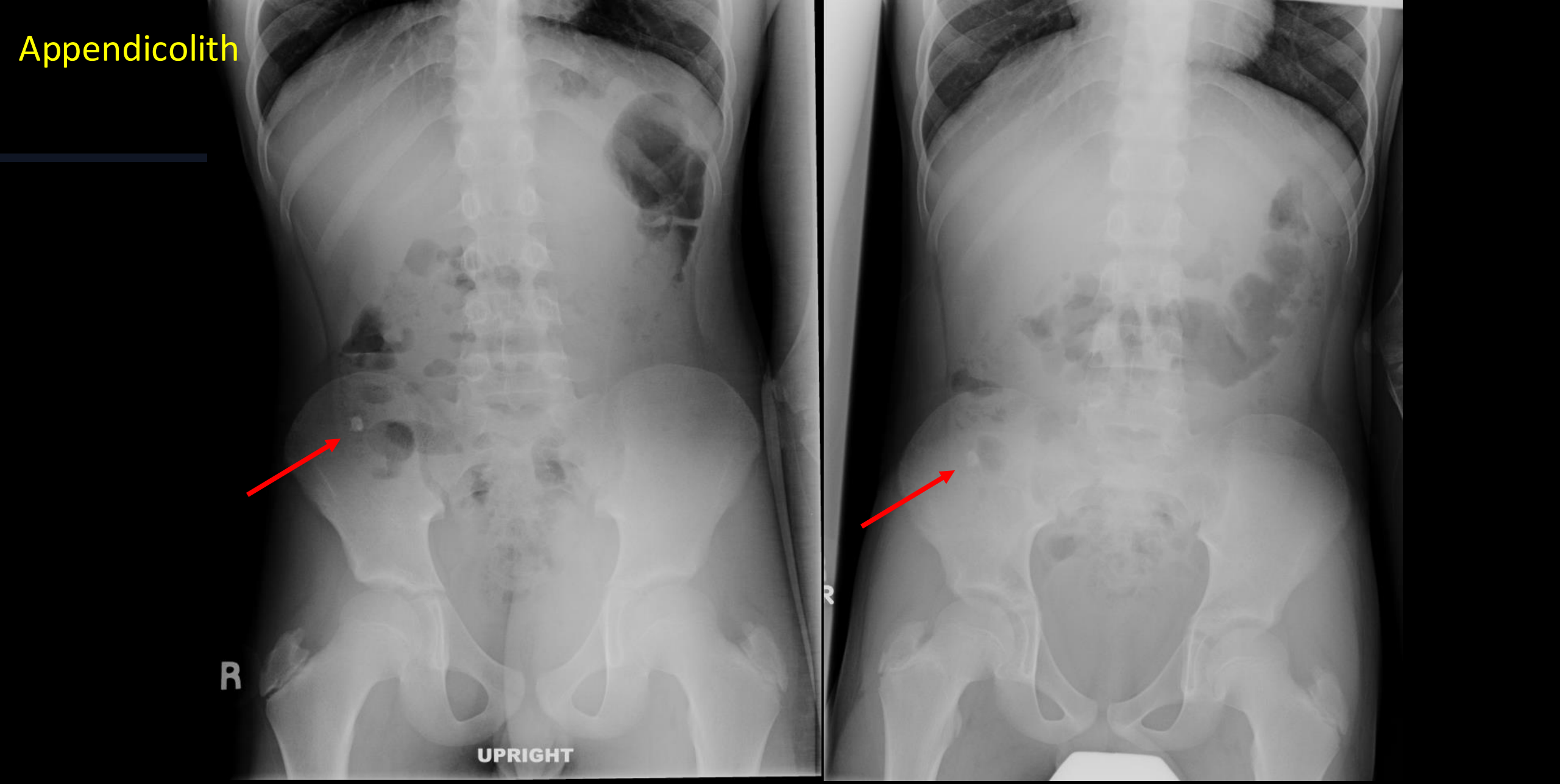
Intussusception: Radiographic Clues and Pitfalls

- **Low Sensitivity:** X-rays detect intussusception only 25%–50% of the time and can't rule it out if suspicion is high.
- **Target Sign:** A soft-tissue mass often seen in the RUQ.
- **Meniscus Sign:** Crescent-shaped air pocket at the intussusceptum's leading edge.
- **Complications Screening:** Used to detect pneumoperitoneum or severe small bowel obstruction, which prevent non-surgical treatment.
- **Gold Standard:** Ultrasound offers nearly 100% accuracy, showing the characteristic "target" or "donut" sign.

RLQ pain



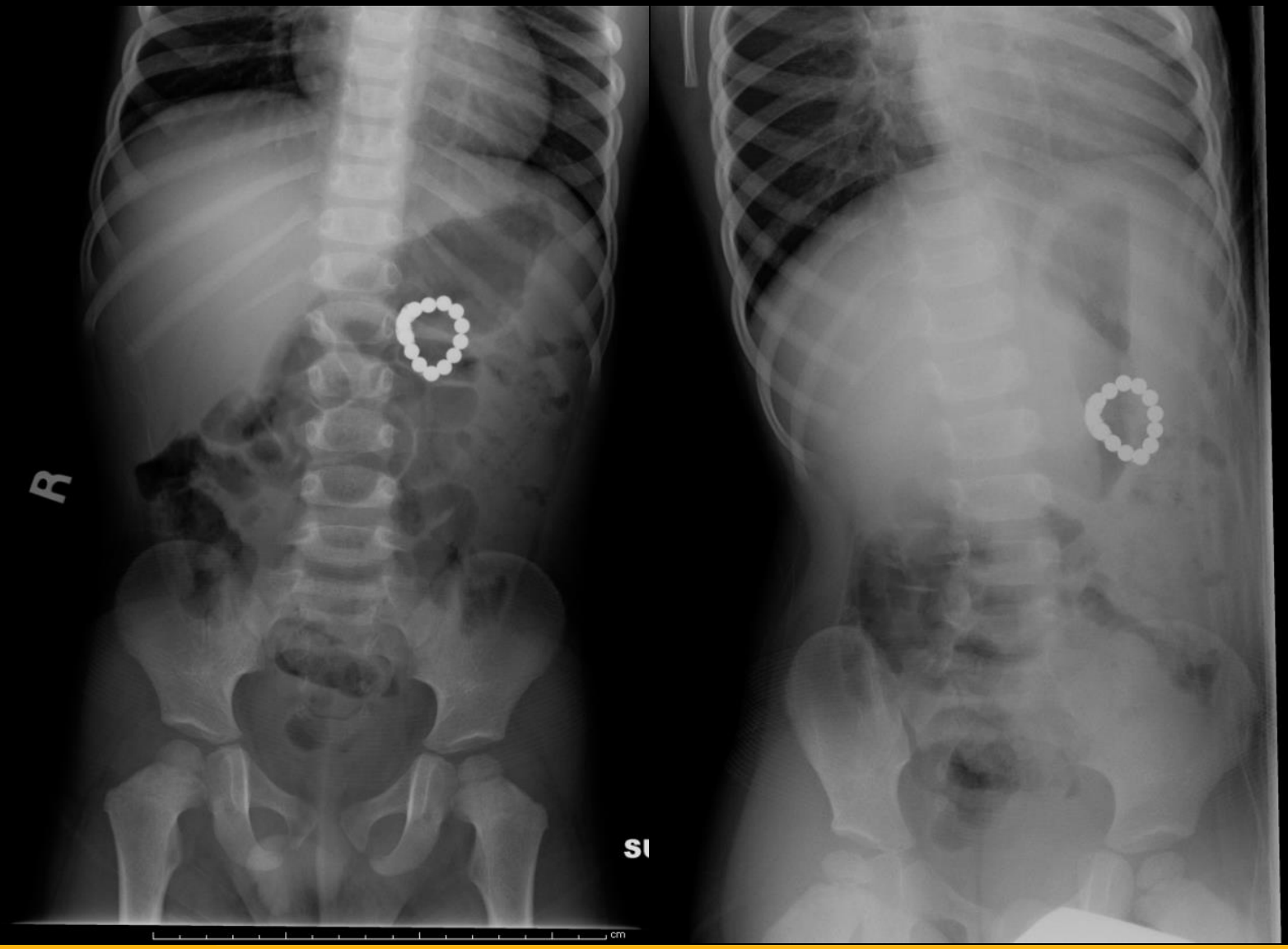
Appendicolith



The Appendicolith: A Subtle Clue in the Right Lower Quadrant

- **Radiographic Appearance:** Small (<1 cm), well-defined calcification in the **Right Iliac Fossa**.
- **Clinical Significance:** Seen in about **10% of children** with appendicitis, increasing diagnostic accuracy.
- **Complication Risk:** Linked to higher chances of **appendiceal perforation** and abscess formation.
- **Differentiation:** Should be distinguished from **phleboliths**, teratomas, or lymph node calcifications.
- **Treatment:** Often indicates failure of antibiotic-only treatment, requiring **surgery**.

R/o foreign body



Foreign Body Ingestion

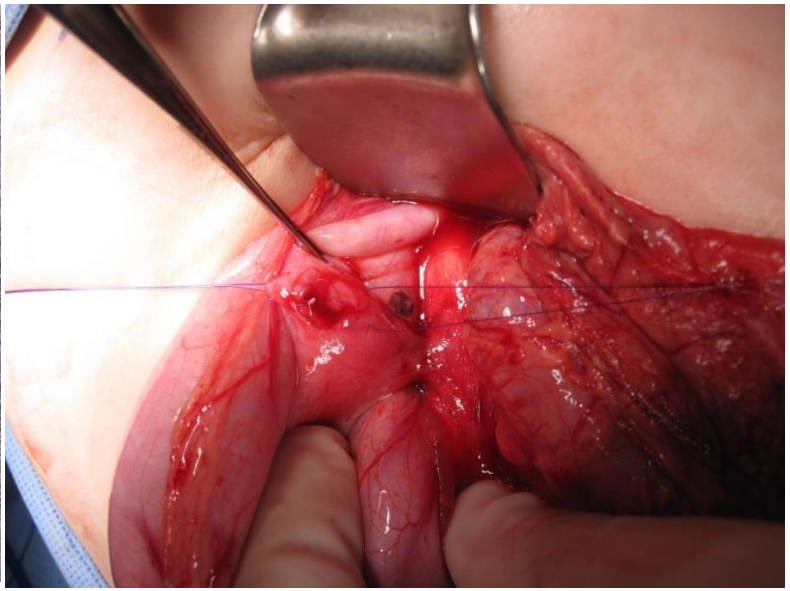
- American Poison Control Center: 99,875 FB ingestion in 2014

- Most FB ingestion benign
  - Distal to esophagus

- Exceptions:
  - Magnets
  - Button Battery

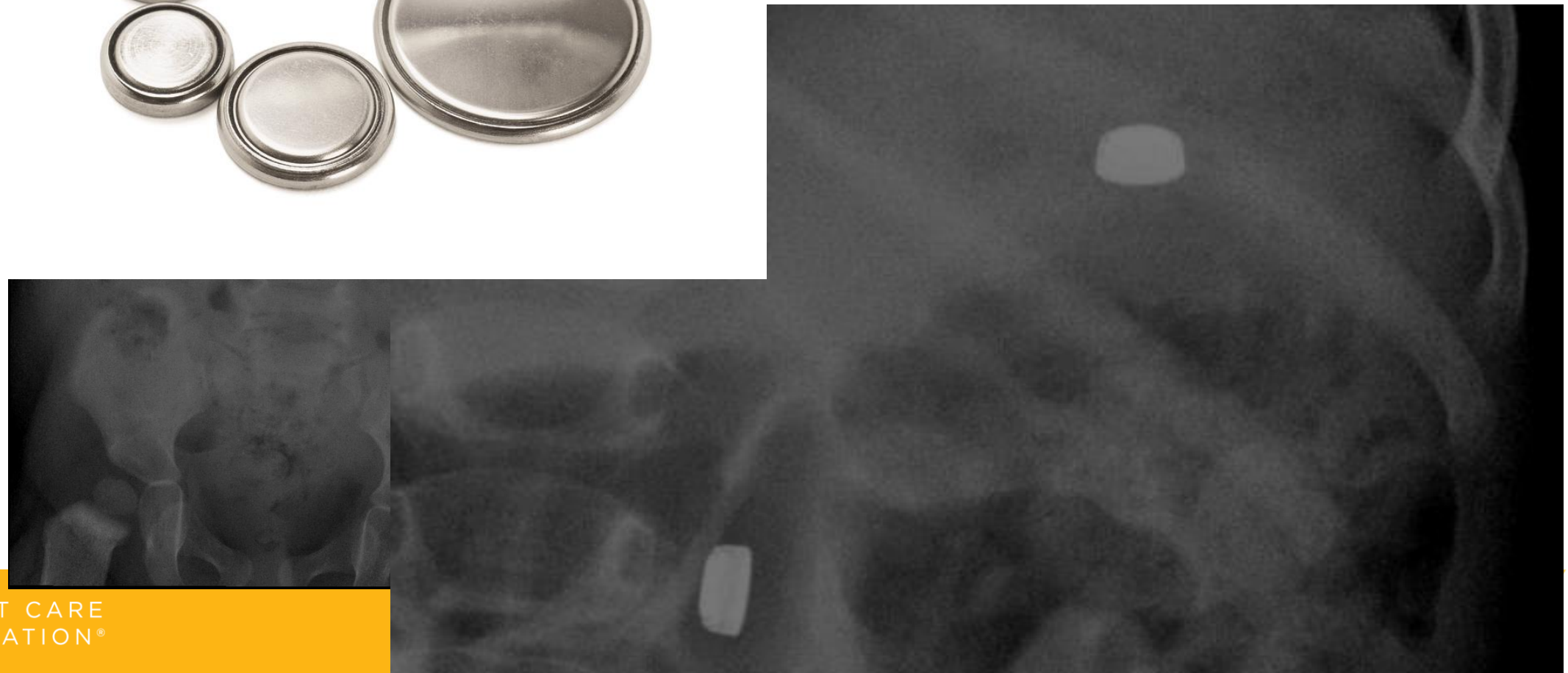
- 8.5 x increase in magnet ingestion from 2001 – 2011

Ingestion of magnet foreign bodies → multiple bowel perforations



- Ingestion of multiple magnets is an ominous scenario
- Located in different bowel loops, attract each other → pressure necrosis → bowel perforation.

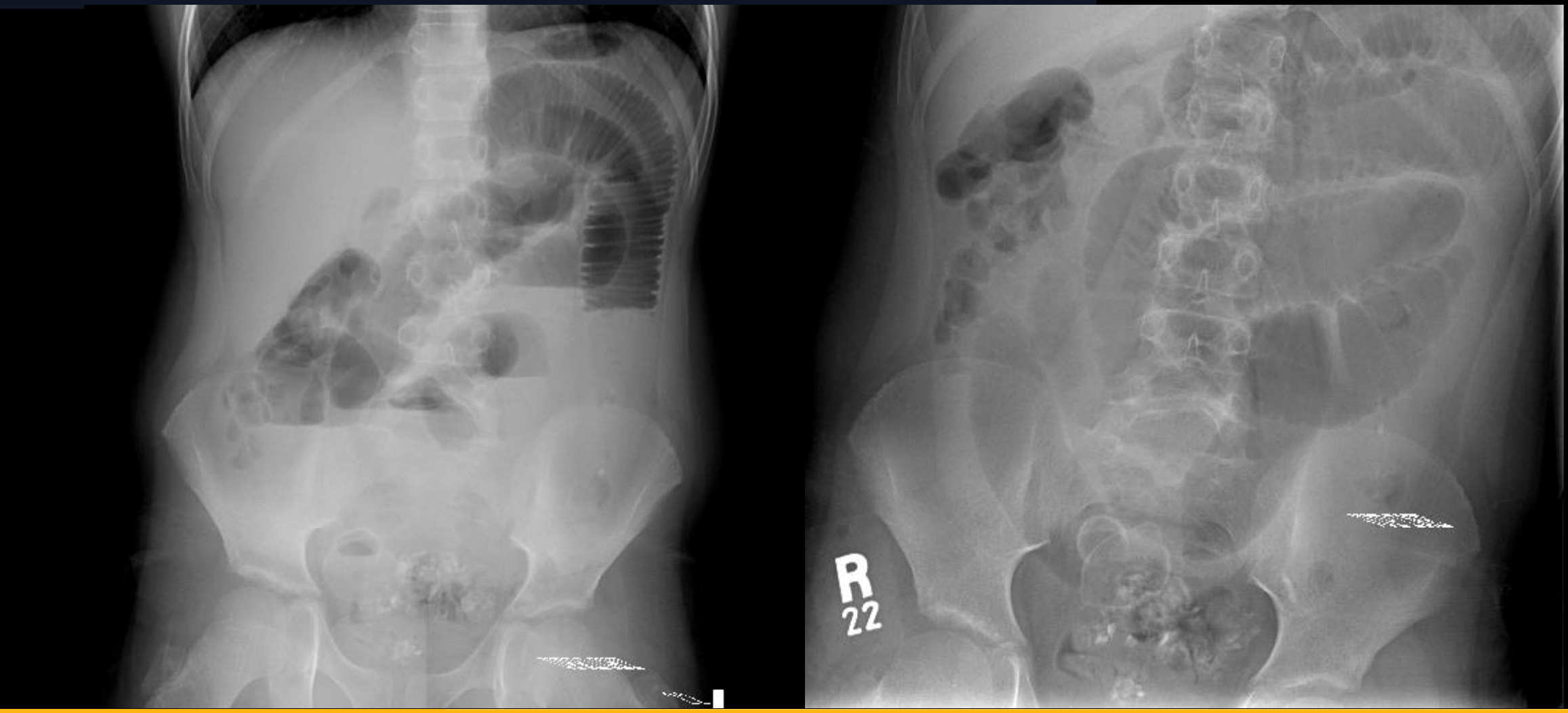
10 month old with foreign body ingestion

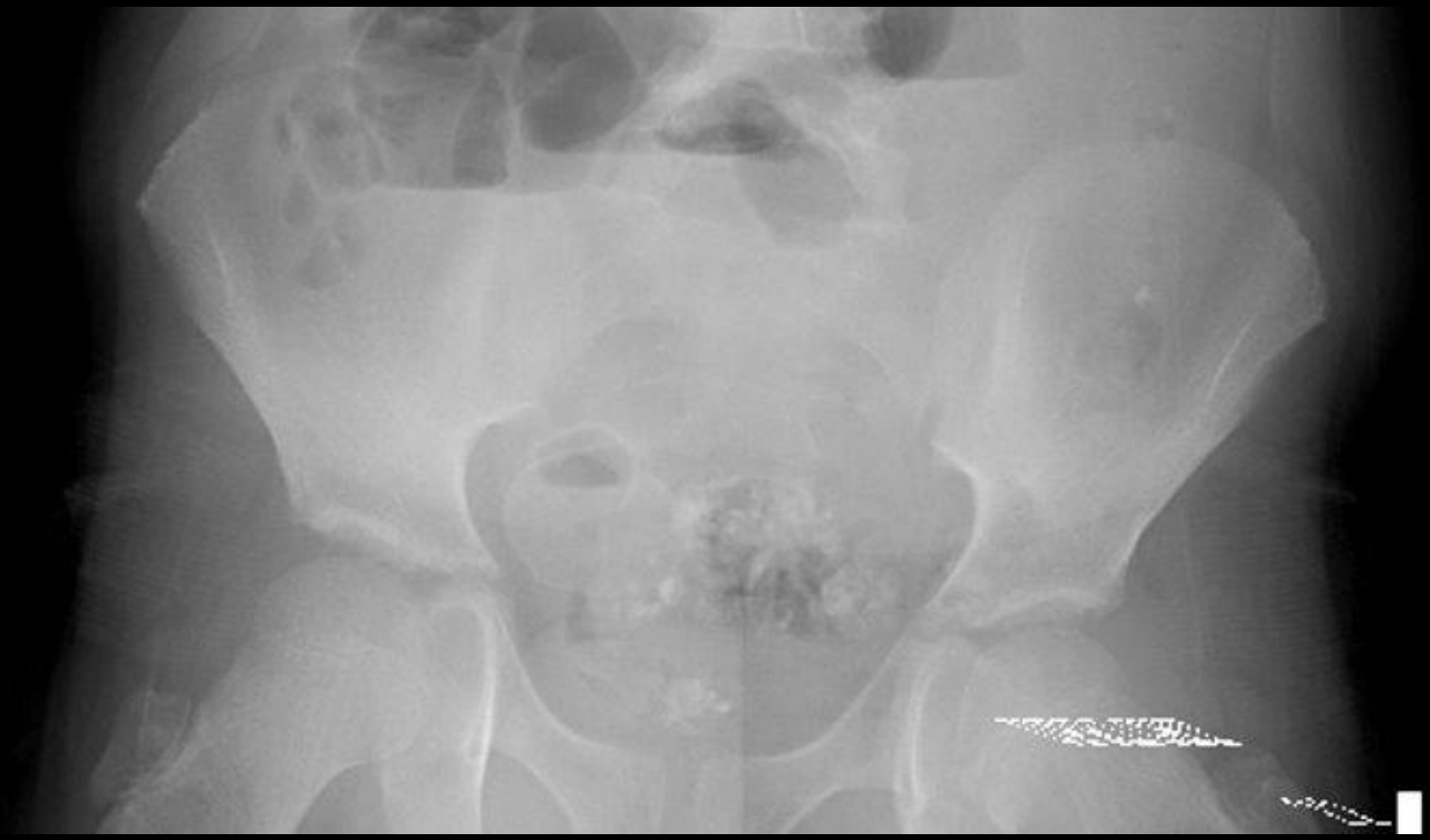


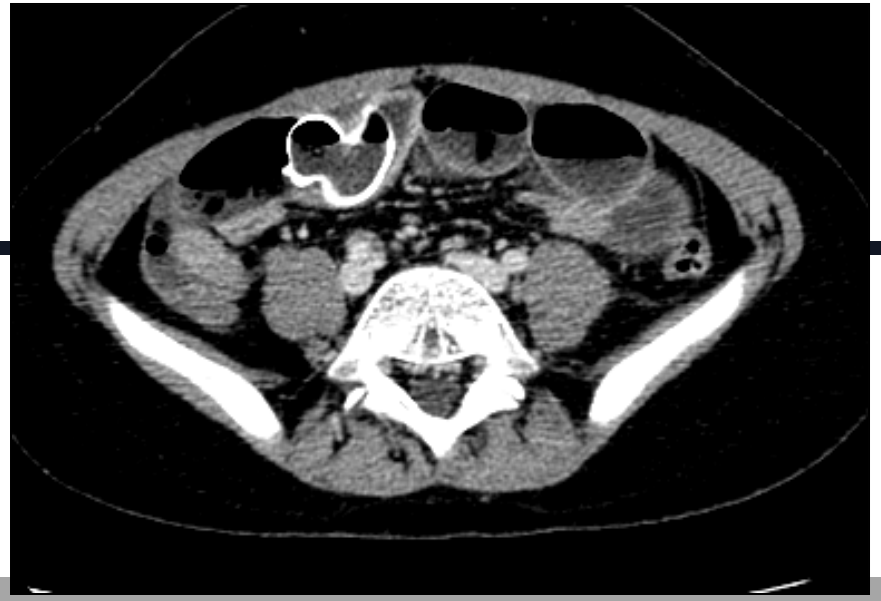
Button Battery Ingestion: "Double-Ring"

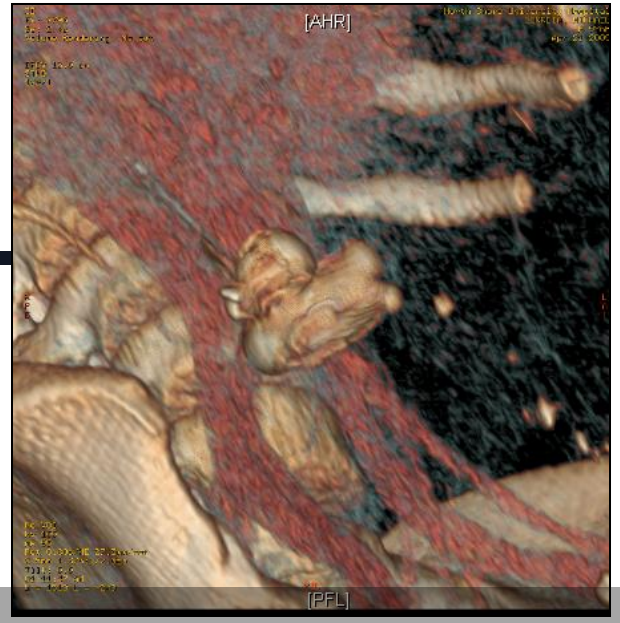
- **The "Halo" Sign (Frontal View):** A characteristic **double-rim** or "circle-within-a-circle" appearance caused by the battery's unique internal structure.
- **The "Step-Off" Sign (Lateral View):** A distinct profile change or "step" where the two halves of the battery meet; this is the most reliable way to confirm it is not a coin.
- **Mechanism of Injury:** Rapid caustic damage via **electrolysis** at the negative pole; can cause esophageal perforation or tracheoesophageal fistula in as little as **2 hours**.
- **Location Matters:**
  - **Esophagus:** A true surgical emergency requiring immediate endoscopic removal.
  - **Stomach:** May be observed if the child is asymptomatic, but consider removal if the battery is >20mm or remains for >48 hours.

9-year-old autistic male with emesis









Diagnosis: Foreign Body Ingestion

Conclusion

- Signs of pneumomediastinum can be subtle, check neck soft tissues and lateral view along the mediastinum and pulmonary artery
- Clear spaces on the lateral view should be clear, remember to check them
- Round PNAs occur in kids <8yo, if older consider other causes
- Check bones for unexpected findings such as posterior rib fractures
- Remember organic causes of constipation such as Hirschsprungs disease and pelvis masses
- DDx of SBO --> AAIIMM
- Beware of magnets and battery FBs

I Need Your Feedback

Scan the QR code to submit your feedback digitally.

Prefer paper?

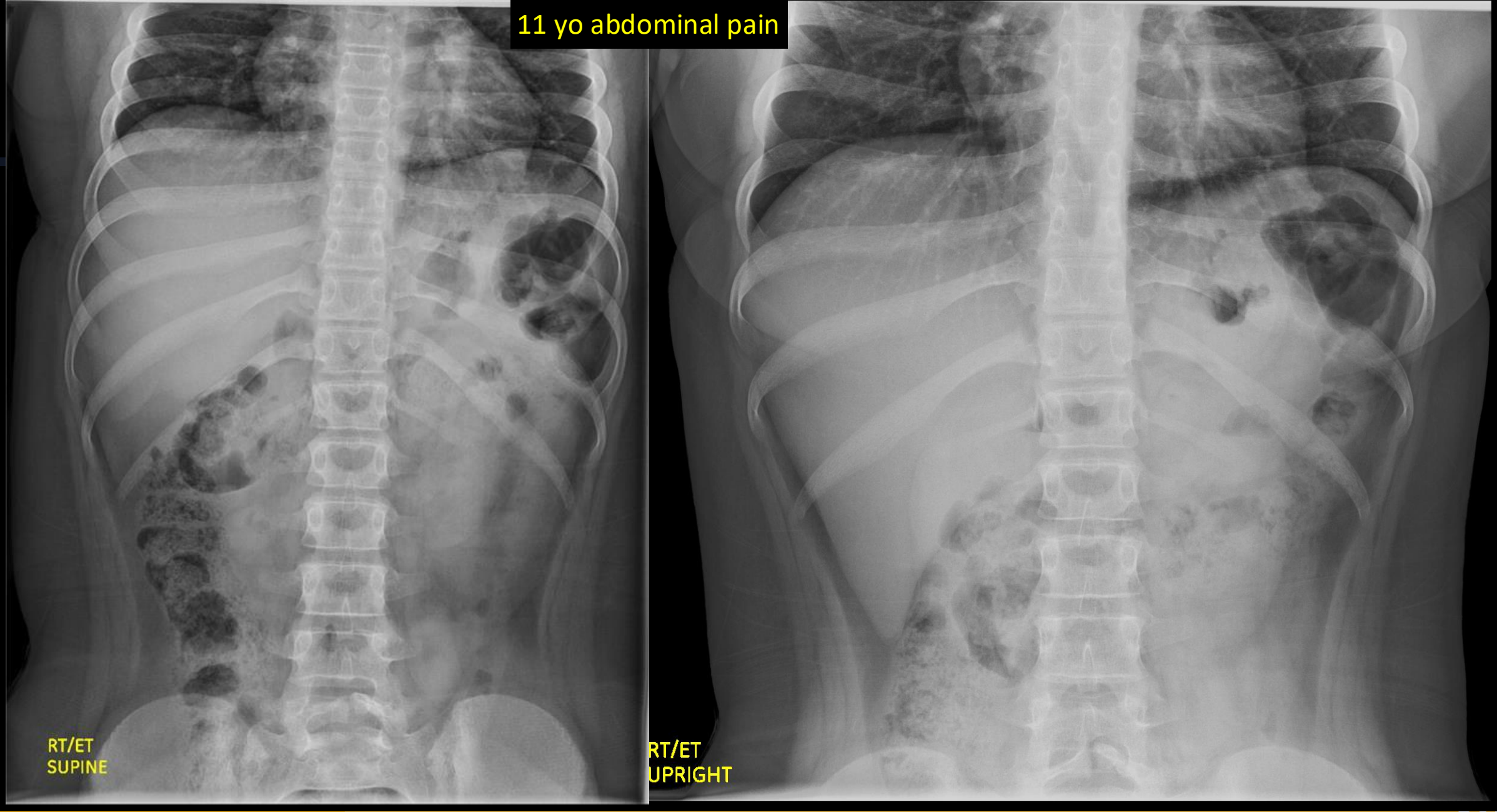
On the form in front of you, please score me and the content I shared with you today.

AFTER THE CONVENTION

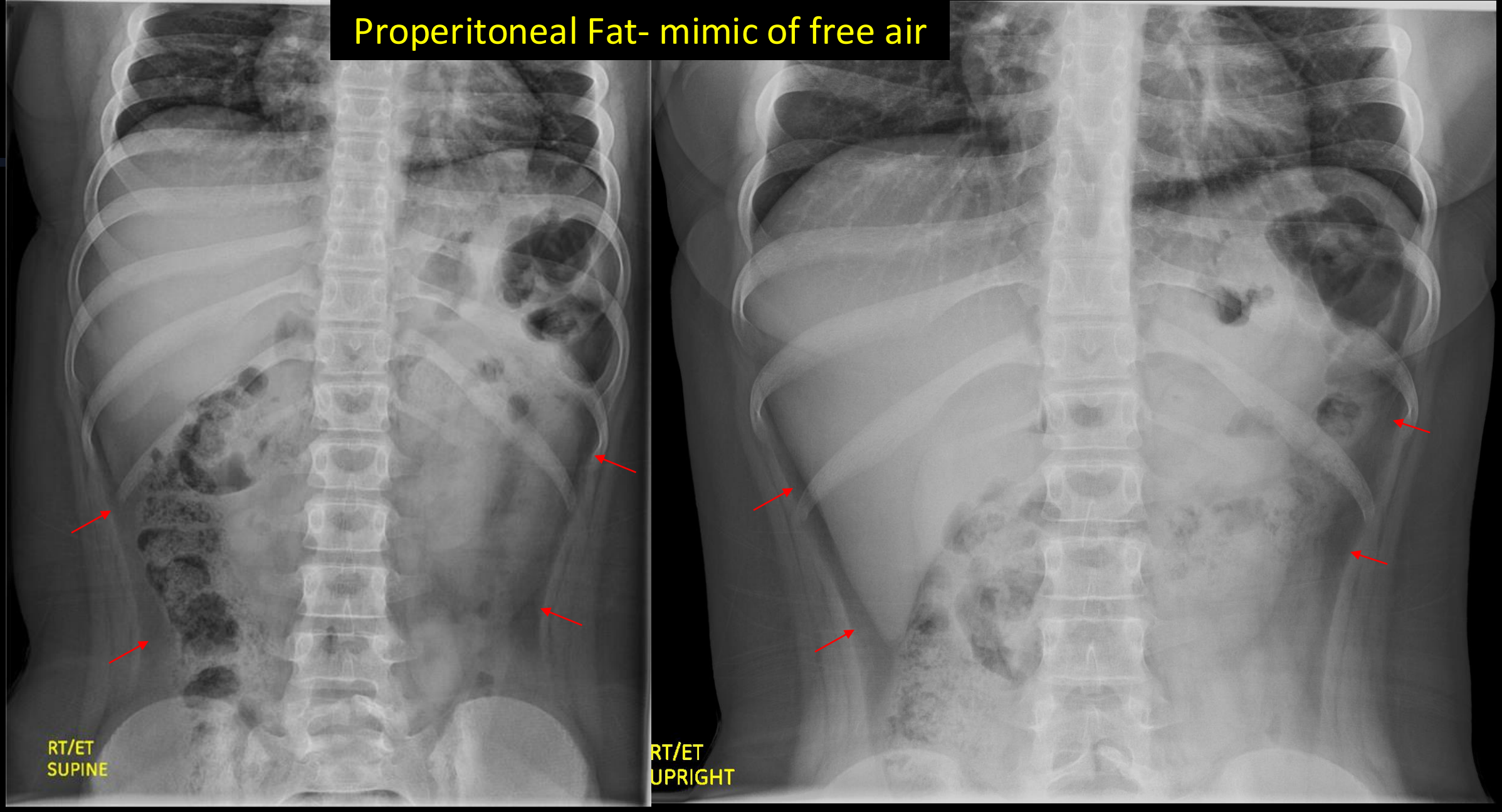
You may claim CME here www.urgentcareassociation.org/learning-center/cme/

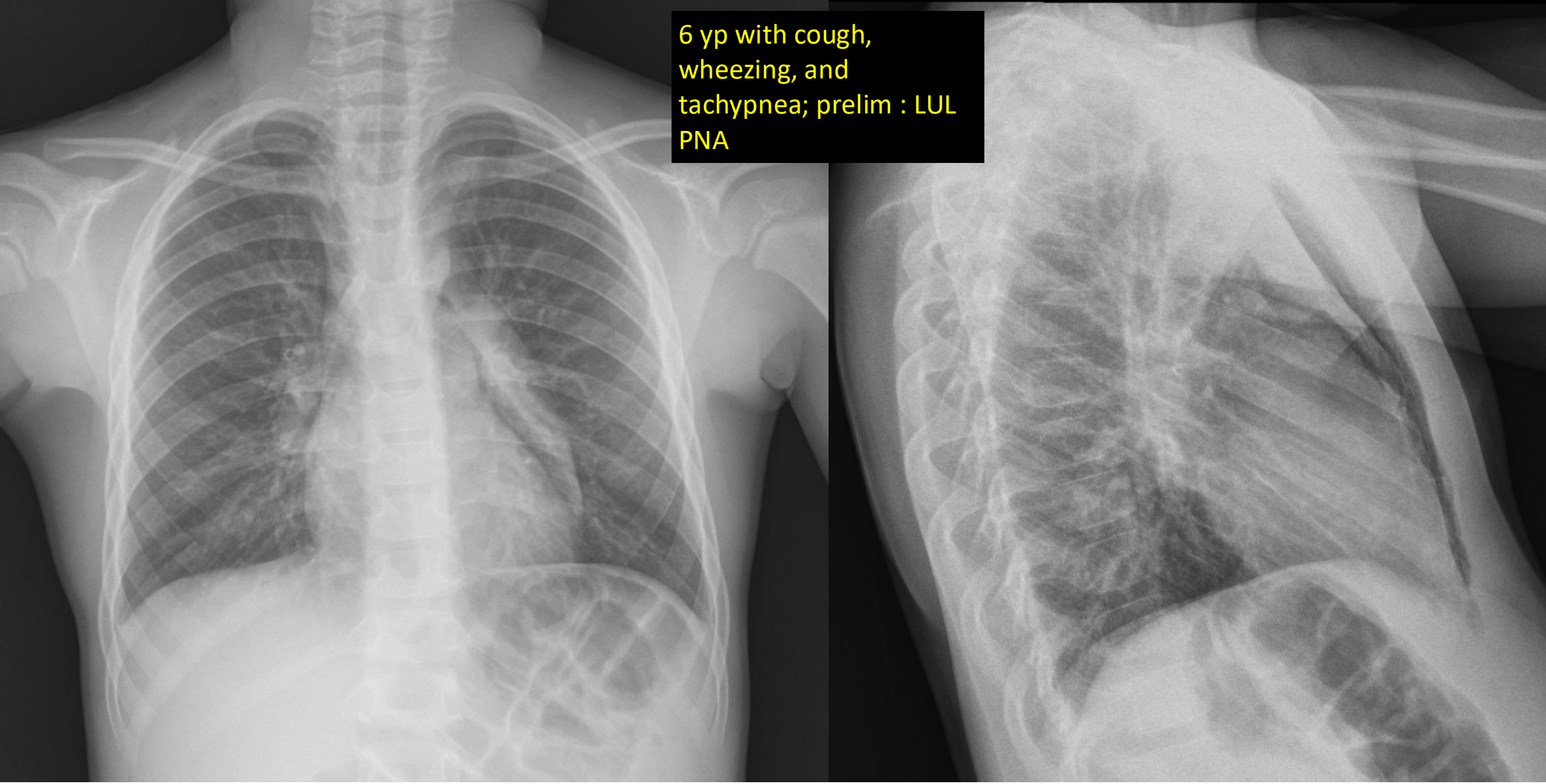
Bonus cases, time permitting

11 yo abdominal pain

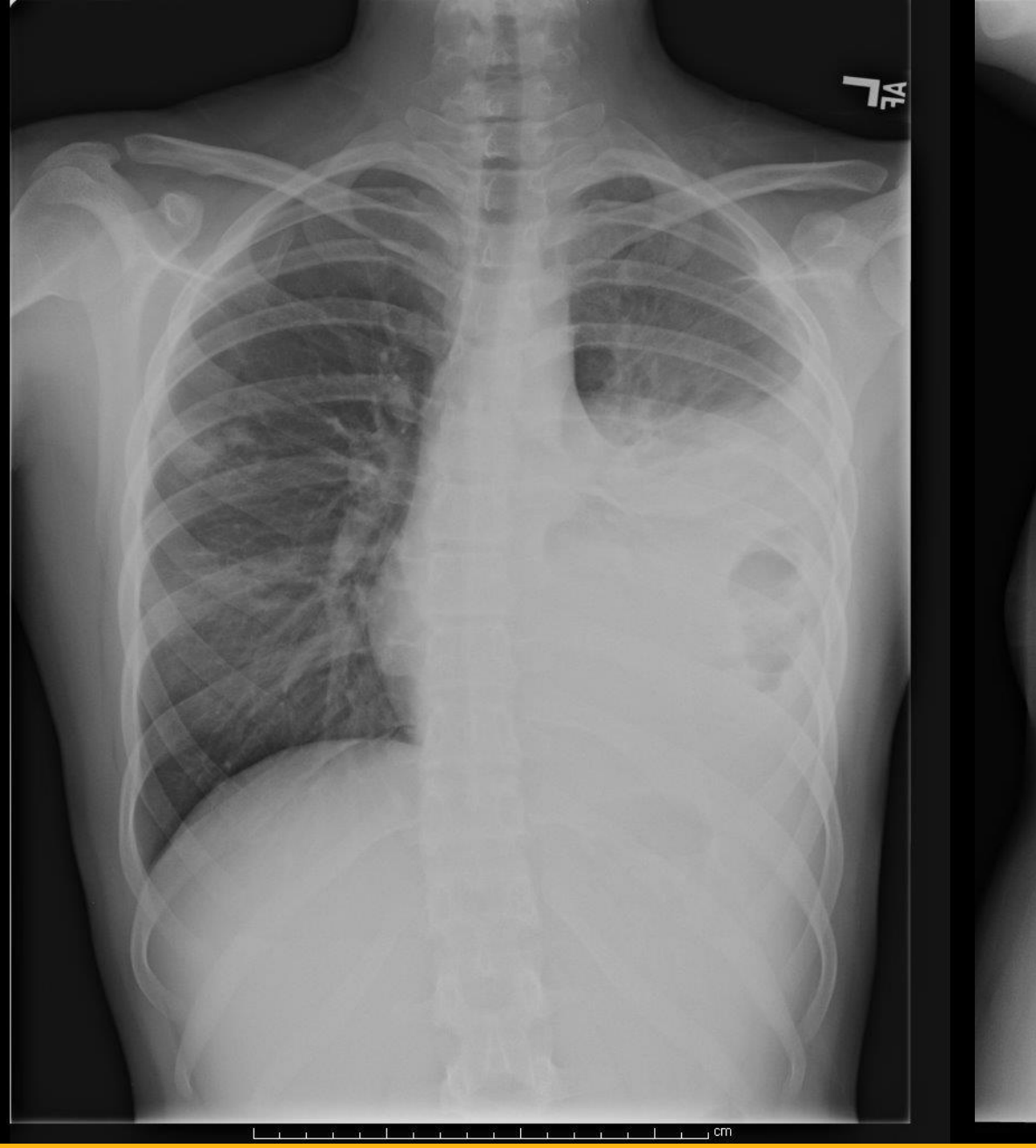


Properitoneal Fat- mimic of free air




6 yp with cough, wheezing, and tachypnea; prelim : LUL PNA

Pneumomediastinum, “spinnaker sail sign”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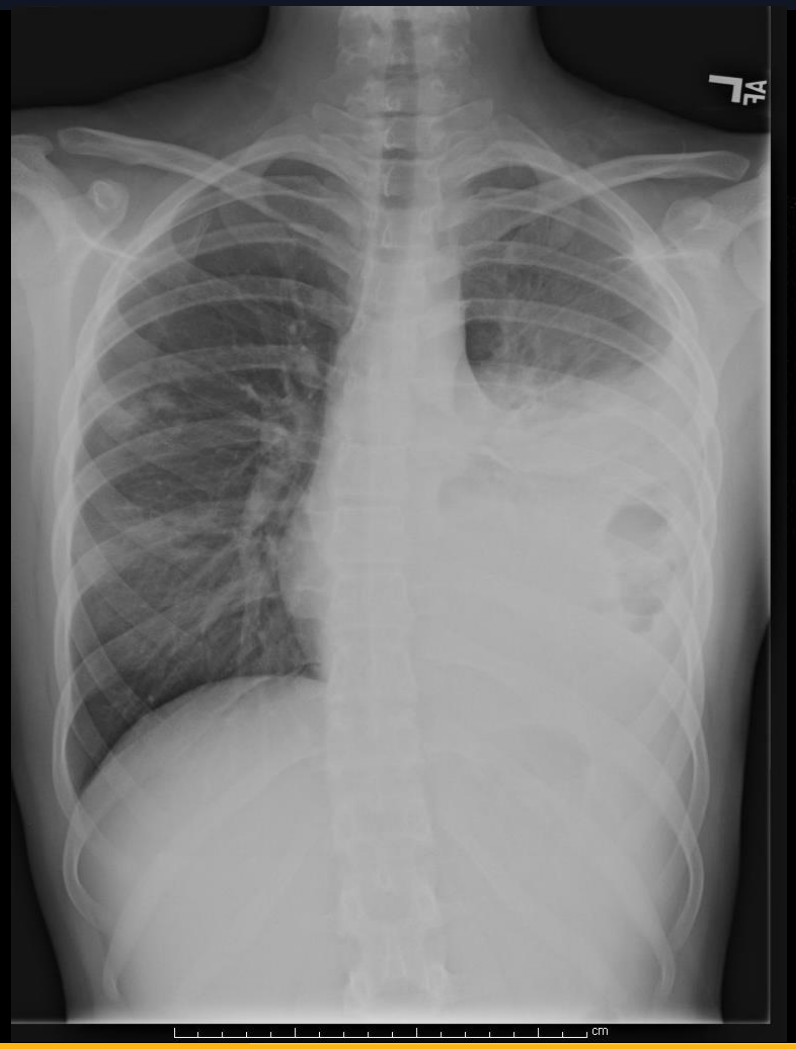
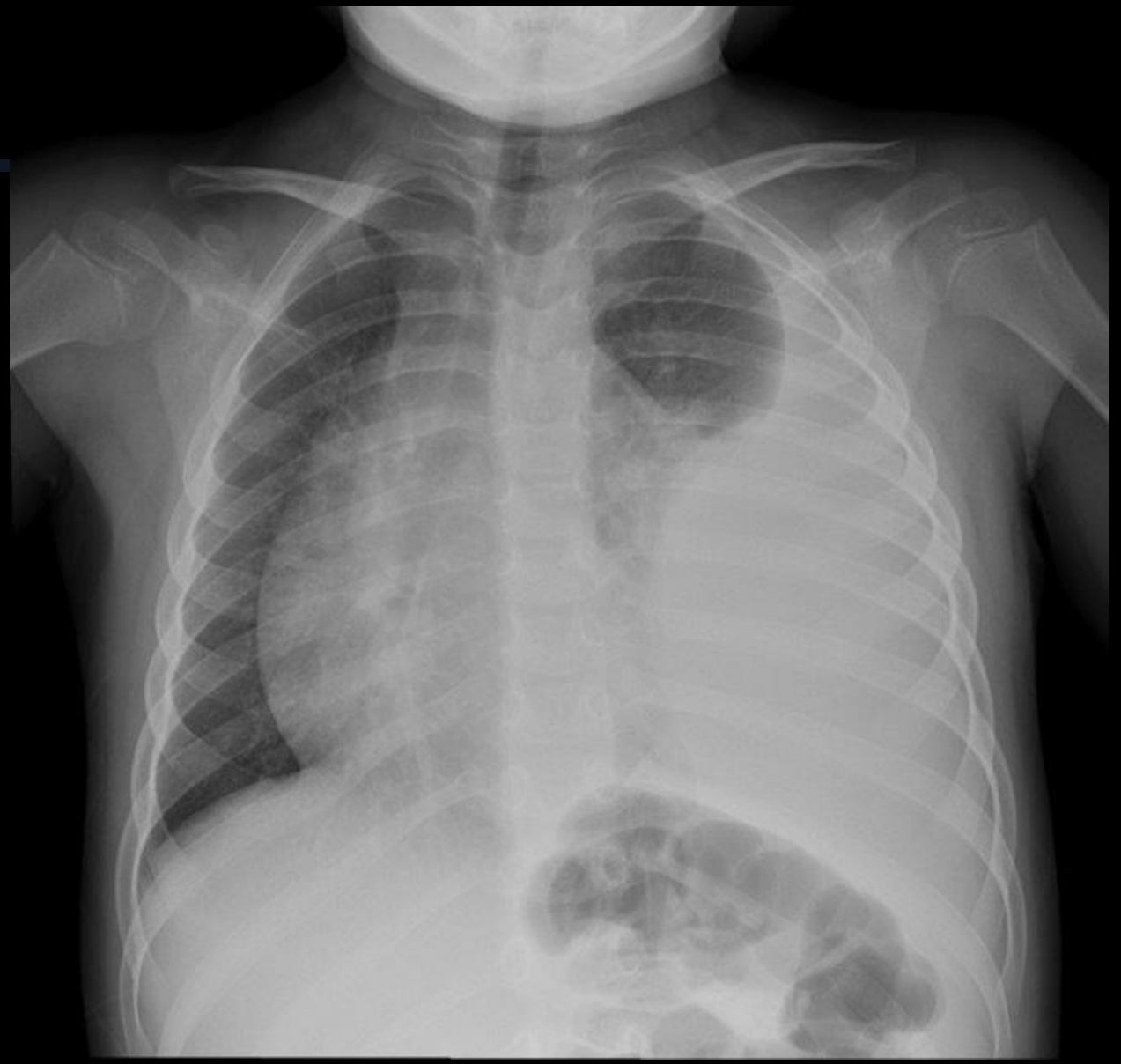
Complicated pneumonia, gas-containing empyema





Pleuropulmonary blastoma

Feedback Requested – Scan the QR