

# Imaging of Pediatric Chest and Gastrointestinal Infections: Imaging Modalities Available and its Judicious Use

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# CLINICAL APPLICATIONS OF CHEST XRAY

## Available imaging options

a. Chest X-Ray

b. Ultrasound

c. Chest CT scan

- conventional chest CT scan with or without contrast enhancement

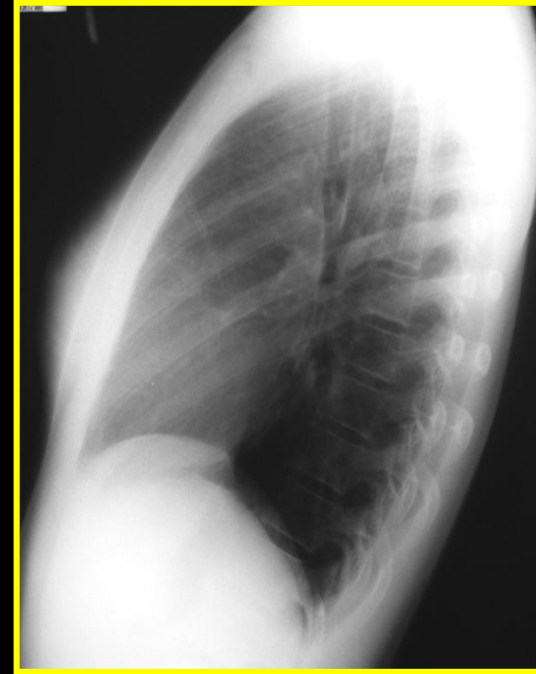
- high resolution chest CT scan

d. MRI

Appropriate and judicious use of imaging modalities available:

## CHEST XRAY

Primary screening modality in the diagnosis of pneumonia and primary pulmonary tuberculosis



# RESPIRATORY TRACT INFECTIONS

## CHEST X-RAY

- Lateral views are still important to detect hidden pneumonias which may not be adequately visualized in the PA or AP views.

# Importance of lateral views



Appropriate and judicious use of imaging modalities available:

## ULTRASOUND

For further characterization of pleural fluid whether it is a serous pleural effusion, empyema or hemothorax and to determine its approximate volume

To determine the presence of atelectasis, consolidation or mass within a fluid collection.

Appropriate and judicious use of imaging modalities available:

## CT SCAN

to detect pulmonary infections when the chest X-ray is equivocal and clinical suspicion for pulmonary infection is strong.

to determine the cause of recurrent and non-resolving pneumonia when the chest X-ray is inconclusive or equivocal.

Appropriate and judicious use of imaging modalities available:

## **HIGH RESOLUTION CHEST CT SCAN**

To detect ground glass opacities, and fine miliary nodules diffusely scattered in both lungs that may not be appreciated in the chest X-ray.

To detect the presence of bronchiectasis.



# Appropriate and judicious use of imaging modalities available:

## MRI

Limited use for evaluation of respiratory tract infections except if there are concomittant malignant processes that may be present in patients undergoing chemotherapy and are immunocompromised and are having indolent and severe opportunistic infections

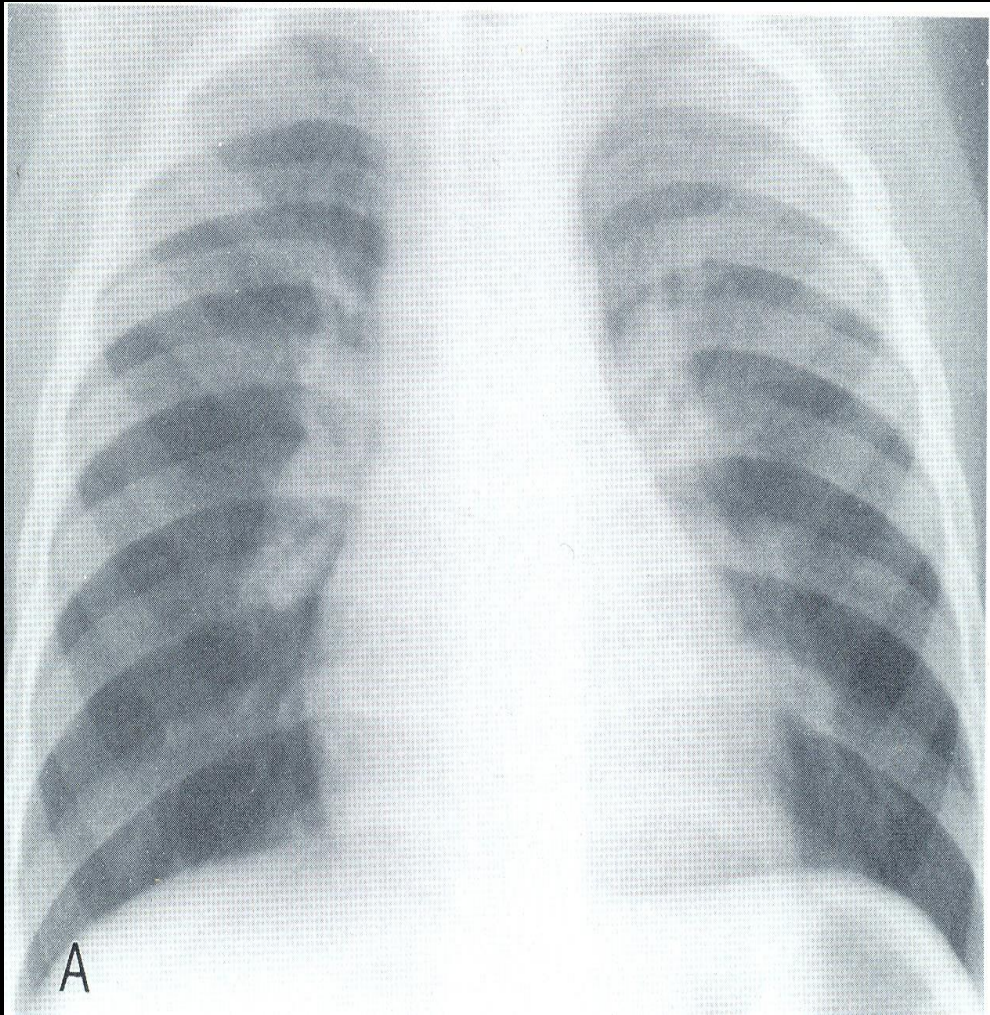
# RESPIRATORY TRACT INFECTIONS

## Clinical applications

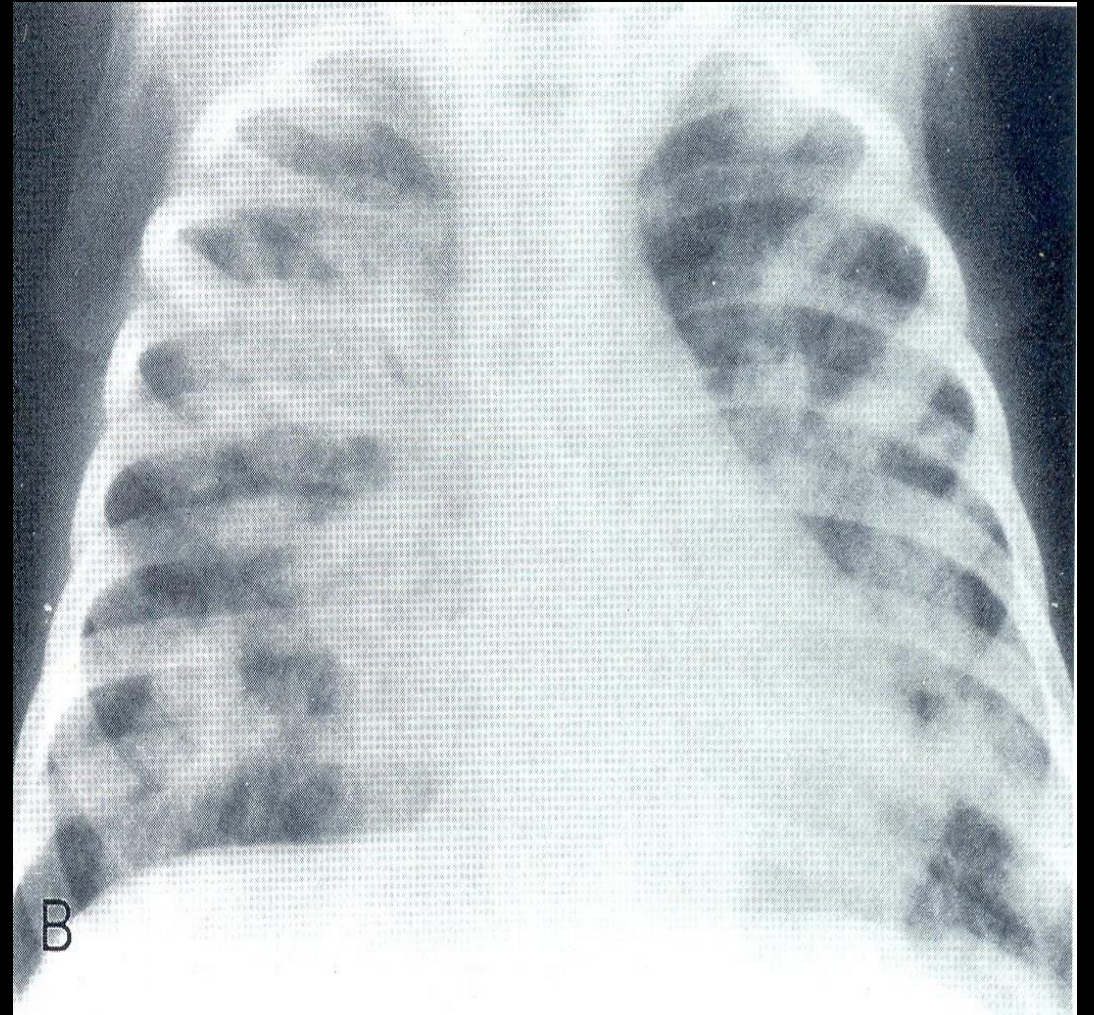
### Pneumonias:

#### Neonate and Infants

Viral	versus	Bacterial
interstitial, reticular	Parenchymal densities	coarse, patchy, consolidation
rare	Pleural effusion	common



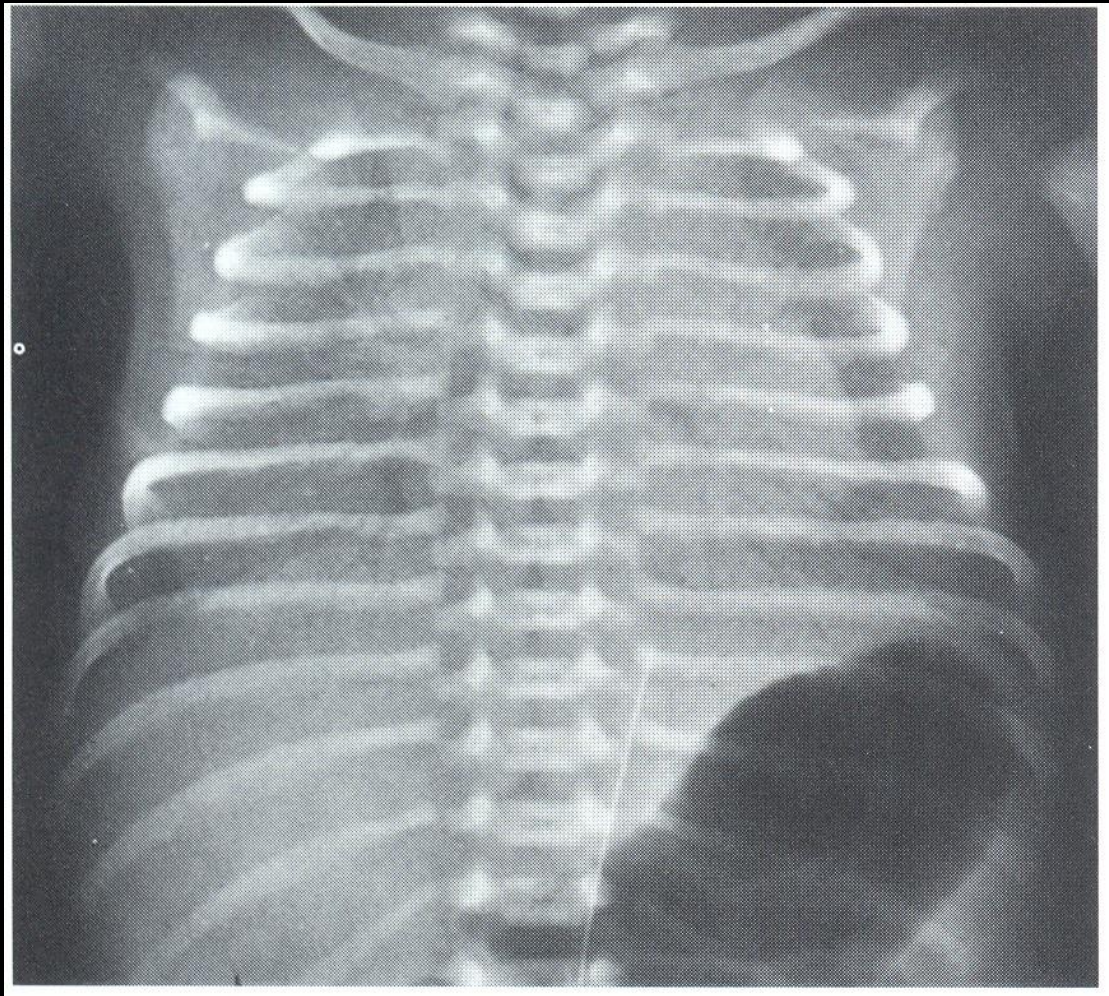
**Viral Pneumonia**



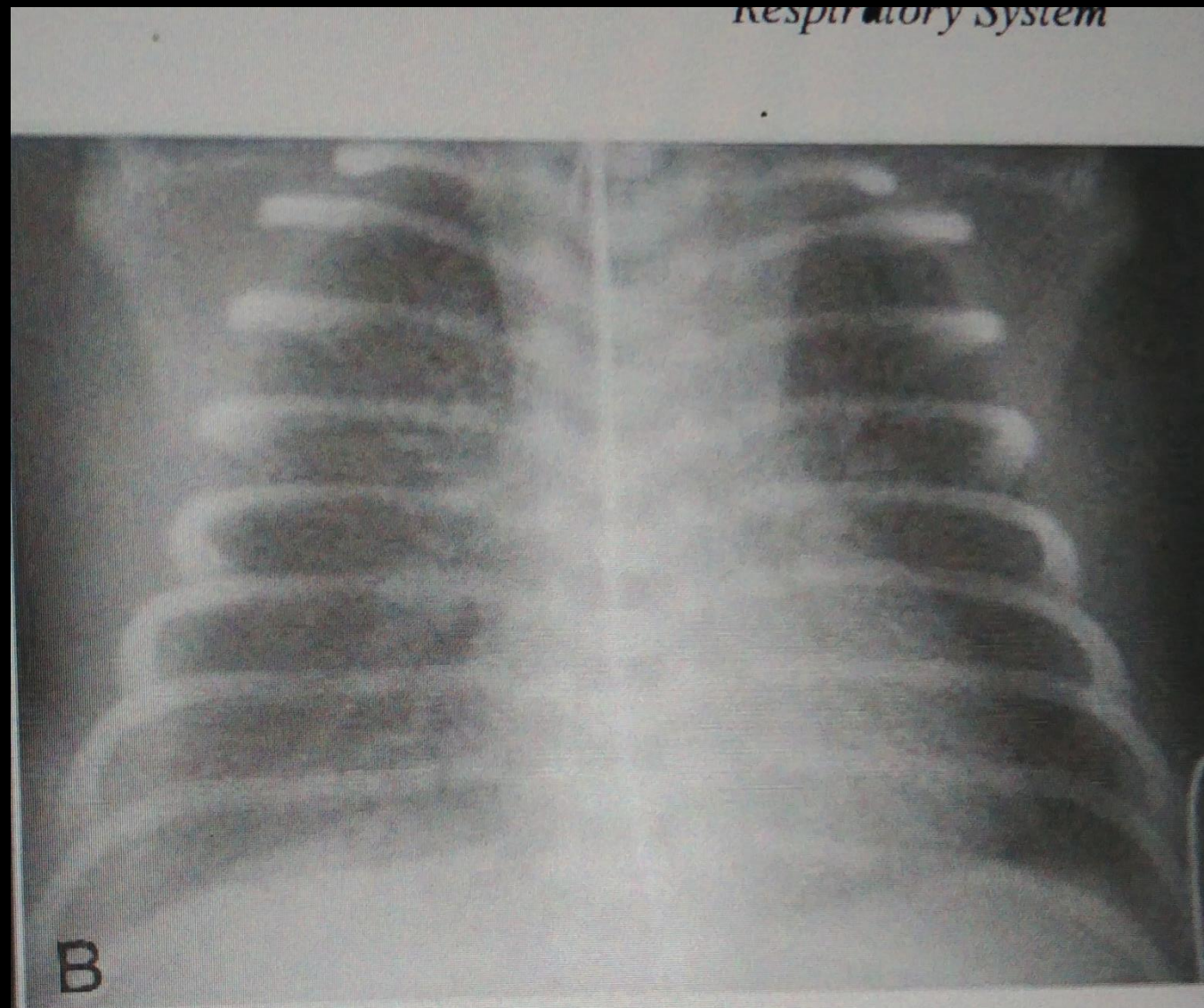
**Bacterial Pneumonia**

## I. Neonates and Young infants: Common concerns

Hyaline Membrane Disease	versus	Viral Pneumonia
Due to collapse of the alveoli producing the granularity, coupled with dilated bronchioles and terminal ducts producing the “ground glass” pattern	Granularity	Due to distended alveoli filled with fluid
(+)	Air bronchogram	(-)
Small	Lung volume	Large
After 72 hours or more, depending on surfactant levels and prematurity of the baby	Clearing of densities	After 1-2 weeks

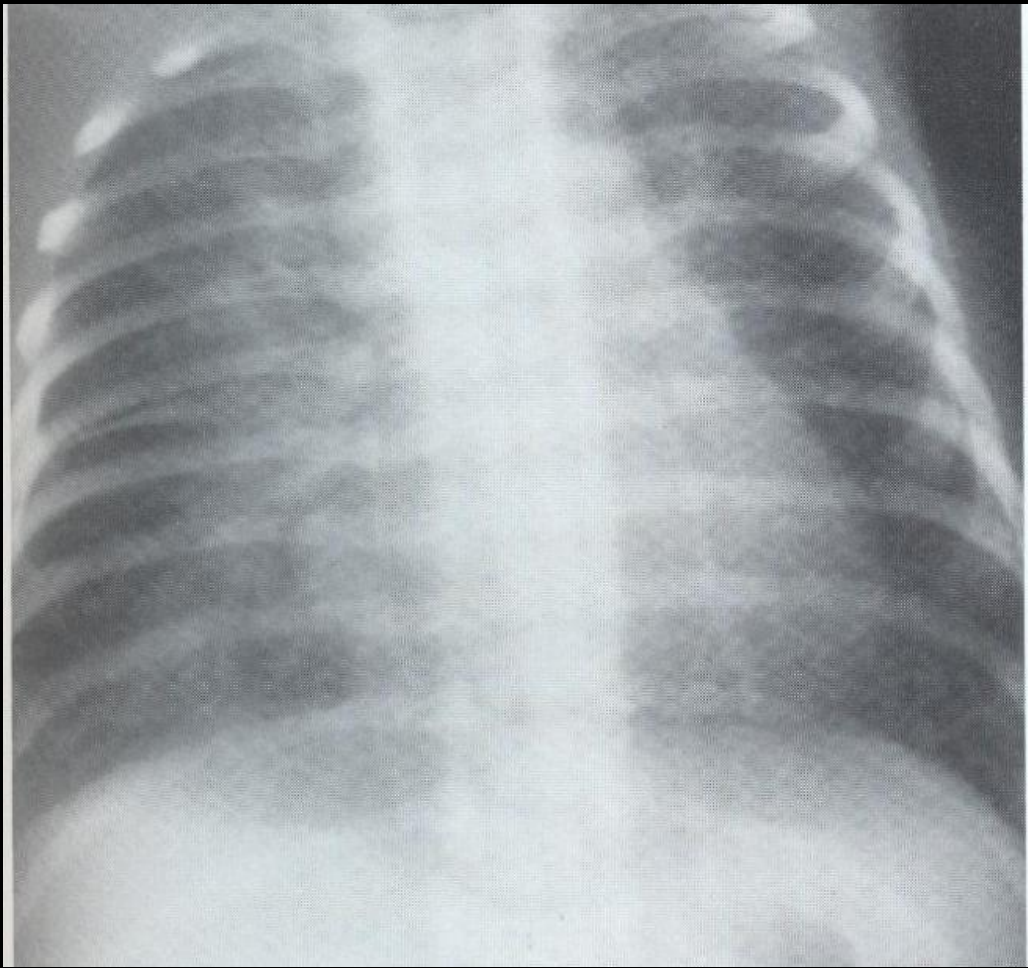


Hyaline membrane disease

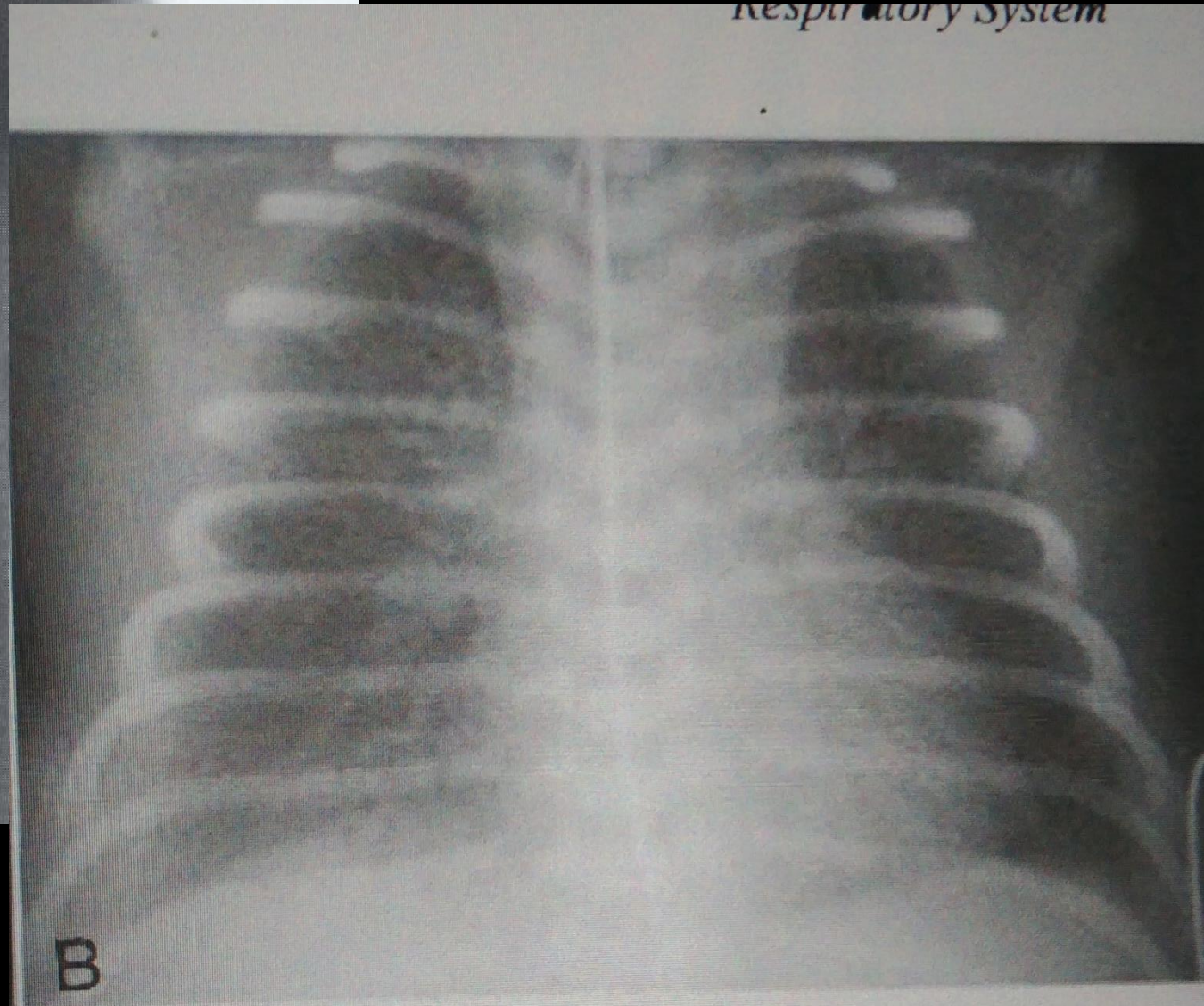


**onia mimicking hyaline membrane disease. A.**  
fields virtually indistinguishable from that seen with  
with hazy to granular lungs with some parahilar  
the right

Transient Tachypnea of the Newborn	versus	Interstitial or Viral pneumonia
Linear densities extending from the hilum to the periphery representing distended lymphatics		Interstitial or streaky densities due to infiltrates in the pulmonary interstitial space
(+)	pulmonary hyperaeration	(+)
Caesarian section delivery	history	<ul style="list-style-type: none"> <li>- Signs and symptoms of pneumonia</li> <li>- Normal spontaneous delivery</li> <li>- Maternal factors predisposing to pneumonia</li> <li>- Full term</li> </ul>
Clears after 48 hours	Clearing of lung findings	Clears after 1-2 weeks



Transient Tachypnea of the Newborn



onia mimicking hyaline membrane disease. A. fields virtually indistinguishable from that seen with with hazy to granular lungs with some parahilar the right

## II. Older children

The chest X-ray can help classify pneumonia into the following:

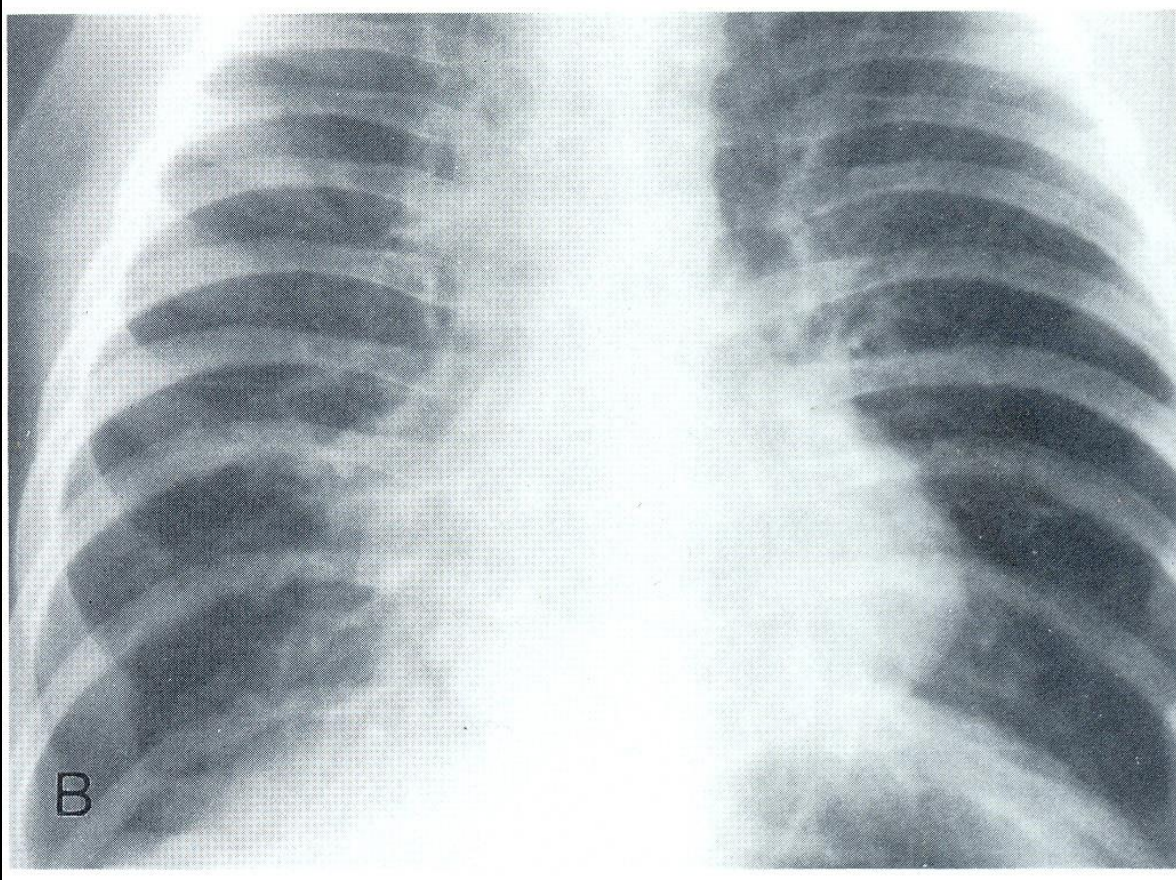
### A. Interstitial

- usually due to viral, mycoplasma, and pertusis
- reticular or lace like densities
- pulmonary hyperaeration
- clears within 1-2 weeks

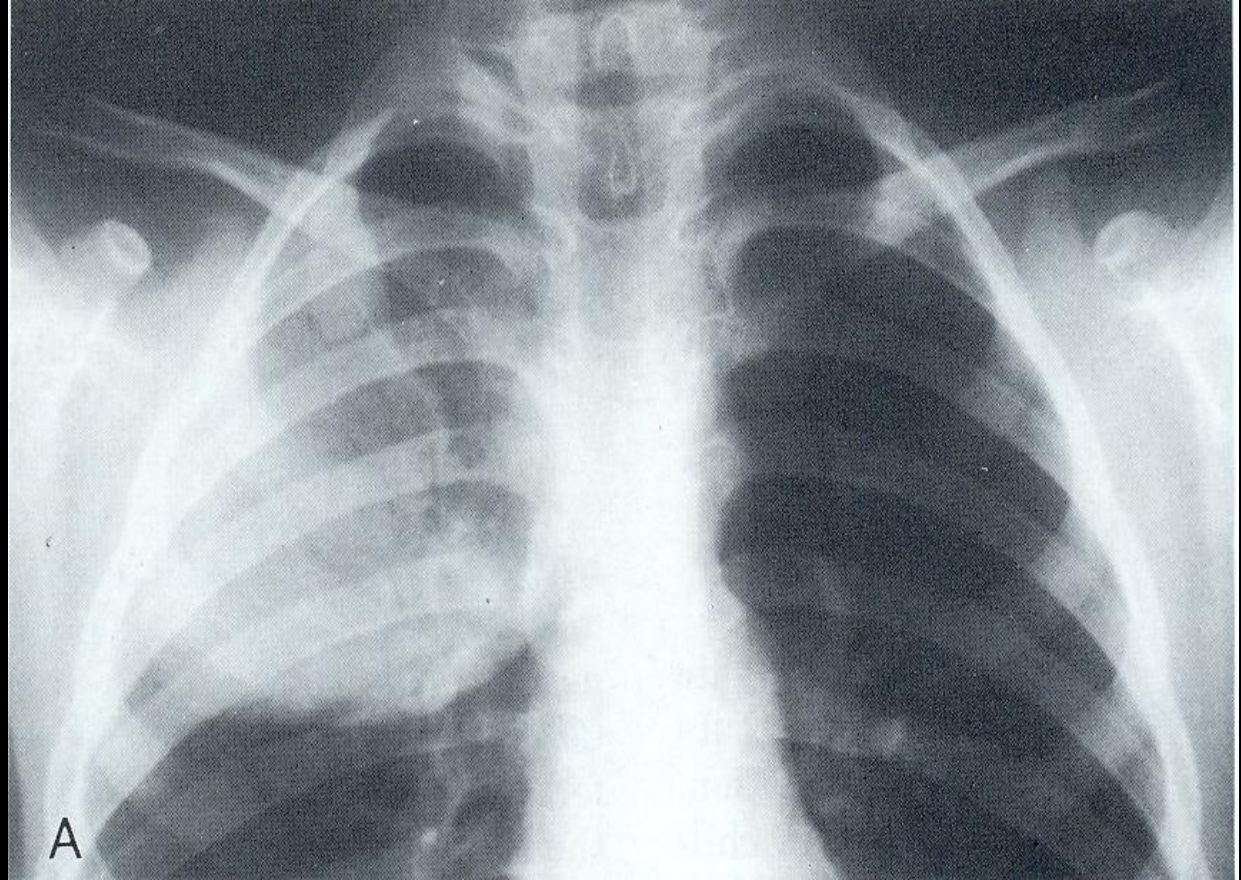
### B. Alveolar

- usually due to pneumococcal infections
- consolidation
- clears within 2 weeks or more





**Interstitial Pneumonia**

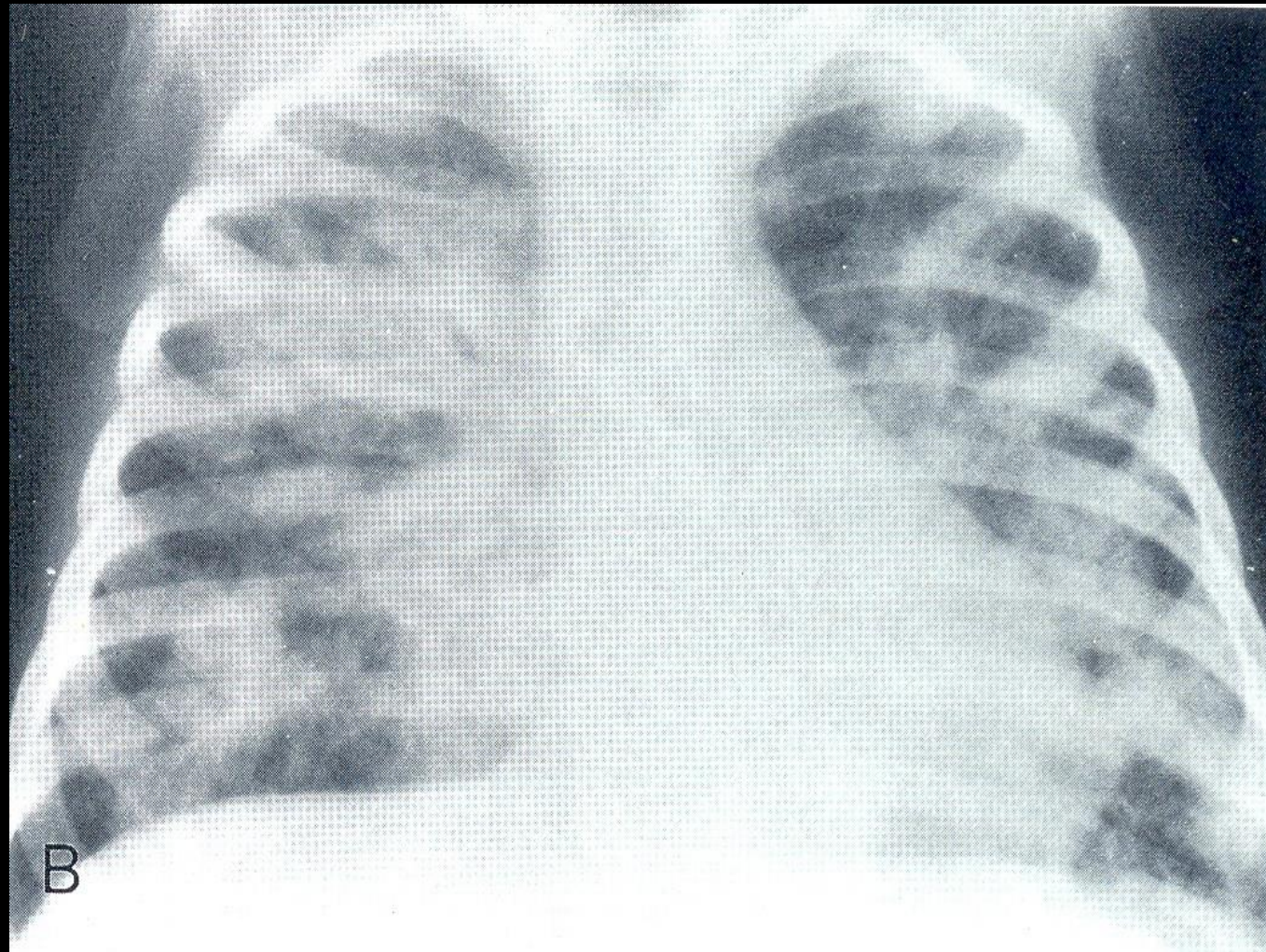


**Alveolar Pneumonia**

# Lobular or bronchopneumonia

usually due to staphylococcal infections  
hazy and patchy densities

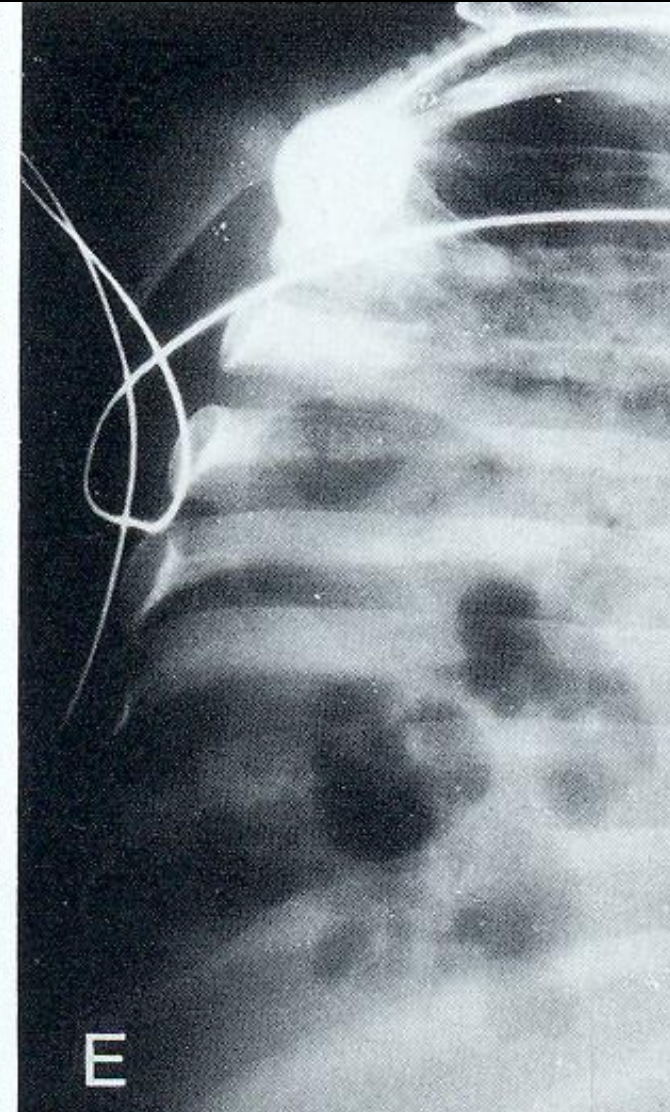
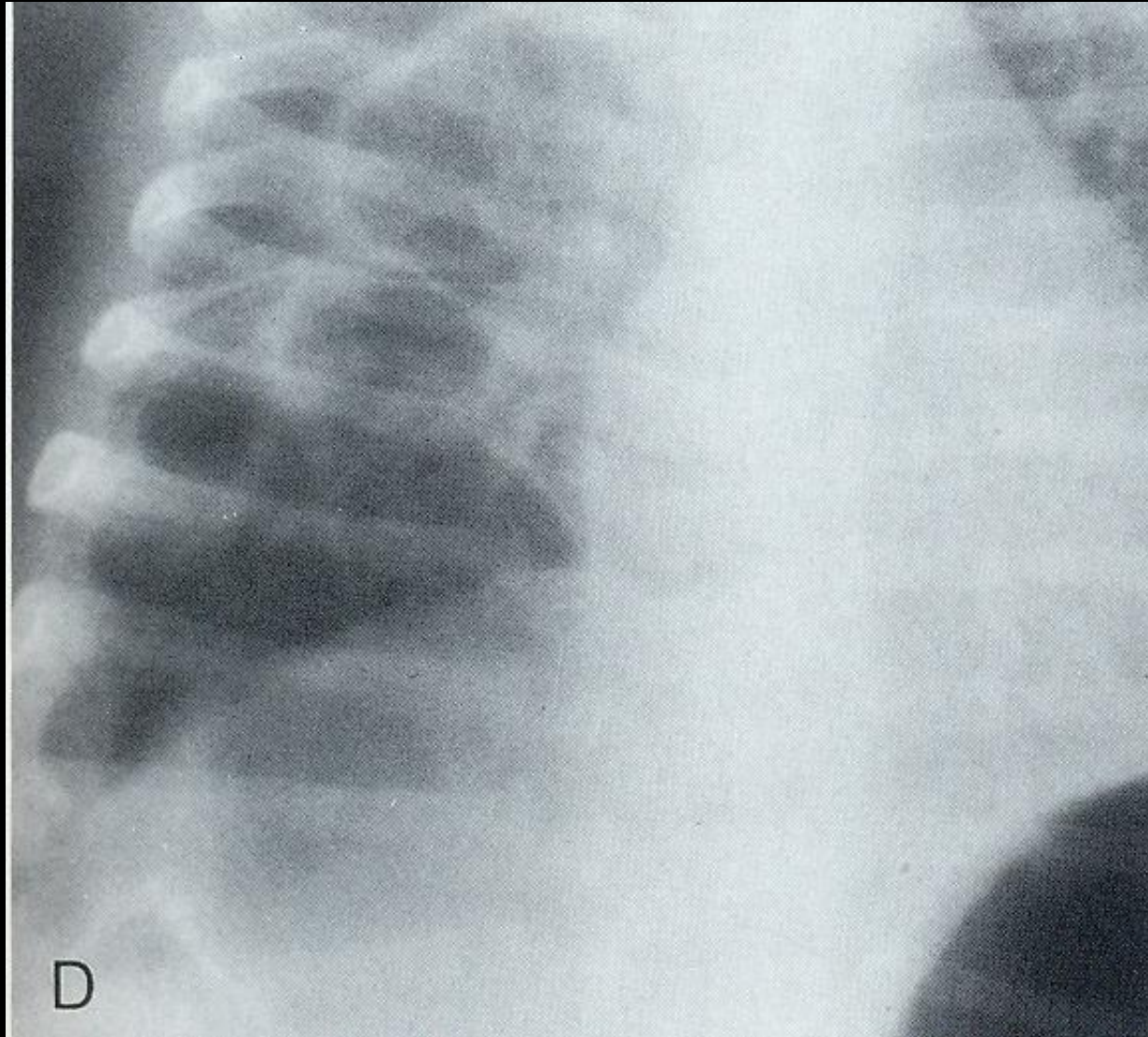
# LOBULAR OR BRONCHOPNEUMONIA



# COMPLICATIONS OF BRONCHOPNEUMONIAS (STAPHYLOCOCCAL)

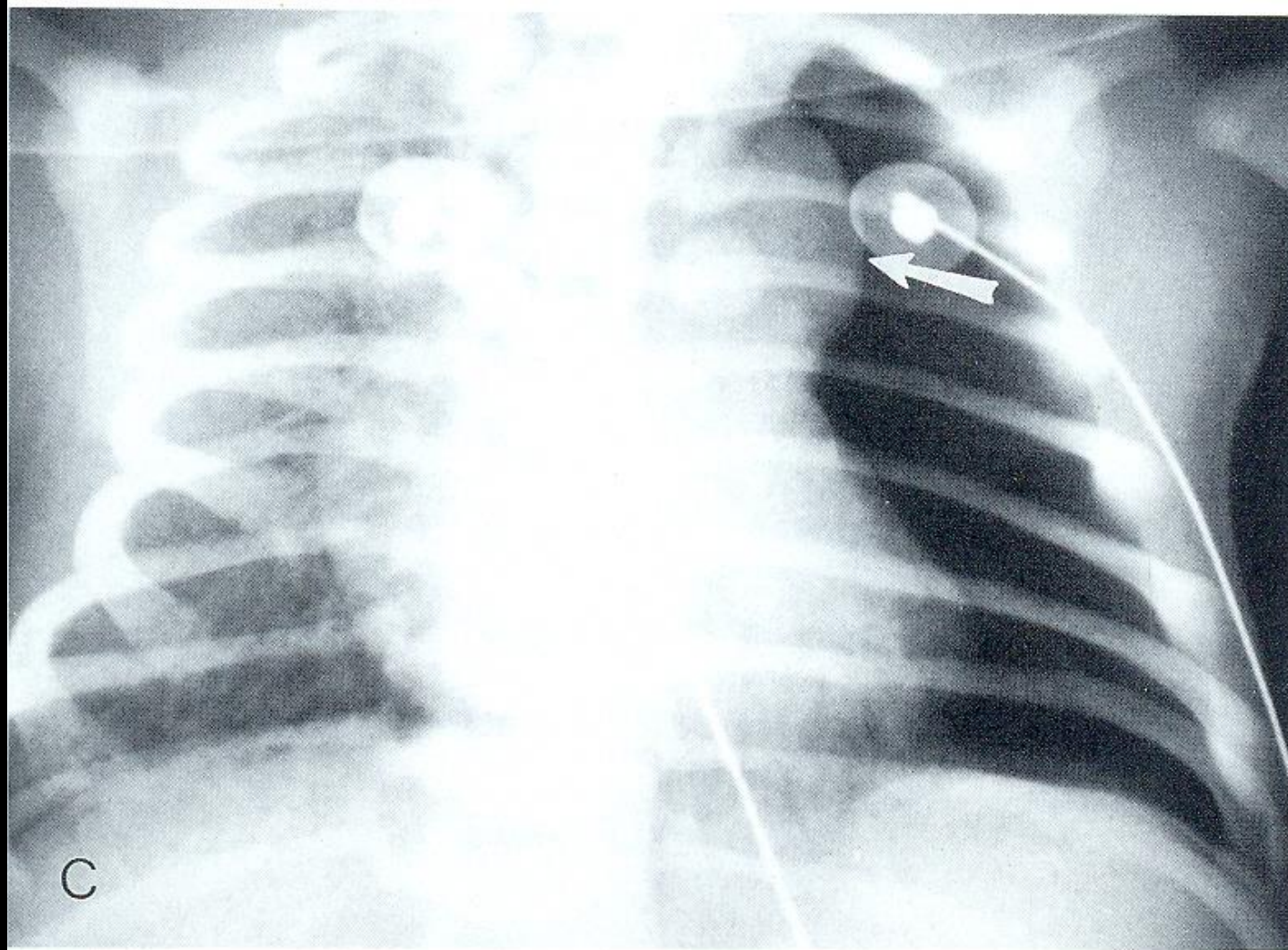
- pneumatoceles
- abscess
- empyema
- pneumothorax

# PNEUMATOCELE

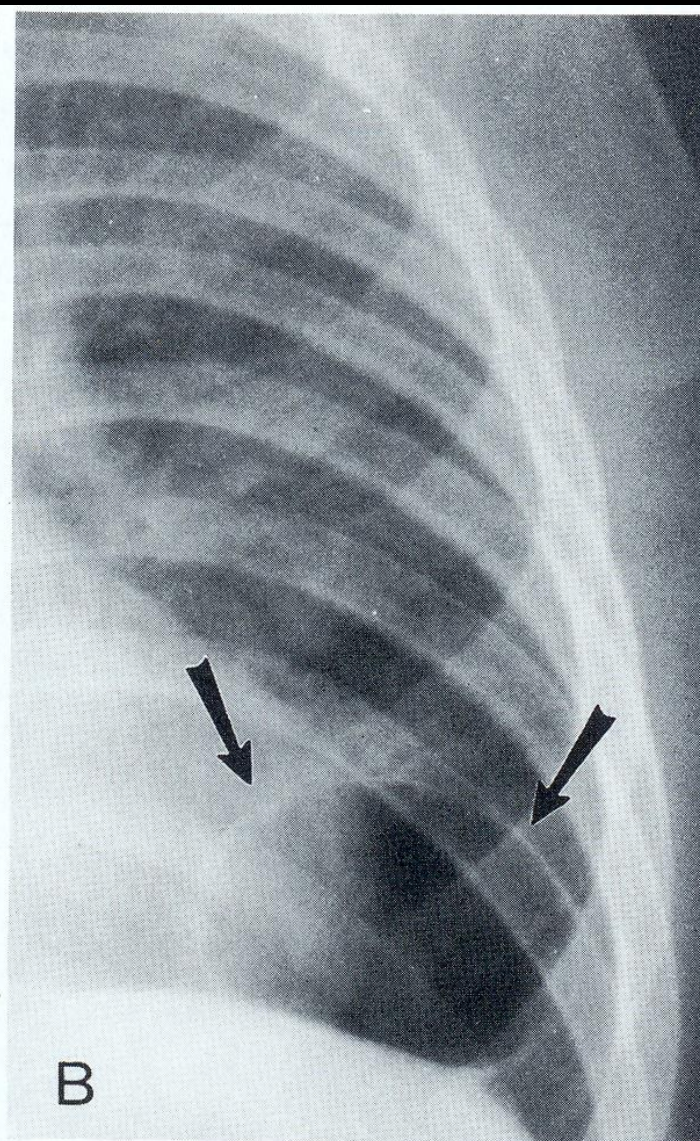
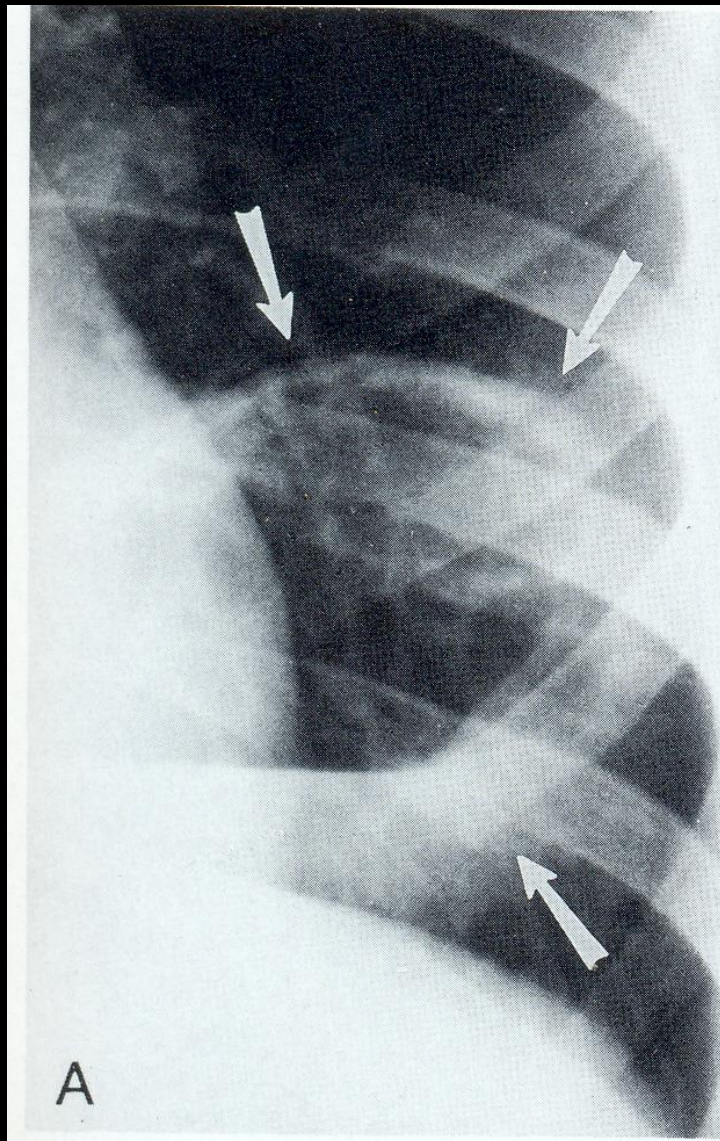


# PNEUMOTHORAX

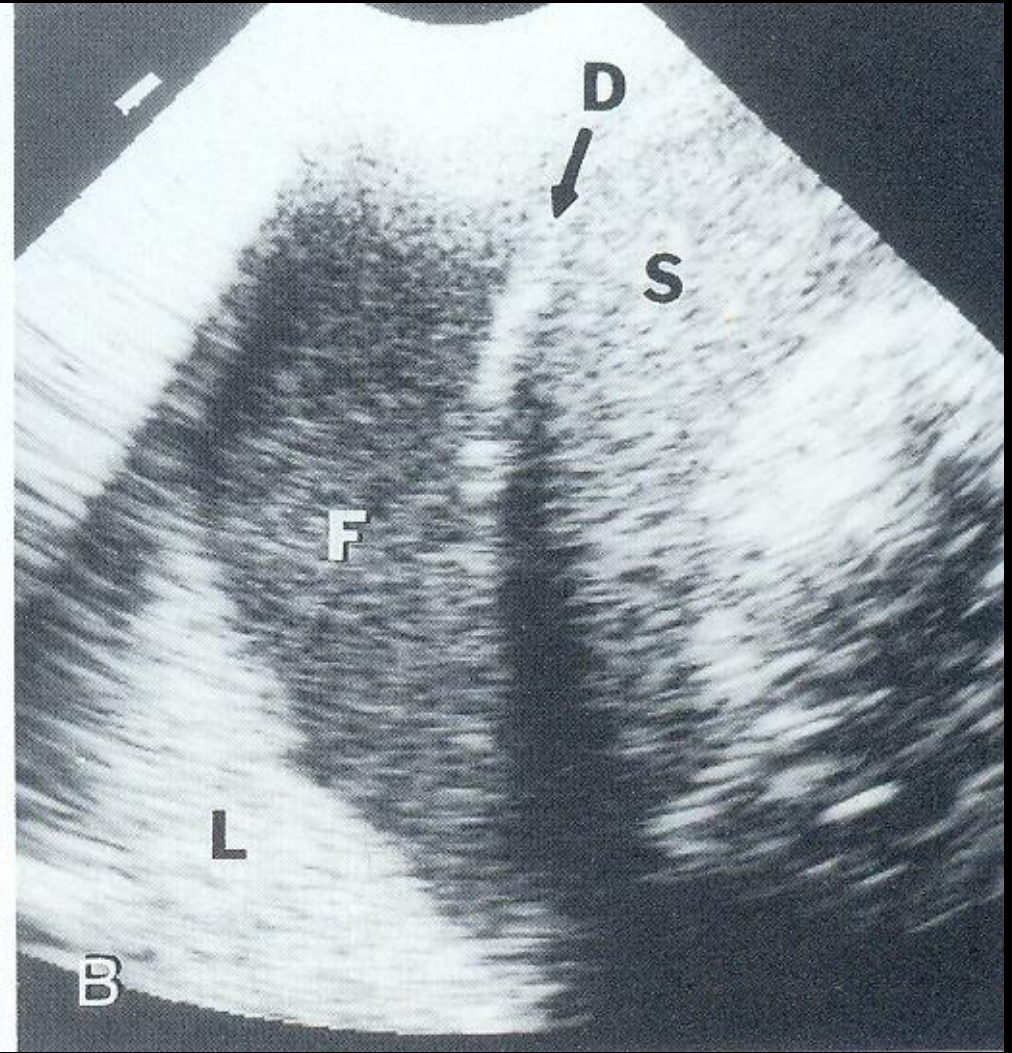
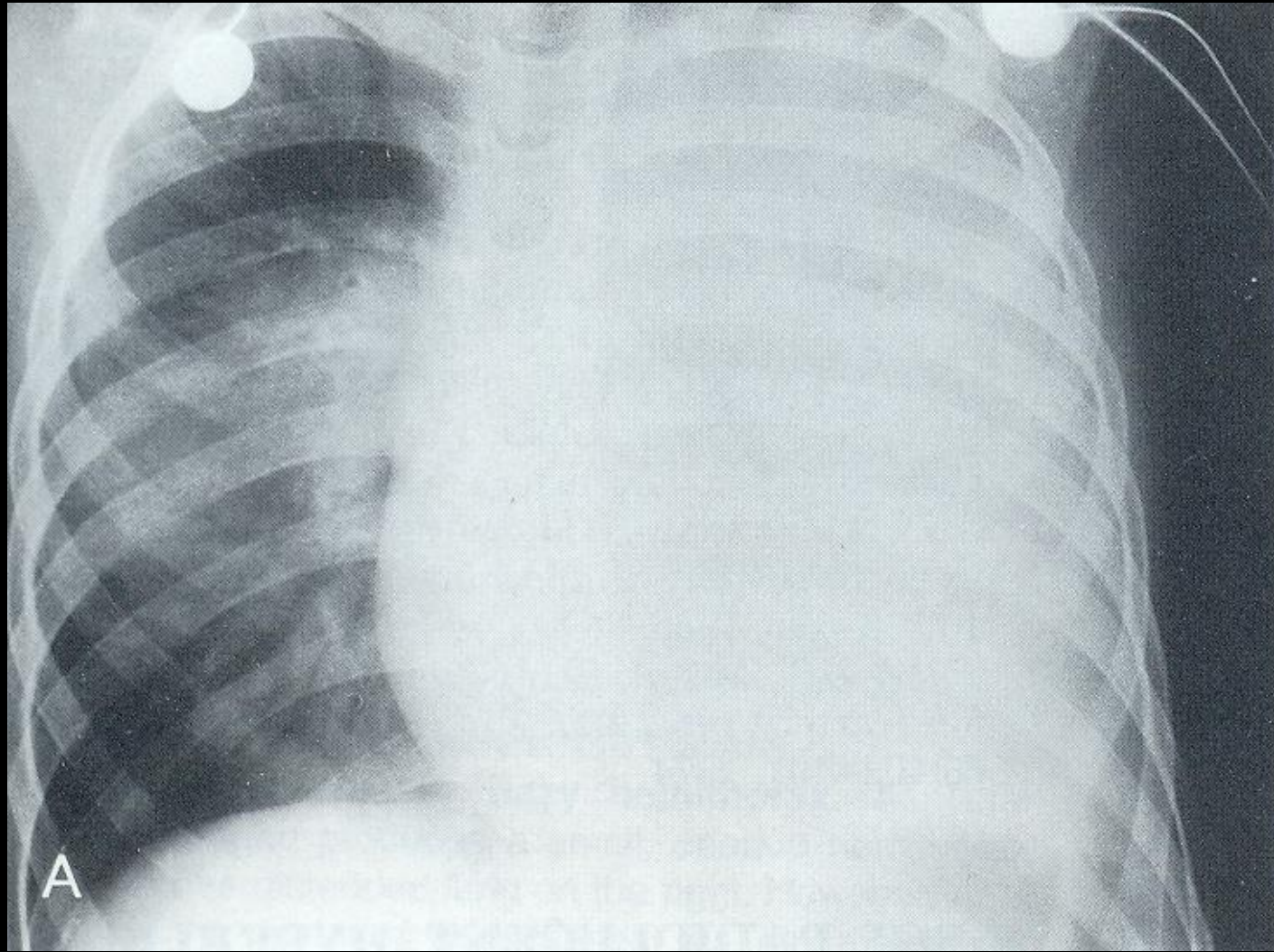
## WHEN A PNEUMATOCELE RUPTURES



# ABSCESS



# EMPYEMA

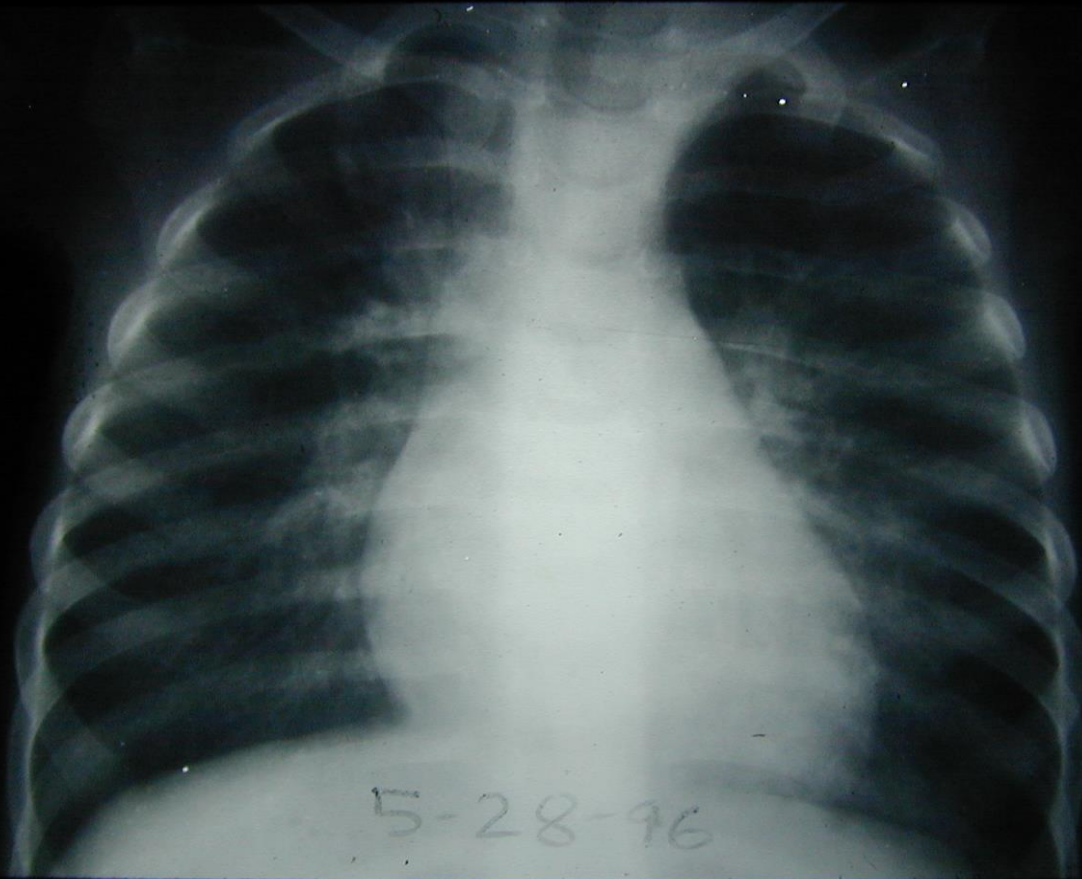




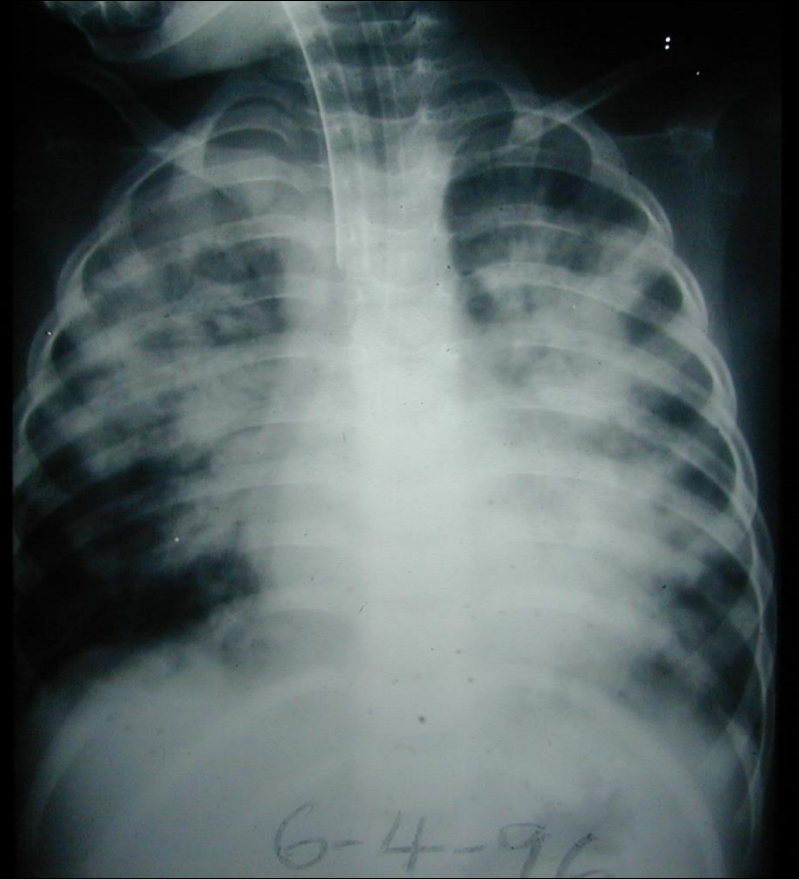
# **Mixed interstitial and alveolar pneumonia**

initial interstitial pneumonia with superimposed bacterial or staphylococcal pneumonia

# MIXED INTERSTITIAL AND INTERSTITIAL PNEUMONIA



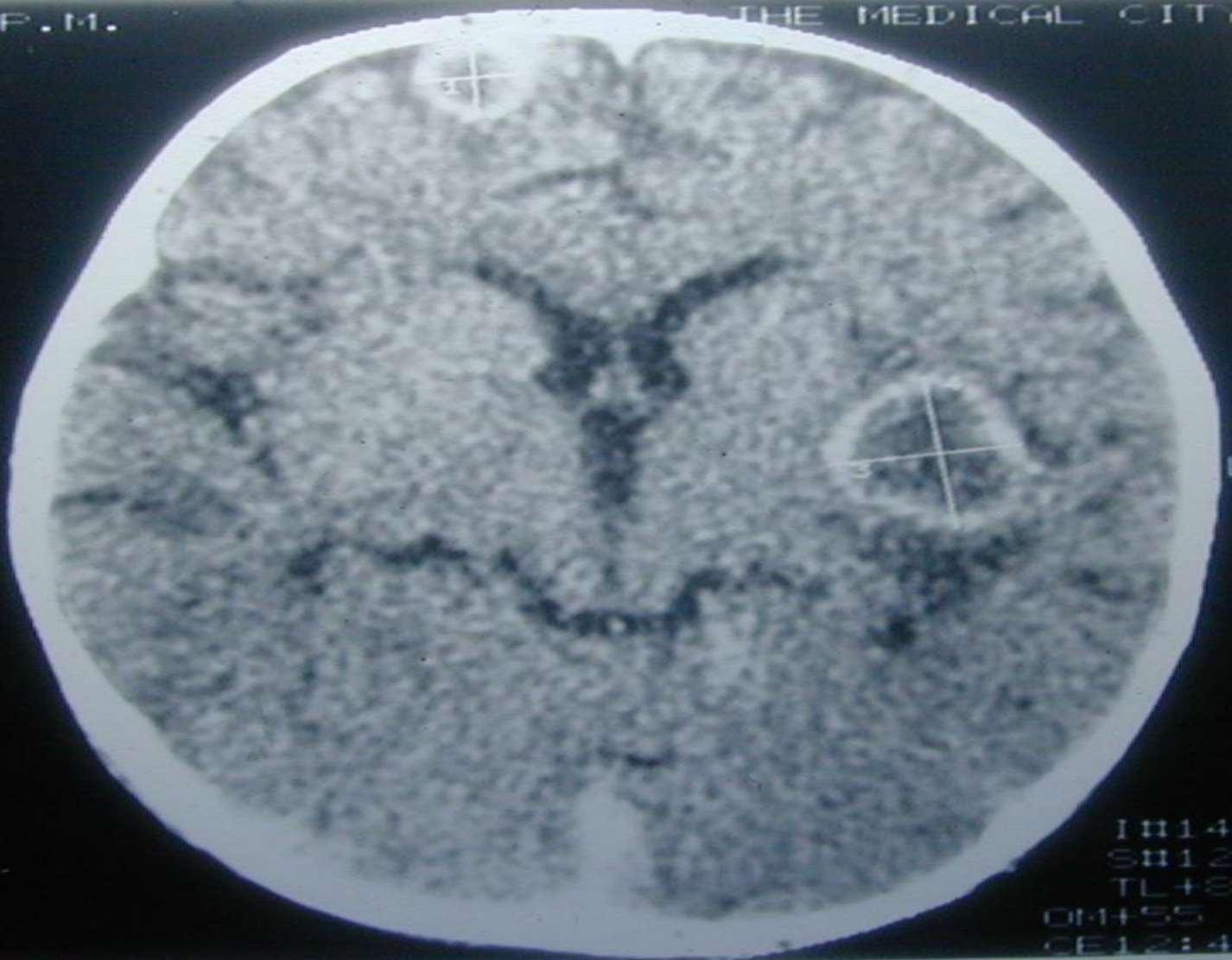
MEASLES PNEUMONIA



STAPHYLOCOCCAL PNEUMONIA

JABAGAT. P.M.  
CONTRAST  
94-4812/E  
M/1  
D#358

THE MEDICAL CITY



120kV  
250mA  
3.0ms  
3.0sec  
300mA  
33/5mm

1 = 11.5  
2 = 12.5  
3 = 21.3  
4 = 23.7

1 = 269  
2 = 741  
3 = 97.94  
4 = 2314

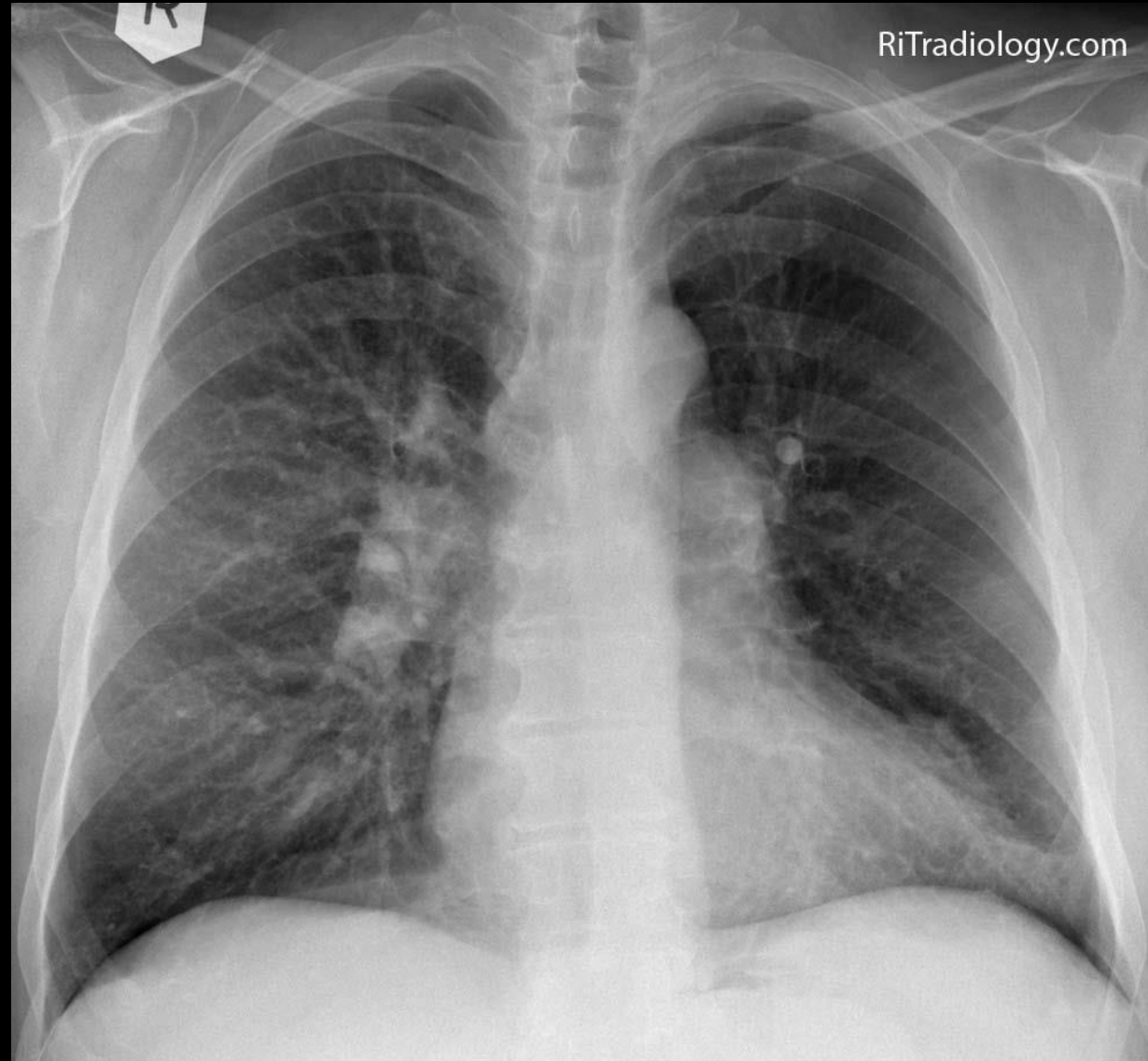
24  
120

I#14  
S#12  
TL+8  
OM+55  
CE12:4

# SWYER JAMES LUNGS

- acquired hypoplastic lung
- obliterative viral bronchiolitis due to adenoviral infection or any infection that can lead to obliterative bronchiolitis
- small peripheral bronchioles are damaged and scarred leading to narrowed lumina and faulty aeration of the lung
- decreased blood flow to the lung and resultant hyperlucency of the lungs
- X-ray Findings:
  - clear small hyperlucent lung that doesn't change in size on expiration and inspiration, diminished blood flow.
  - diffuse reticulonodularity secondary to interstitial fibrosis

# Swyer James



# ASTHMA AND PNEUMONIA

Regarding Asthma with acute exacerbation, is it important to take a chest X-ray?

Yes, especially in infants with high grade fever. There maybe a superimposed bacterial infection, a consolidating pneumonia or atelectasis which maybe confused

# ASTHMA AND PNEUMONIA

## X-ray findings of patients with asthma:

- usually negative
- pulmonary hyperaeration
- parahilar, peribronchial infiltrates
- hilar prominence
- scattered wedge like segmental atelectasis or migrating opacities due to mucous plugs
- Peribronchial thickening or “cuffing” or “tram lines” in asthma with acute exacerbation

# IMMUNOLOGIC DEFICIENCY AND CHEST INFECTIONS

## Role of the radiologist:

- detect the degree of pulmonary involvement in any given case and whether complications have arisen



# IMMUNOLOGIC DEFICIENCY AND CHEST INFECTIONS

Deficiency of the T cells, B cells, Phagocytic cells lead to viral, bacterial, staphylococcal, or fungal infections

# IMMUNOLOGIC DEFICIENCY AND CHEST INFECTIONS

## HIV acquired immunodeficiency

- acquired transplacentally from the mother or in later life through transfusion or IV drug use
- susceptible not only to ordinary bacterial, viral or fungal organisms but to virulent or opportunistic organisms such as *Pneumocystis carinii*, TB, atypical TB, etc.

pronounced lymphocytic response in the lungs lead to lymphoid interstitial pneumonia.

# RECURRENT PNEUMONIA

## Causes:

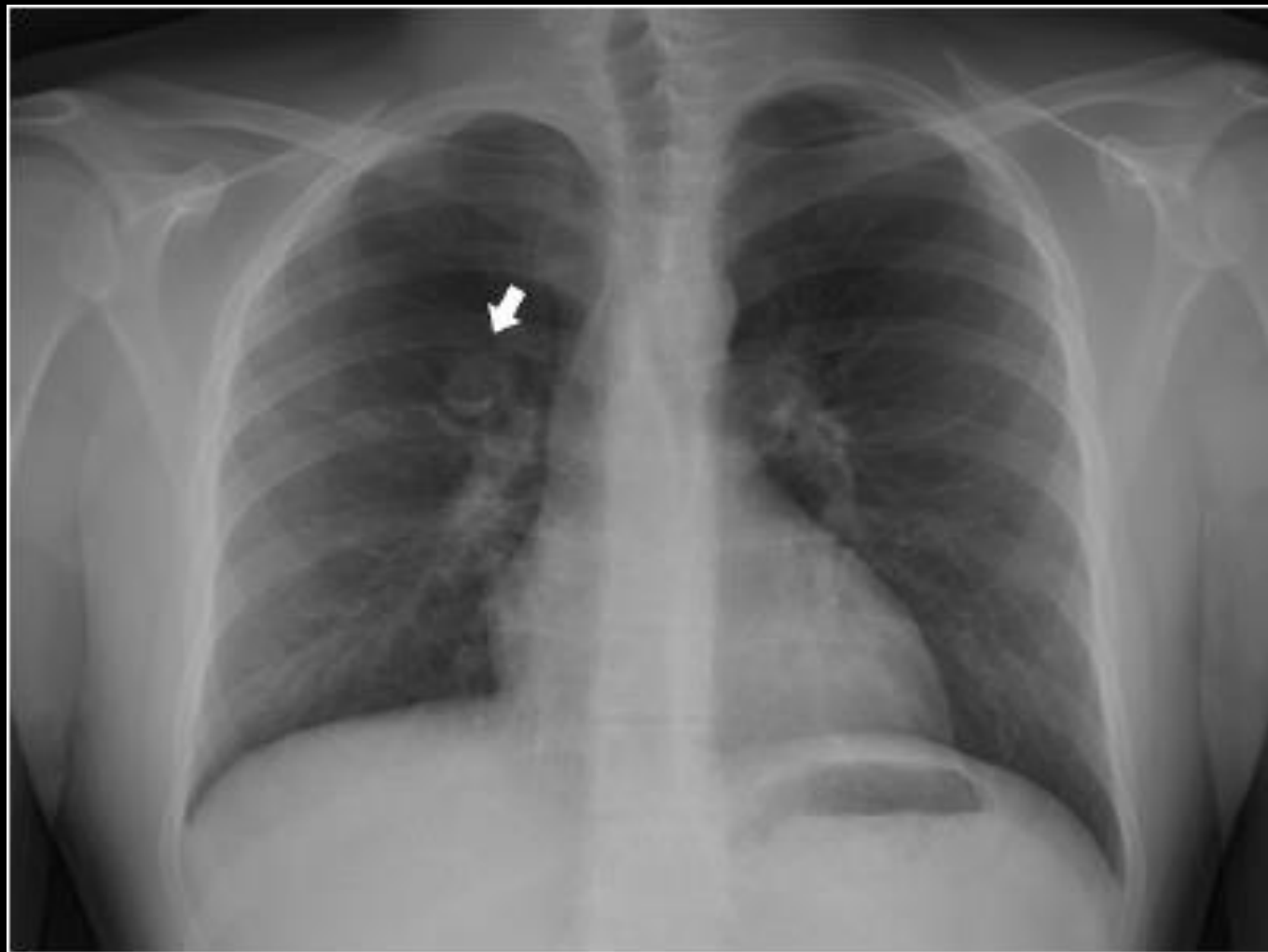
maybe due to associated lung tumors, like carcinoid tumors

- when a post-obstructive pneumonia or atelectasis does not follow an expected clinical course, think of airway-associated tumors like carcinoid tumors

# Recurrent pneumonia due to airway associated tumors

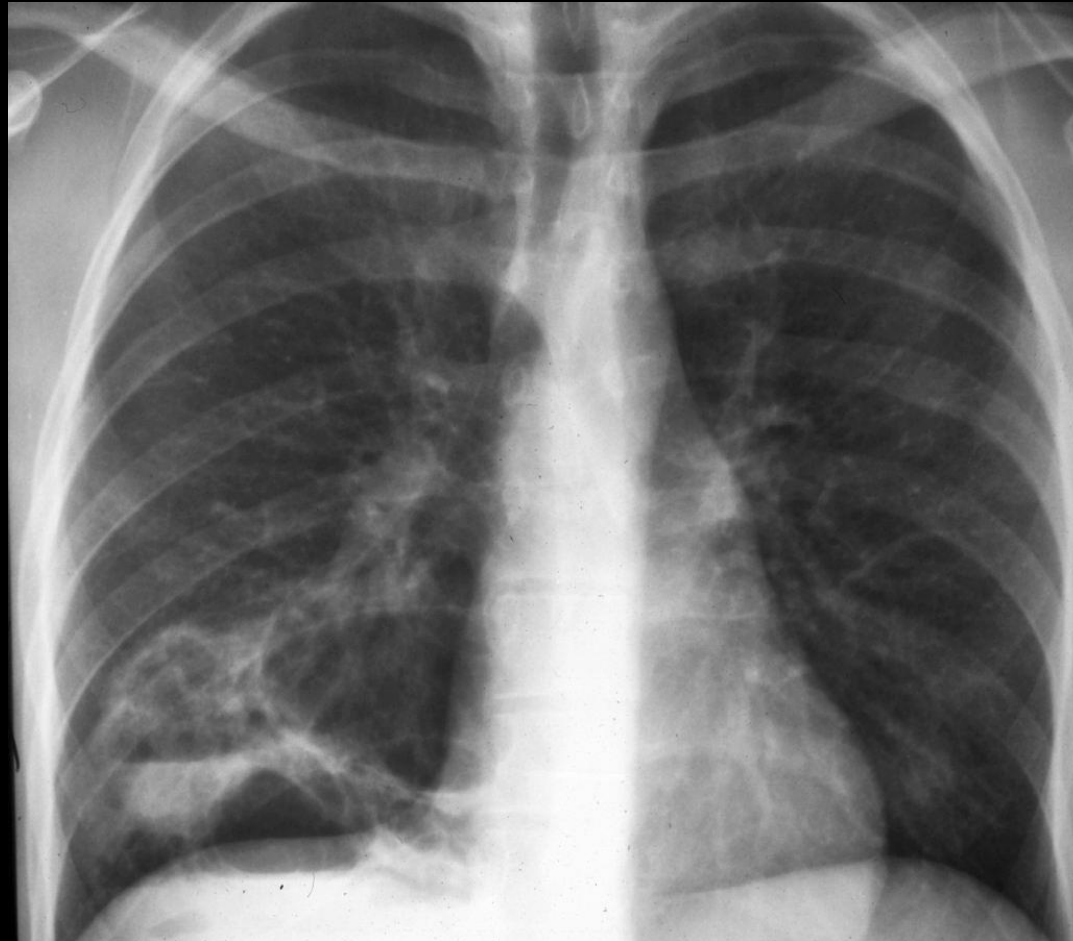
- Imaging features of airway associated tumors like carcinoid tumors
  - Chest X-ray - perihilar mass
  - Chest CT scan allows better characterization of carcinoid tumors showing airway wall association whether the tumor grows into the lumen or beyond the bronchial cartilage into the lung, often the tumor is partially endobronchial and with a more extensive lung component, this relationship to the airway wall and slow growth of the tumor results in recurrent infection and mucous filled bronchiectasis

# Carcinoid tumor



# RECURRENT PNEUMONIAS DUE TO CONGENITAL ANOMALIES

Congenital pulmonary airway malformation

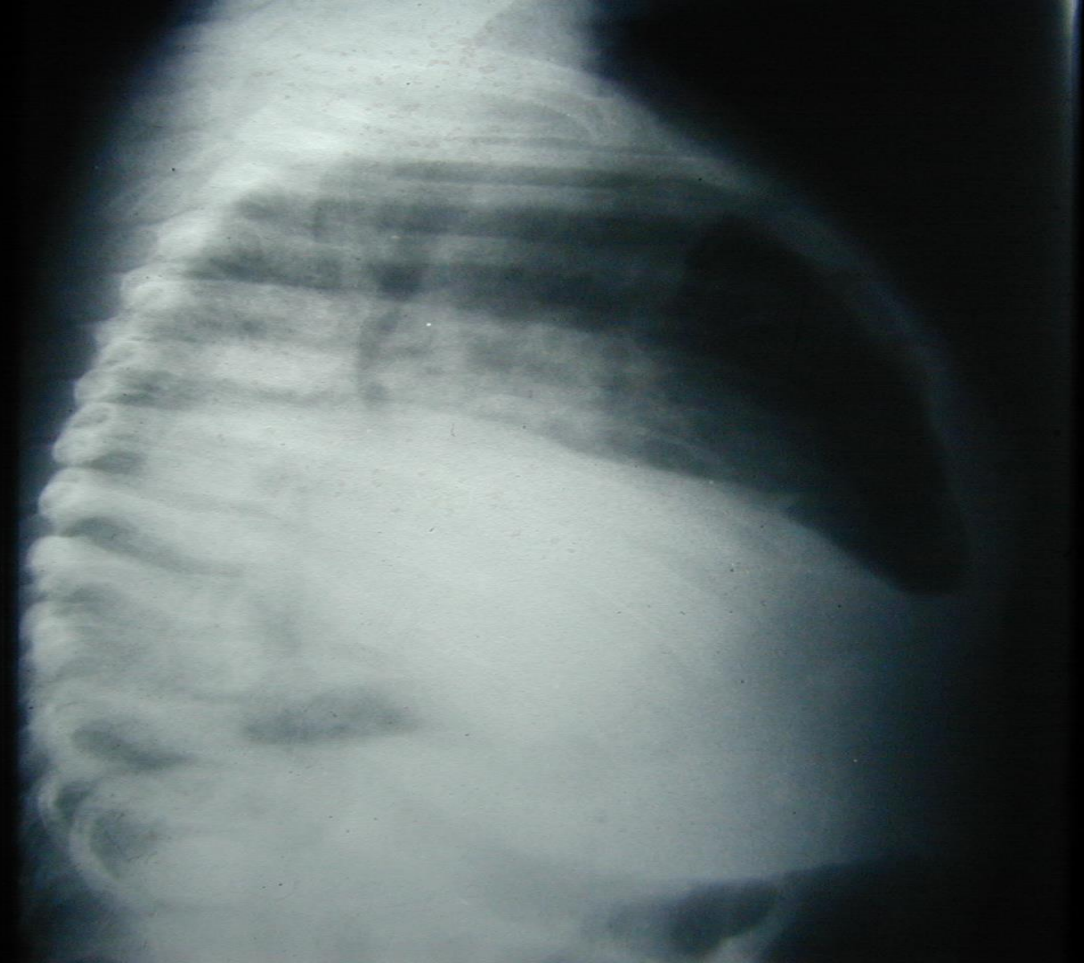
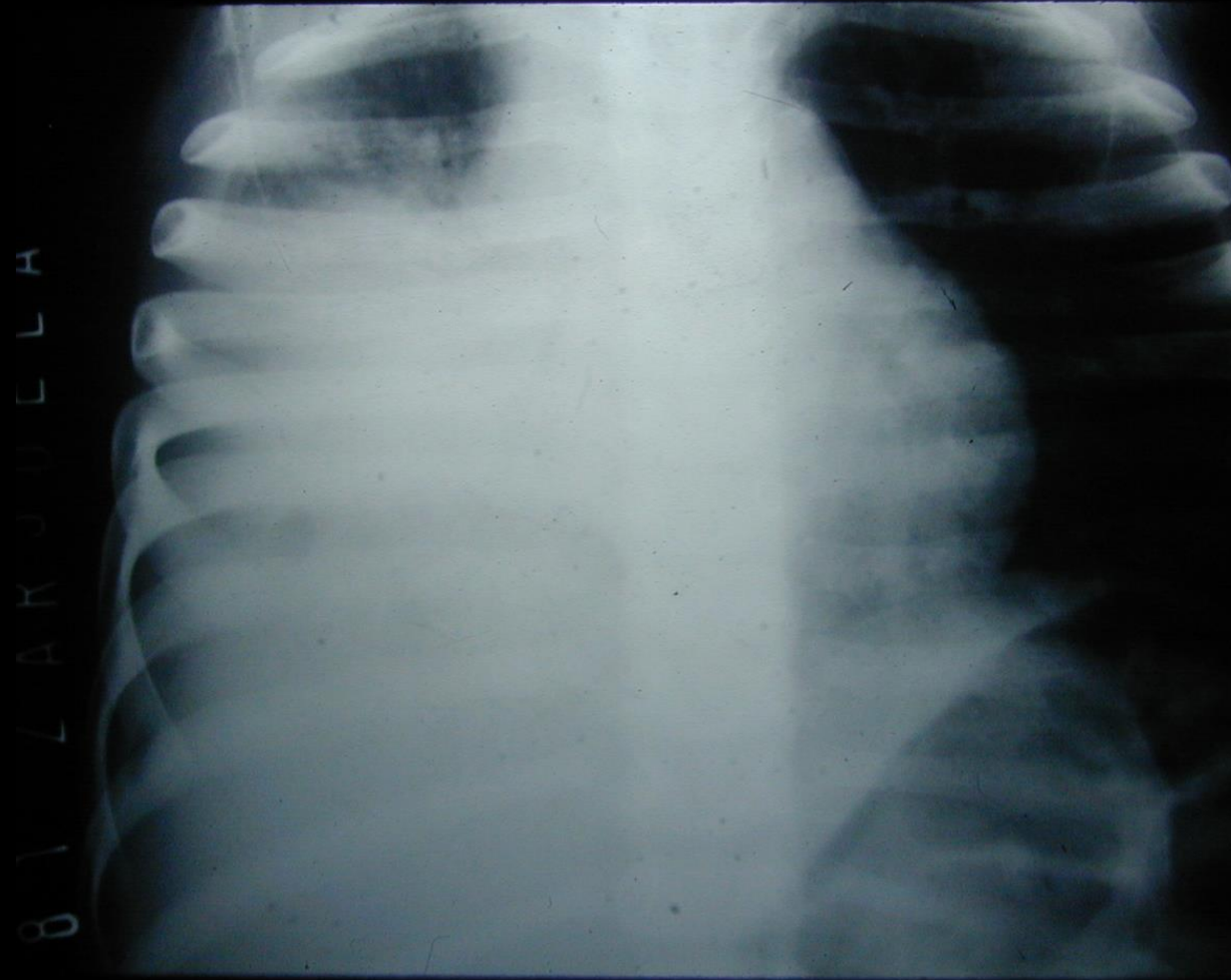


# Non-Resolving Pneumonias

## Causes:

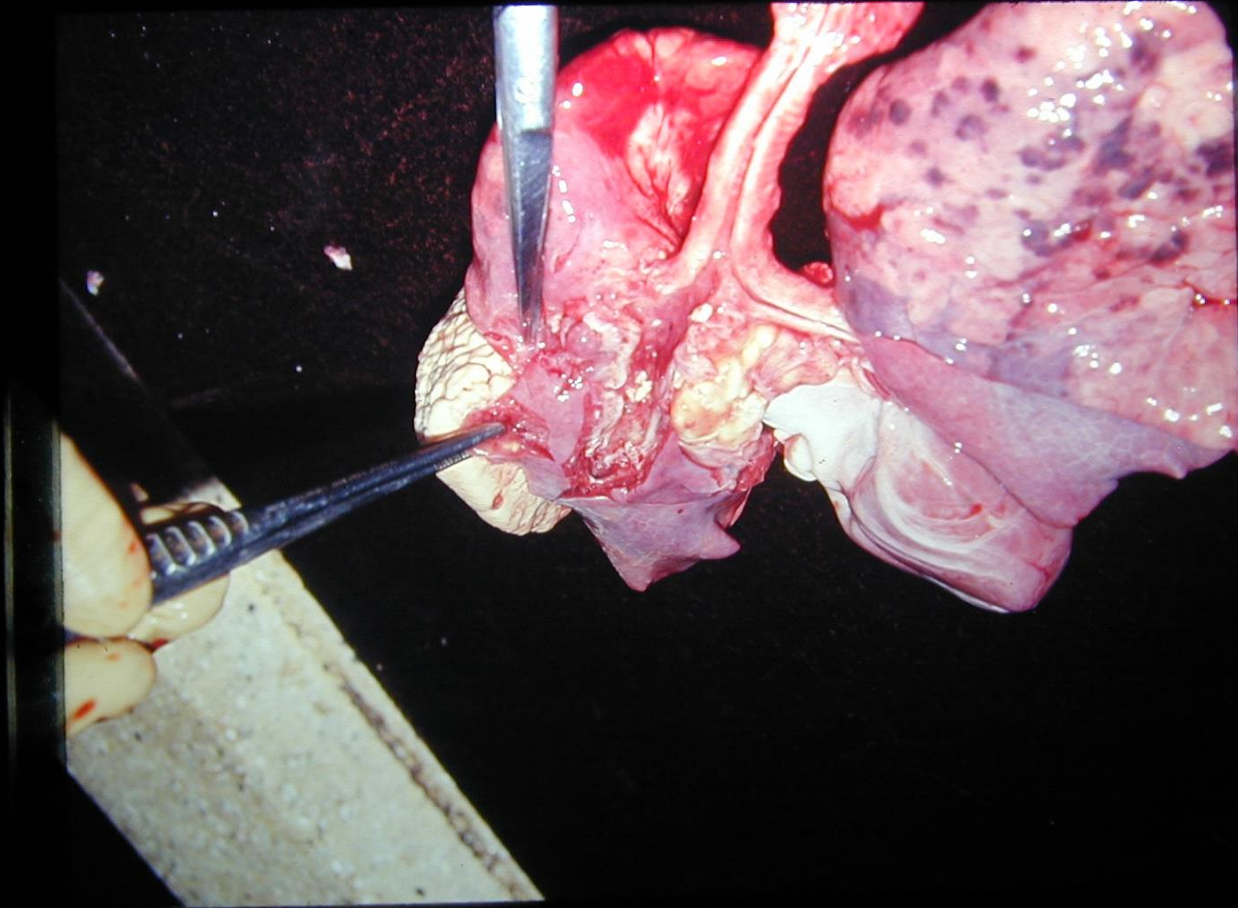
- Right middle lobe syndrome

# Right middle lobe syndrome

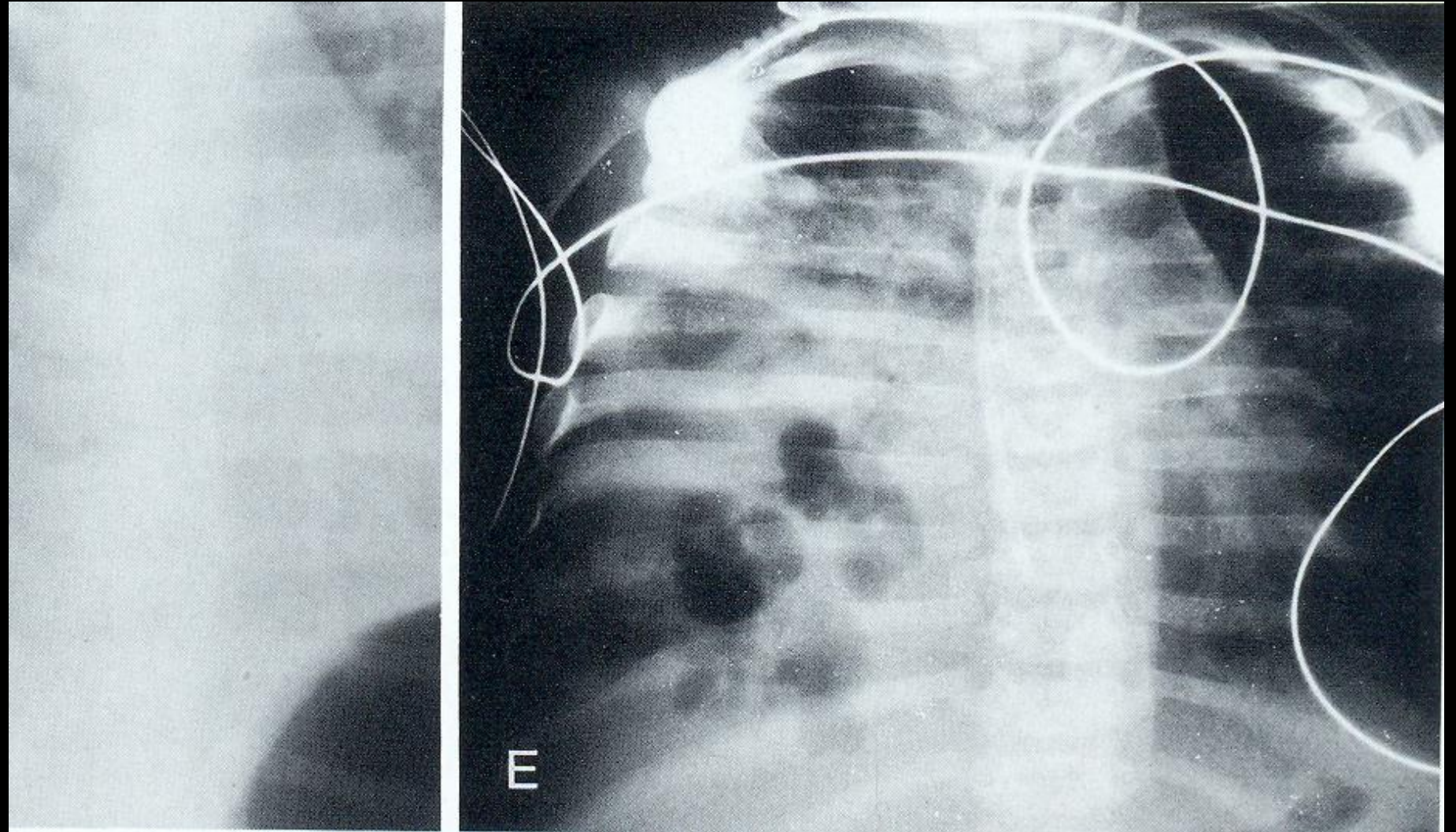




# Right middle lobe syndrome



# Necrotizing pneumonia



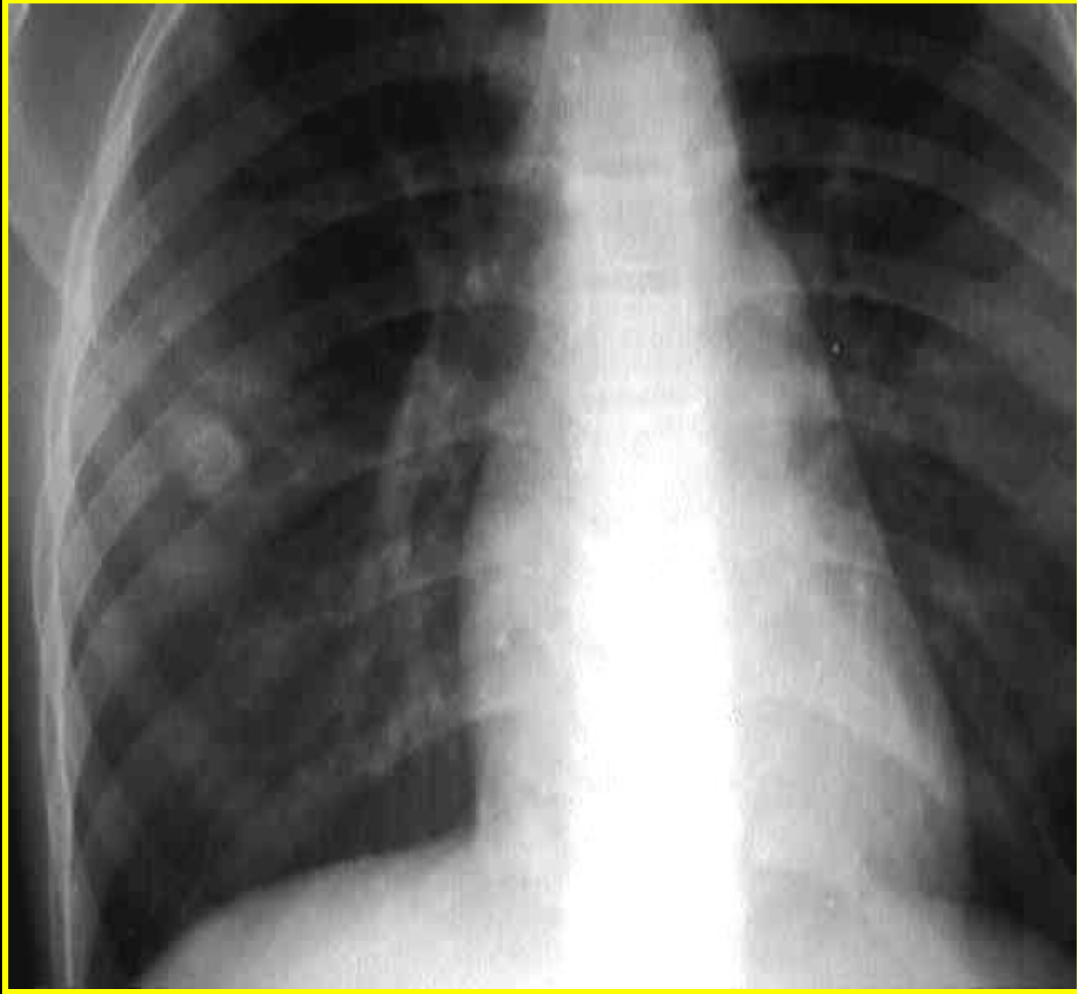
# PRIMARY PULMONARY TUBERCULOSIS

Four (4) Roentgen Features of PPTB according to Caffey's

## **1. Ghon's lesion or the primary focus of tuberculosis infection:**

- round or oblong density usually at the upper or middle lobes, but may occur anywhere in the lungs
- can be mistaken for a round pneumonia
- never clears in 1-2 weeks as could be expected from a bacterial pneumonia except for necrotizing pneumonia, which takes a longer time to clear
- decrease in size and starts to calcify usually after

# Ghon's lesion



## 2. Lymphangitis

- linear densities extending from the Ghon's lesion to the enlarged lymph node representing tuberculous lymphatic channels
- may mimic interstitial pneumonia especially if they occur at the lung bases
- clear spontaneously or scarring may occur
- clinical correlation with the patient's signs and symptoms can help differentiate one from the other

## Regional lymphadenopathy

Enlarged lymph nodes involved by tuberculosis.

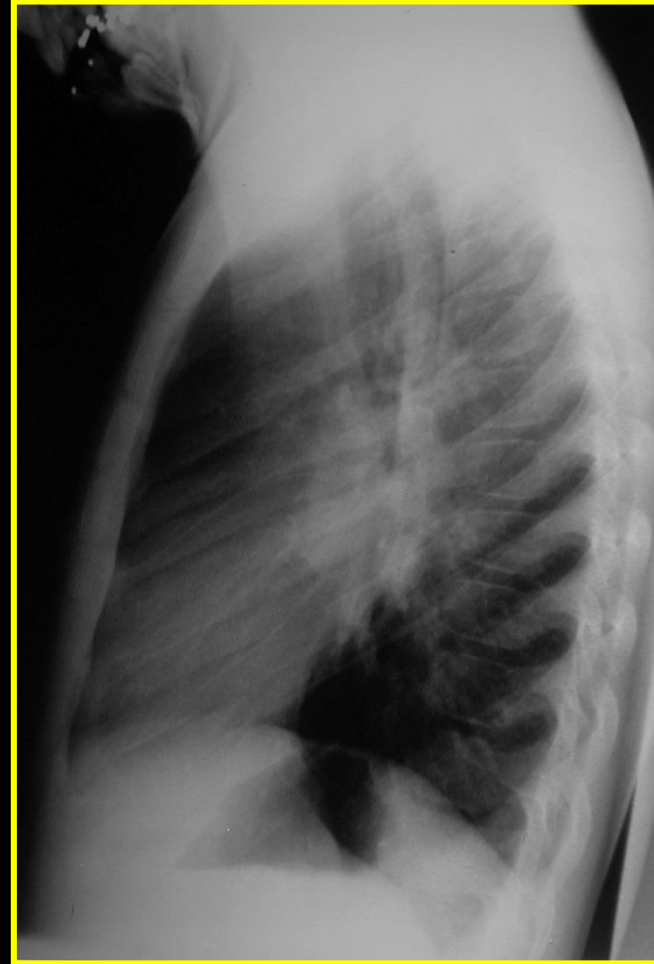
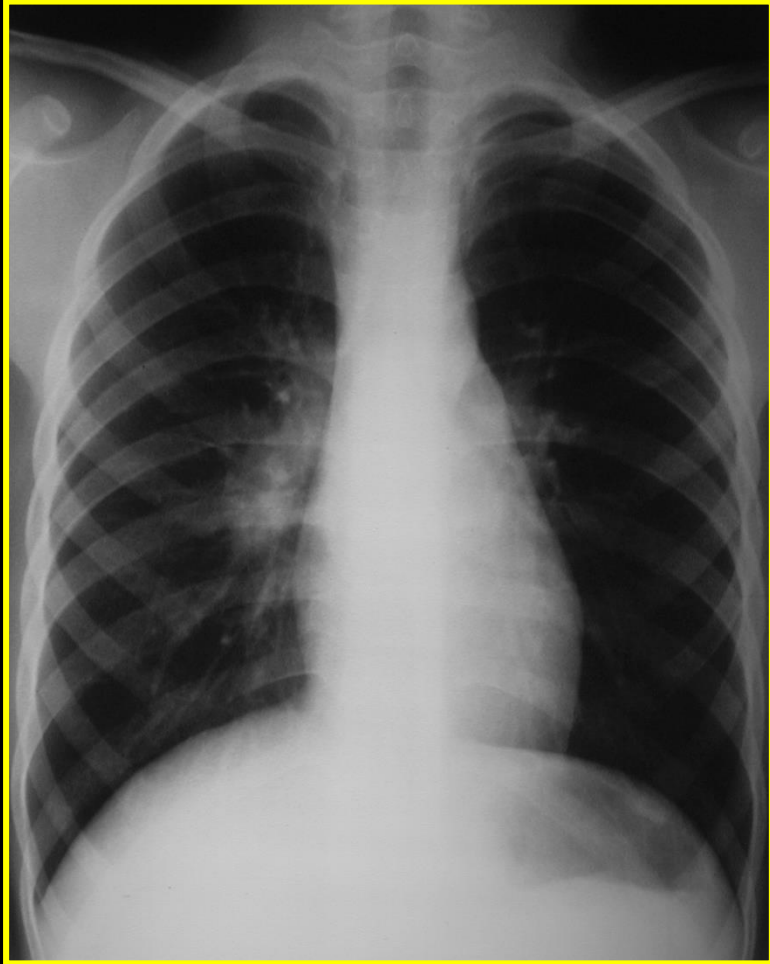
Radiographic features of tuberculous lymph nodes which will help differentiate them from lymphadenopathy due to other conditions:

- unilateral, hilar enlargement usually at the right
- commonly located in the subcarinal, hilar, distal paratracheal, or peribronchial regions

- occurs in clusters

- regresses in size and calcifies after anti-Koch's treatment

# Right hilar lymphadenopathy



# PRIMARY PULMONARY TUBERCULOSIS

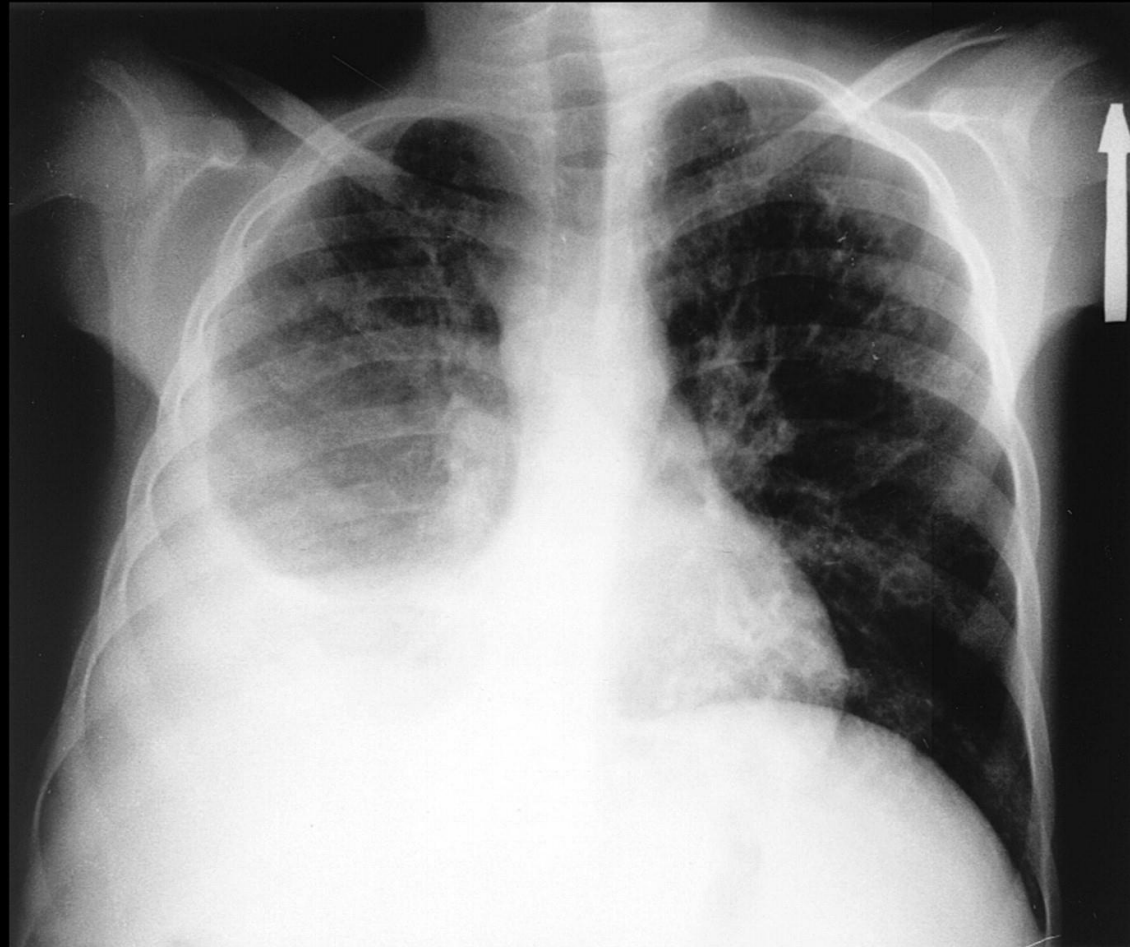
## **Pleural effusion or thickening**

homogeneous density obliterating the ipsilateral cardiac border, hemidiaphragm or sulcus depending on the amount of pleural fluid.

Tuberculous effusion tend to calcify leaving calcified pleural plaques in cases of chronic PTB (fibrothorax)



# Pleural effusion



# Summary

- Among the imaging modalities available, the chest X-ray is still the imaging modality of choice for the initial screening of pediatric patients. Chest CT scan can be done to further characterize lesions, and for further investigation of lung findings when the chest X-ray is normal or equivocal. Chest ultrasound is useful for characterizing and quantifying pleural effusion.
- Imaging findings are non-specific. Hence, correlation with the patient's clinical history and physical examination

# IMAGING OF GASTROINTESTINAL INFECTIONS

# Ultrasound

- **Ideal screening imaging modality in the evaluation of the acute abdomen in the pediatric age group:**
  - **non ionizing**
  - **non invasive**
  - **fast**
  - **highly sensitive & specific in selected conditions**

# Ultrasound

- **Ideal for the following pediatric gastrointestinal infections:**
  - **Acute appendicitis**
  - **Mesenteric adenitis**

# Conventional Protocol

## Scout film of the abdomen

A good initial screening modality since one can assess the following:

- gastrointestinal gas pattern if obstructive or non-obstructive
- presence of pneumoperitoneum or hydroperitoneum
- mass lesion like abscess
- abnormal calcification, particularly an appendicolith at the right lower quadrant
- presence of peritonitis

# CONVENTIONAL PROTOCOL

UPPER GI SERIES - to look for gastritis and ulcers

SMALL INTESTINAL SERIES - to look for enteritis as well as to evaluate the ileocecal region in cases of ileocecal tuberculosis

BARIUM ENEMA - to look for colitis or inflammatory strictures

# **CT SCAN OF THE ABDOMEN**

## **CLINICAL APPLICATIONS**

### **Acute appendicitis**

**When the clinical and ultrasound findings are equivocal or the appendix is obscured by overlying gas on ultrasound, the CT scan can help determine the presence of an inflamed appendix, appendicolith, phlegmon or periappendiceal abscess**



# **A. ACUTE APPENDICITIS**

- Premier imaging modality in imaging children with equivocal or ambiguous clinical findings**
- It allows one to perform a transducer guided physical examination**

# **A. ACUTE APPENDICITIS**

## **Role of Ultrasound**

- **To establish the diagnosis of acute appendicitis**
- **To aid in the diagnosis of other abdominal and pelvic conditions that may mimic acute appendicitis**
- **For post-operative evaluation to detect pelvic or abdominal abscess and guide percutaneous needle aspiration if present**

# **A. ACUTE APPENDICITIS**

## **Normal Appendix:**

- **Tubular appearance with a blind end on longitudinal scan with a target appearance in the axial plane**
- **Compressible**
- **Cross sectional diameter of 6 mm or less**
- **More ovoid configuration of appendix in cross section**

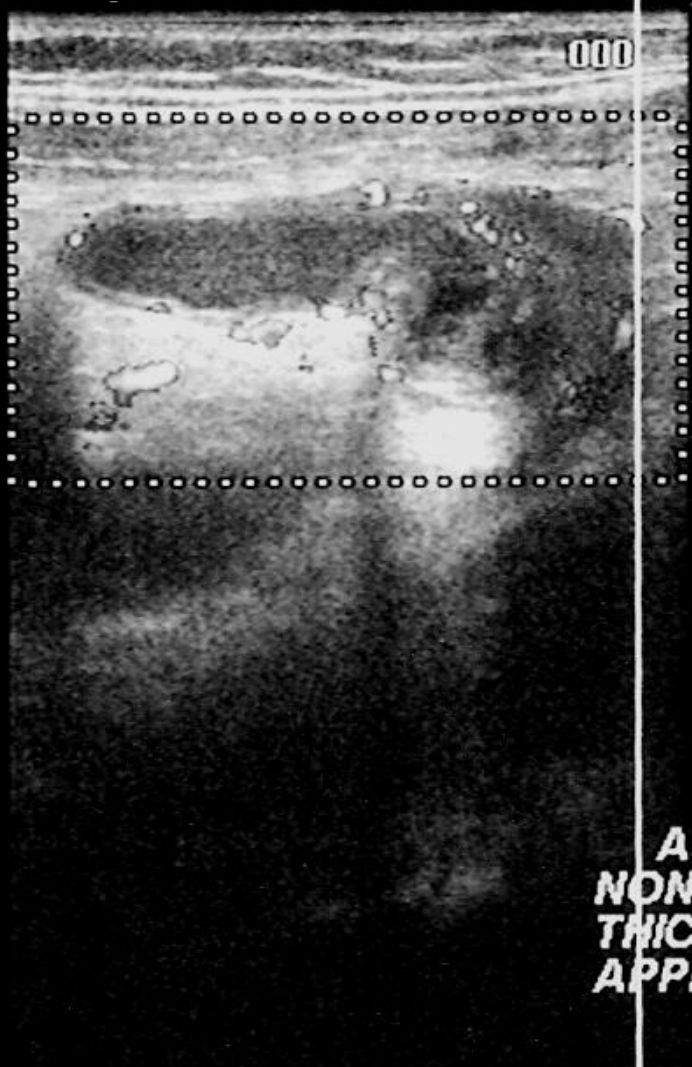


# ACUTE APPENDICITIS

## ◎ Sonographic hallmarks:

Fluid filled, non compressible aperistaltic tubular structure at the RLQ

- Cross sectional diameter of appendix > 6 mm.
- Marked hyperemia of inflammed appendiceal wall
- Appendicolith: echogenic focus with posterior acoustic shadowing within the appendix



**APPENDIX  
NON COMPRESSIBLE  
THICKENED HYPEREMIC WALL  
APPENDICOLITH**

No.53/53

No.44/44

BG:20 75H/2/4/2/A/6 CG:46 M/2M/2/4/3 800/6.5M BG:20 75H/2/4/2/A/6  
L54M 9.0M Thyroid 85mm L54M 9.0M Thyroid 85mm

1 Review 2 SPD; 3 Color Map; 5 4 Flow Invert 5 Volume 6 Ratio-Area 7 Area-E

FR:7

8F

Calip

D1:

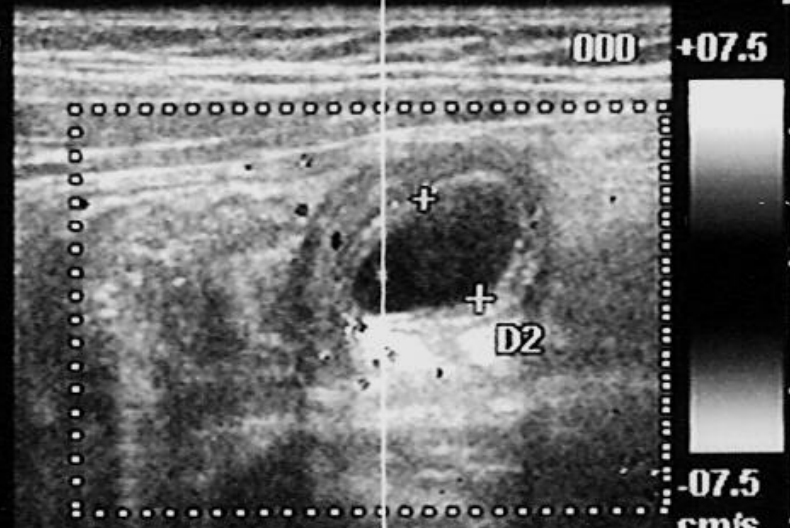
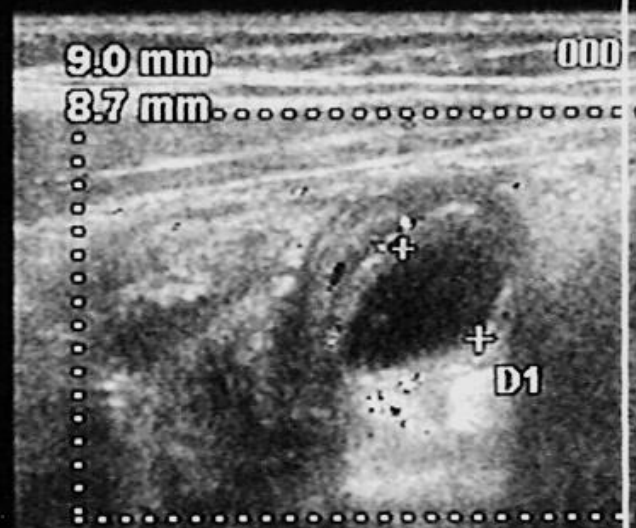
9.0 mm

000 +07.5

D2:

8.7 mm

07.5  
cm/s



APPENDIX  
NON COMPRESSIBLE  
THICKENED HYPEREMIC WALL  
APPENDICOLITH

No.22/22

CV

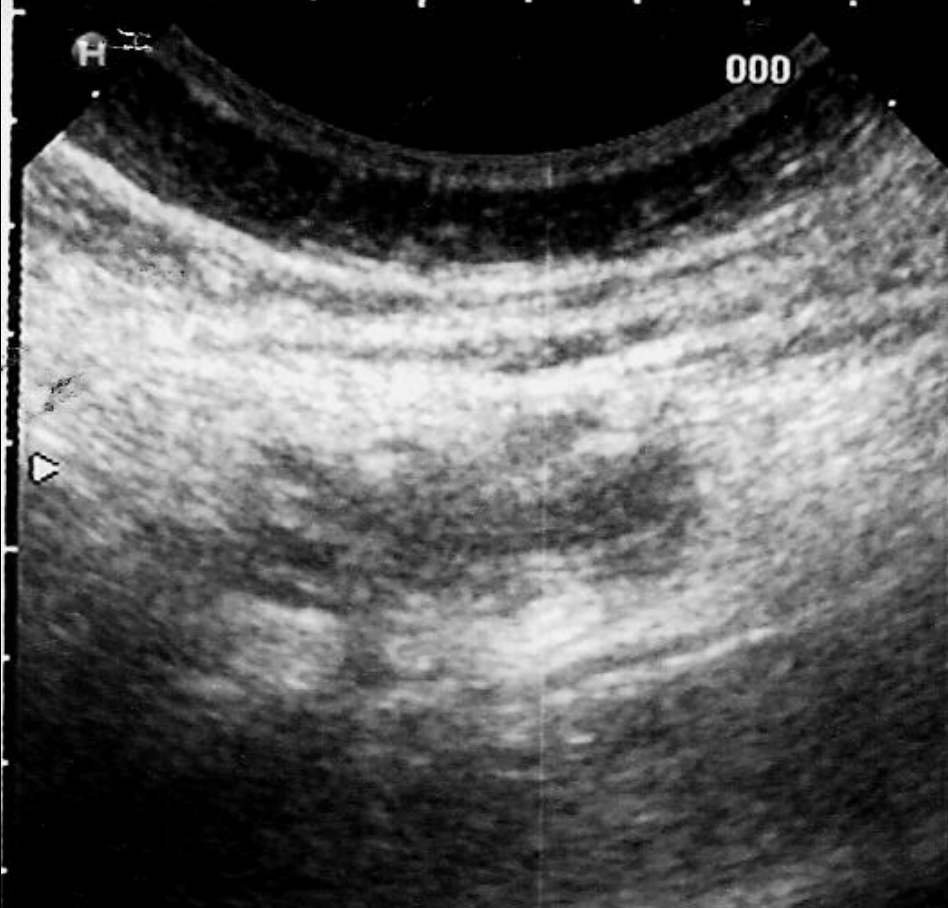
No.42/42

BG:20	75H/2/4/2/A/6	CG:42	M/1/M/3/3/B	1.3k/6.5M	BG:20	75H/2/4/2/A/6	CG:42	M/1/M/3/3/B	1.3k/6.5M
L54M	9.0M	Thyroid		85mm	L54M	9.0M	Thyroid		85mm

Review   
  SPD;   
  Color Map;5   
  Flow Invert   
  Volume   
  Ratio-Area   
  Area-E







**ACUTE SUPPURATIVE APPENDICITIS**

**CV**

No.97/98

No.98/98

BG:15 80/11/11/1-1-

BG:15 80/11/11/1-1-

C314G dTHI-R Adult Abdomen

110mm

C314G

dTHI-R

Adult Abdomen

110mm

1 B-Dyn.;80

2 HI REZ+

3 B-Enh.;1

4 Gray Map;1

5 B-AGC;1

6 R-Filter;-

7



RLQ PHLEGMON

No.98/98

No.98/98

BG:-13 65/+1/1/1/1-  
C514

dTHI-P

Adult Abdomen

85mm

1 B-Dyn:65

2 HI REZ+

3 HI REZ+1

4 Gray Map:1

5 B.AGC:1

6 B Filter

7

BG:-13 65/+1/1/1/1-  
C514

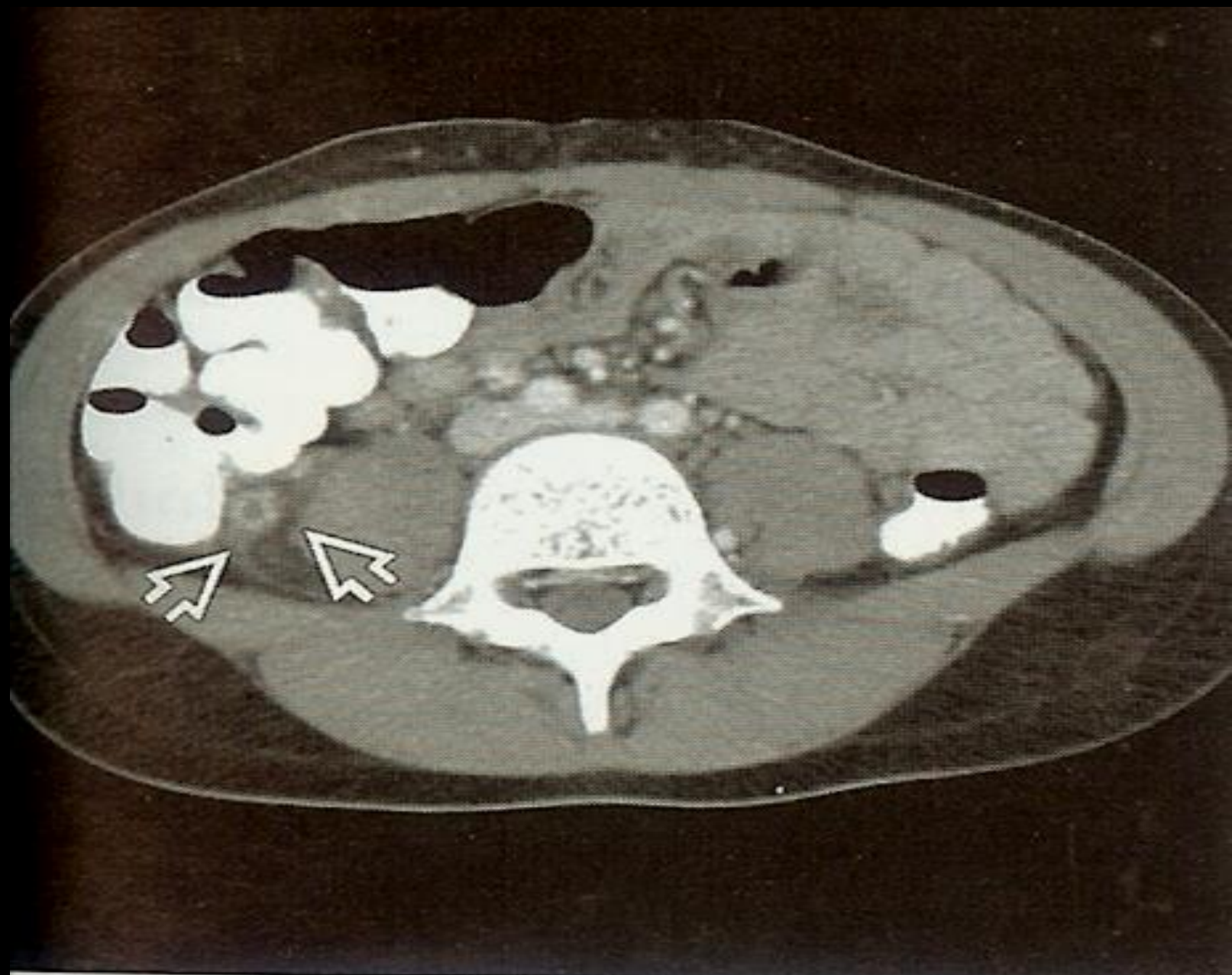
dTHI-P

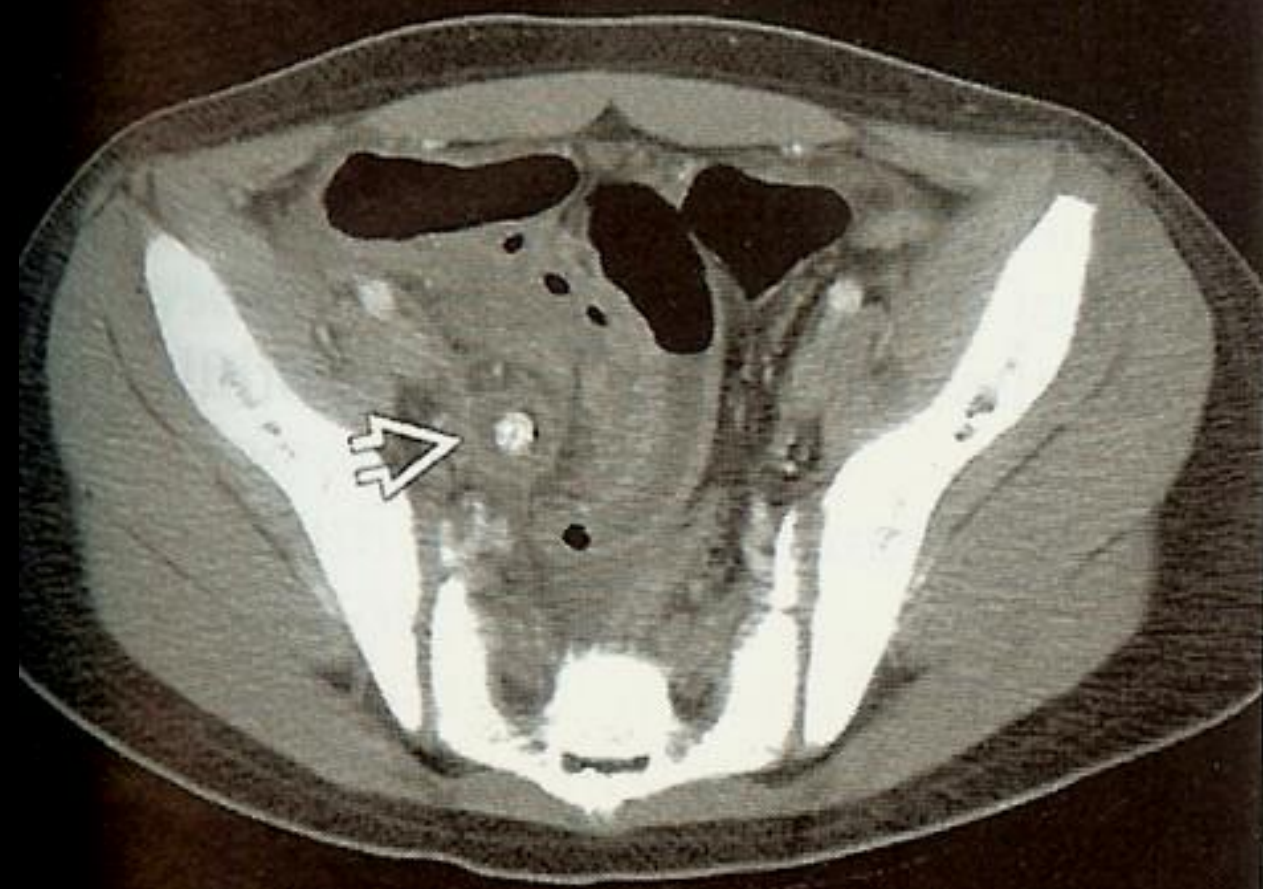
Adult Abdomen

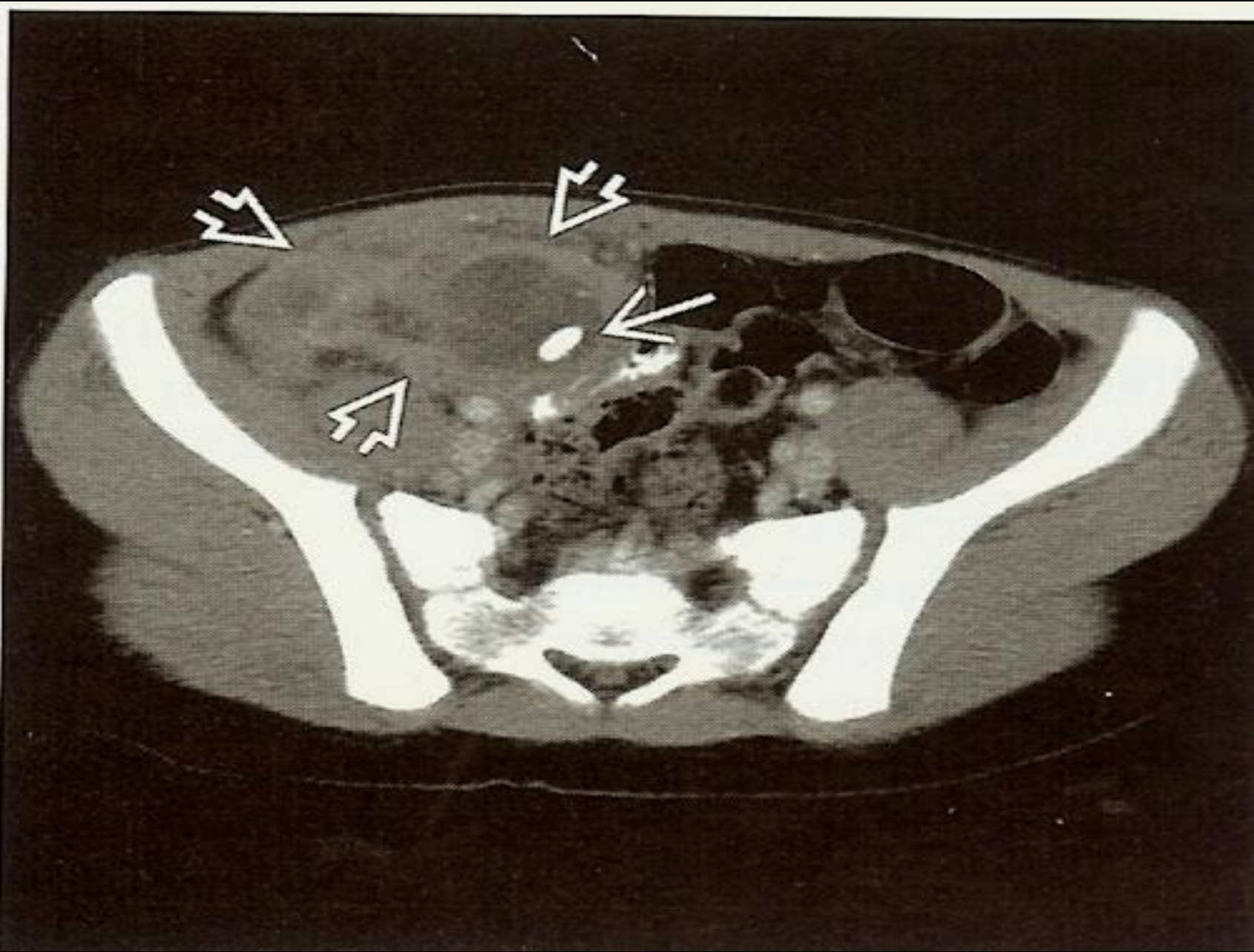
85mm

**ROLE OF CT SCAN  
IN  
ACUTE  
APPENDICITIS**

- CT scan can visualize the appendix when it is obscured by overlying gas and cannot be detected by ultrasound
- It can further detect complications of acute appendicitis when these are not seen on ultrasound.







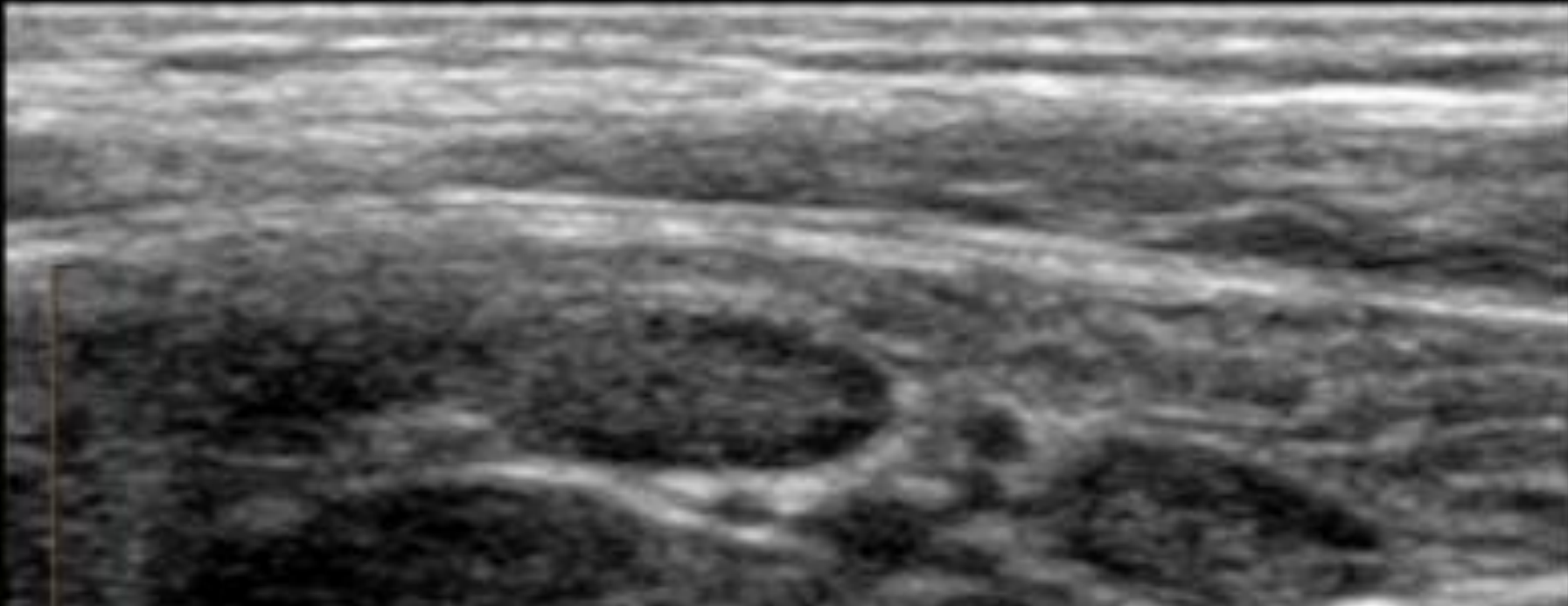
# Mesenteric Adenitis

- Mesenteric adenitis is a self-limiting inflammatory process that affects the mesenteric lymph nodes in the right lower quadrant, and is clinically often mistaken for acute appendicitis.
- As mesenteric adenitis usually presents in the young, ultrasound is often the investigation of choice.
- 3 or more nodes with a short-axis diameter of at least 5 mm clustered in the right lower quadrant
- Appendix is normal



# Mesenteric adenitis

## 1. Mesenteric Adenitis



Mesenteric adenitis is the most common condition that can be negative. It is a benign condition of the ileum characterized by enlarged lymph nodes that are caused by a variety of factors including enterococci and pseudotuberculosis.

# NECROTIZING ENTEROCOLITIS

- : In premature infants especially those with a history of difficult delivery
- : “dive seal reflex” - visceral blood supply is compromised in order to preserve the vascular supply to the brain resulting in ischemic bowel disease, secondary invasion and destruction of mucosa by overgrowth of intestinal flora

# NECROTIZING ENTEROCOLITIS

## Etiology:

- Intestinal ischemia or hypoperfusion leading to altered mucosal integrity
- Bacterial overgrowth with gas formation in bowel wall

# SCOUT FILM OF THE ABDOMEN

- ◎ **PLAIN FILM FINDINGS OF NECROTIZING ENTEROCOLITIS**

- I. EARLY SIGNS:

- ◎ ADYNAMIC ILEUS

- ◎ “SAUSAGE SHAPED ILEUS”

# SCOUT FILM OF THE ABDOMEN

- ◎ **PLAIN FILM FINDINGS OF NECROTIZING ENTEROCOLITIS**

- LATE SIGNS

- ◎ PNEUMOPERITONEUM

- ◎ PORTAL VEIN GAS

- ◎ PNEUMATOSIS INTESTINALIS



# SUMMARY

- In the pediatric age group, the most ideal imaging modality is one that is non-ionizing and non invasive, and that is ultrasound.
- For other infections involving the gastrointestinal tract like reflux esophagitis, peptic ulcer or gastritis, which do occur in children, upper GI series is the imaging modality of choice.
- For enteritis, small intestinal series can be done.
- For colitis, like amoebic or ischemic, barium enema is the imaging modality of choice.

# SUMMARY

- CT scan is reserved for conditions which are not appreciated in ultrasound and contrast studies of the gastrointestinal tract due to the increased radiation.



Thank you and  
good afternoon!