

# CHEST EXAMINATION IN CHILDREN

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# DIAGNOSTIC METHODS IN CHEST DISEASES

- **Chest X-ray**  
first choice in most diseases in the chest
- **Computed Tomography (CT)**
- **USG**
- **NS**
- **MRI**

# CHEST EXAMINATION

I. TECHNICAL FACTORS AND FILMS  
INTERPRETATION

II. COMMON PATHOLOGIC CONDITIONS

III. LUNG DISEASES IN NEONATE

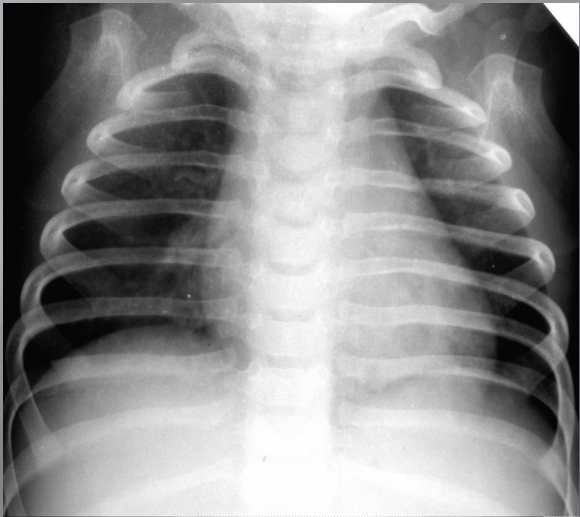
IV. MEDIASTINAL MASSES

V. CONGENITAL HEART DISEASE

# I. TECHNICAL FACTORS AND FILMS INTERPRETATION

# CHEST X-RAY

the most frequently ordered examination



# INTERPRETING THE FILM ( A, B, C, D's)

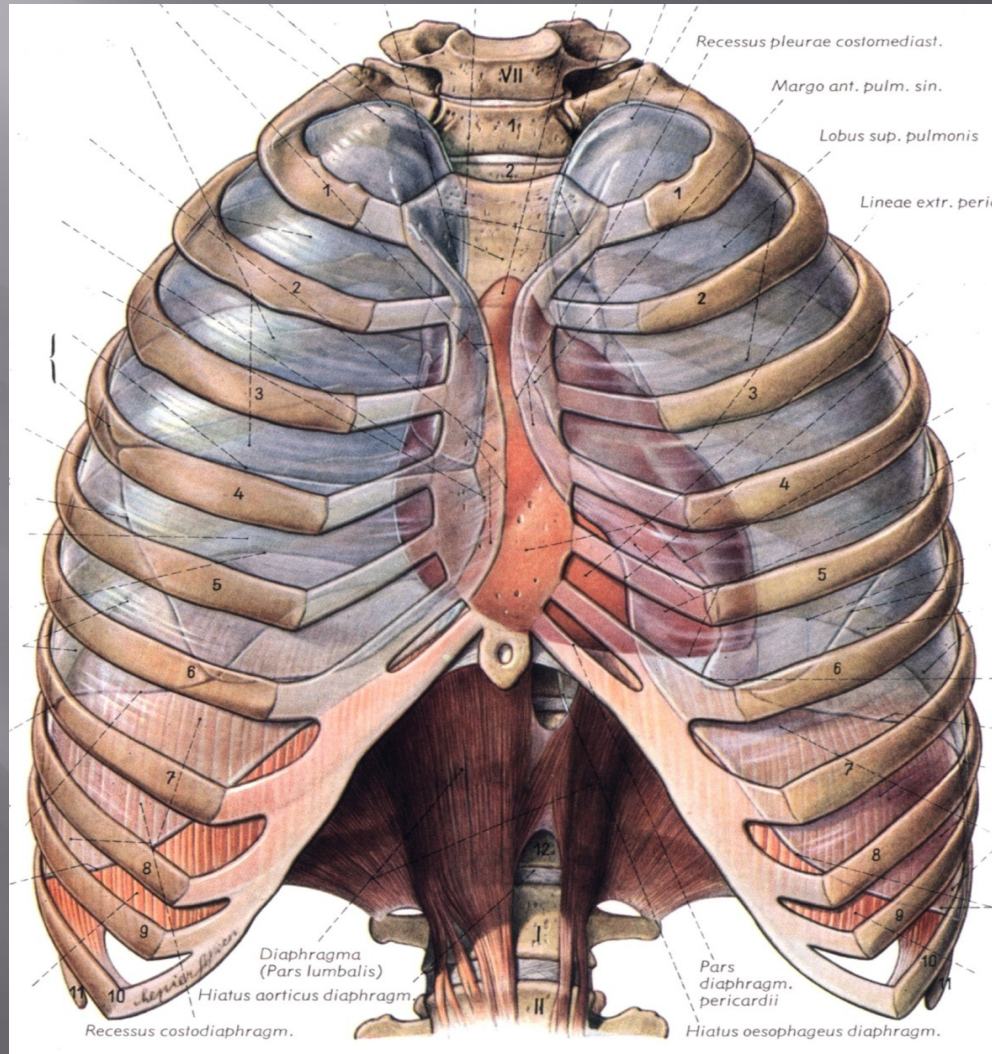
**A** = ABDOMEN

**B** = BONES & SOFT TISSUES

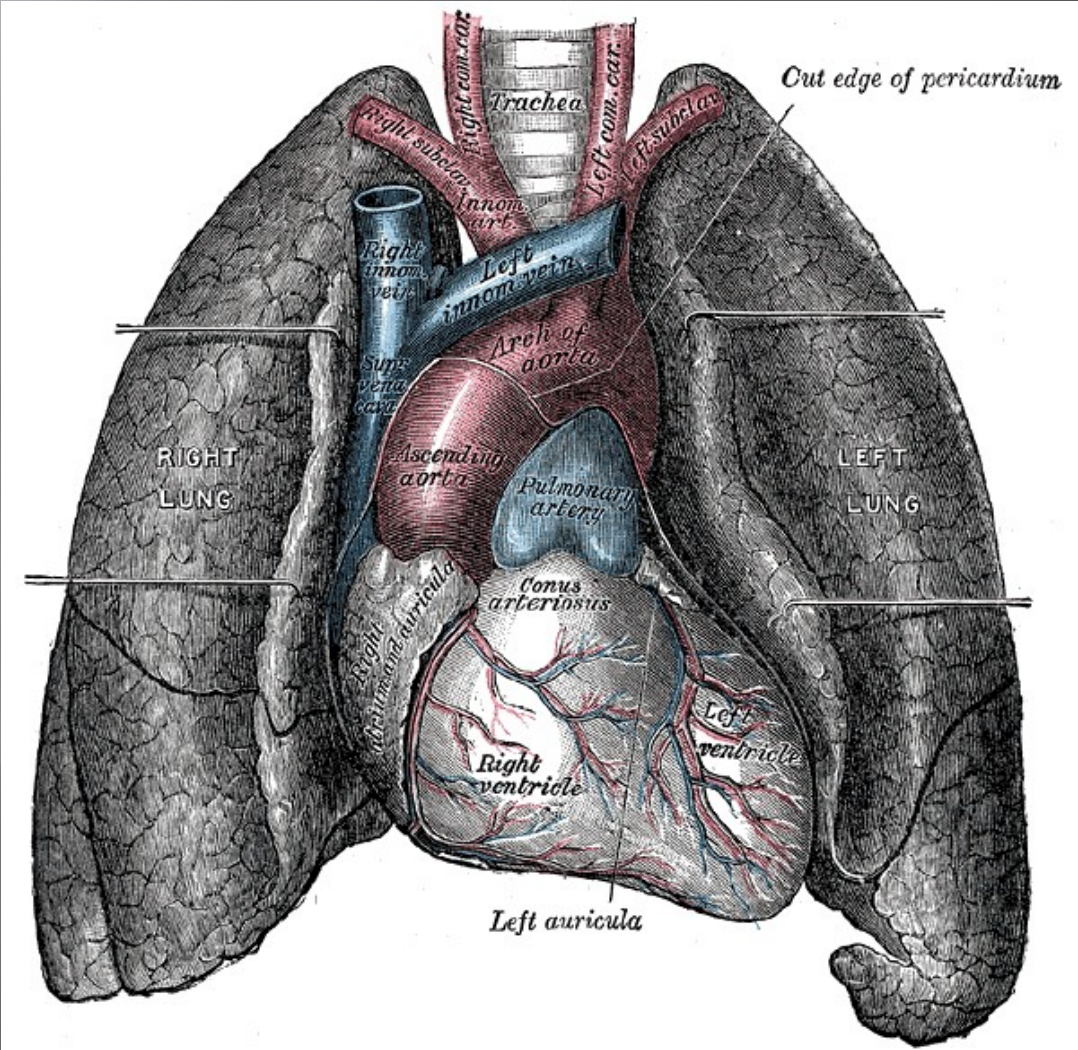
**C** = CHEST - airways, mediastinum, lungs

**D** = Diaphragm

# CHEST ANATOMY

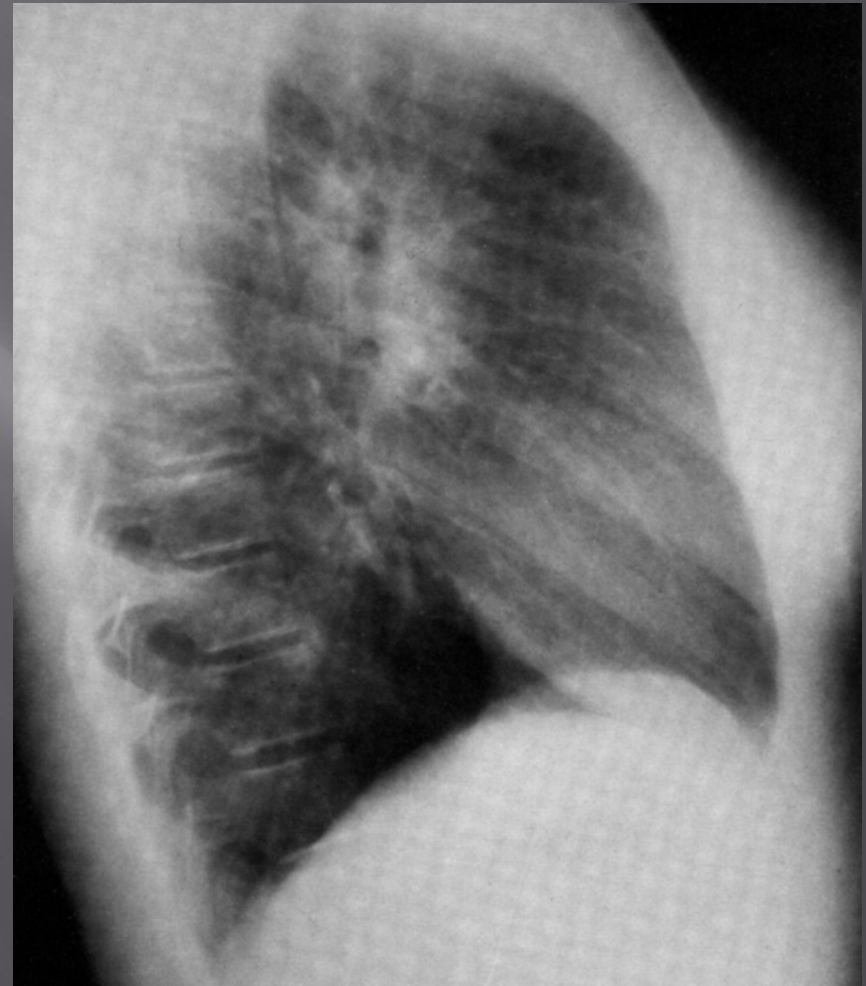
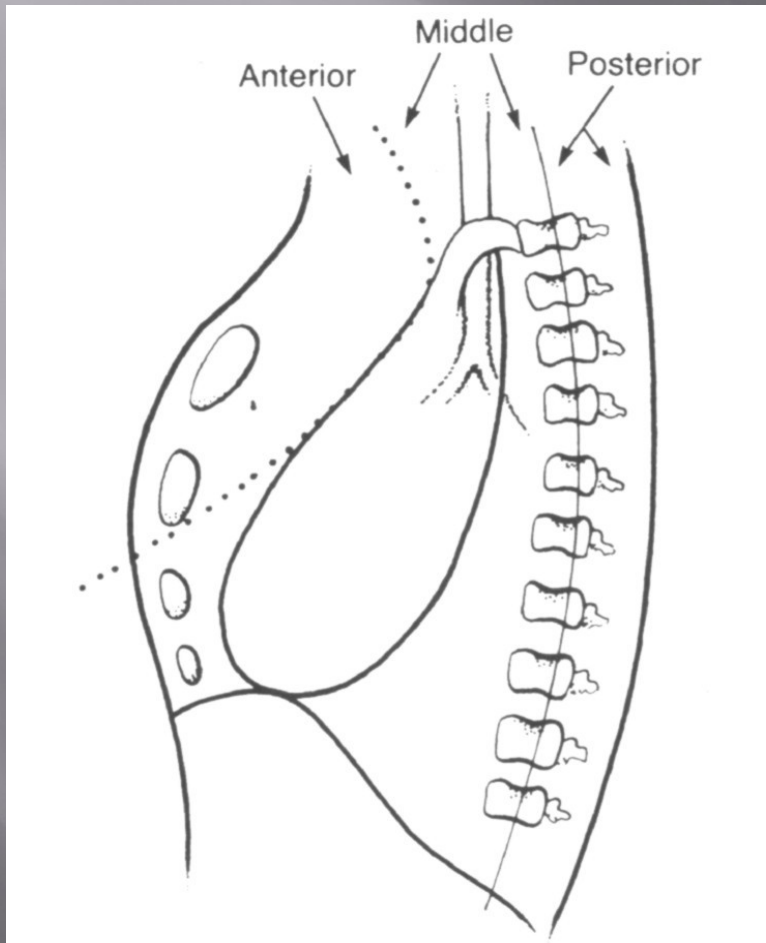


# CHEST ANATOMY - MEDIASTINUM

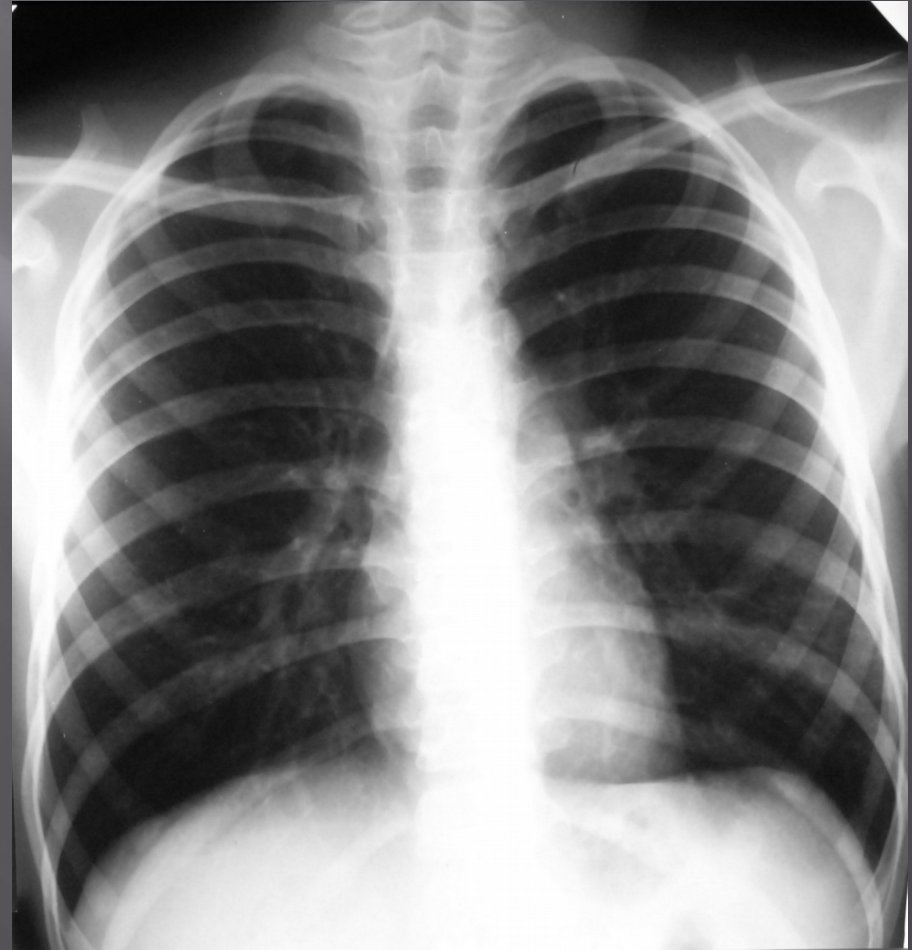
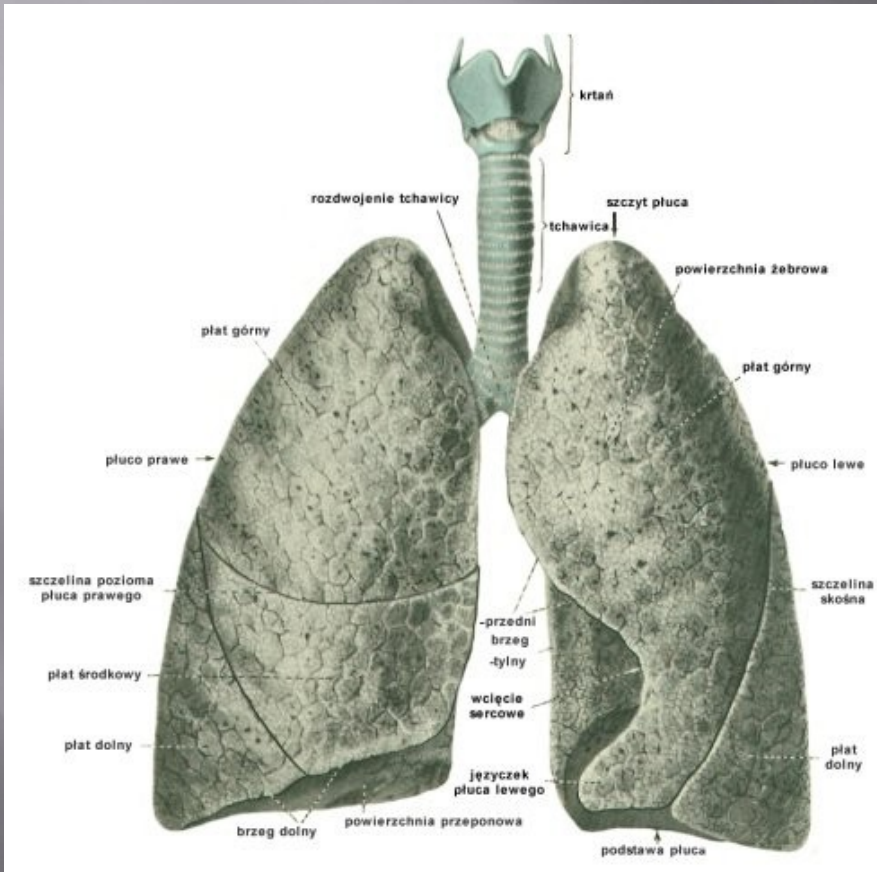




# MEDIASTINUM



# LUNGS



# STANDARD CHEST X-RAY

- position – erect
- beam direction - PA
- distans 120-150 cm



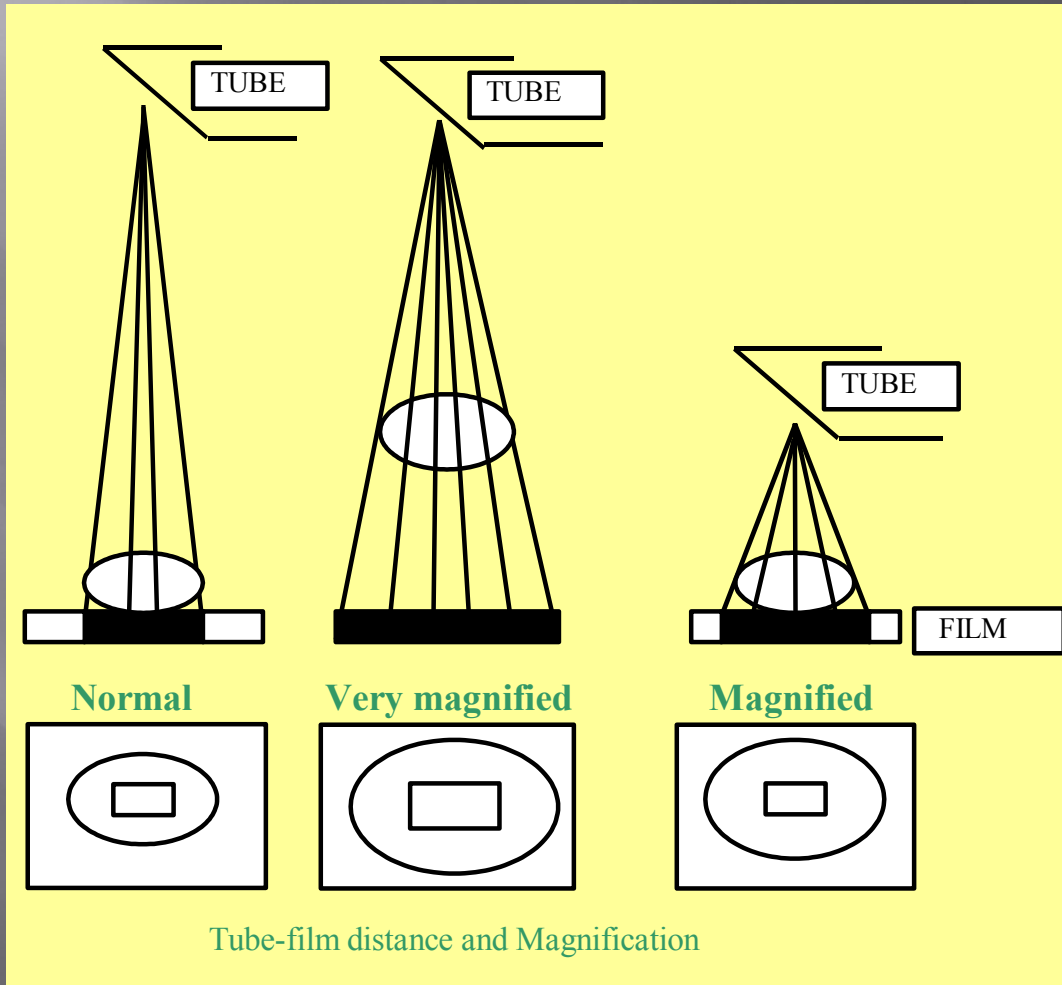
# PEDIATRIC CHEST

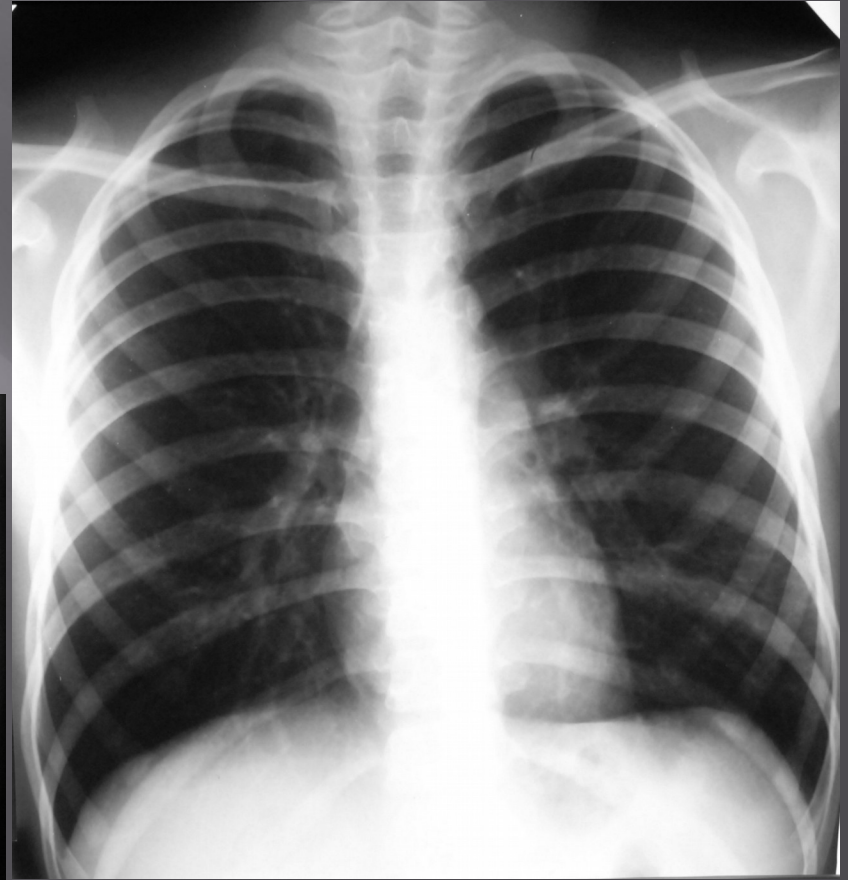
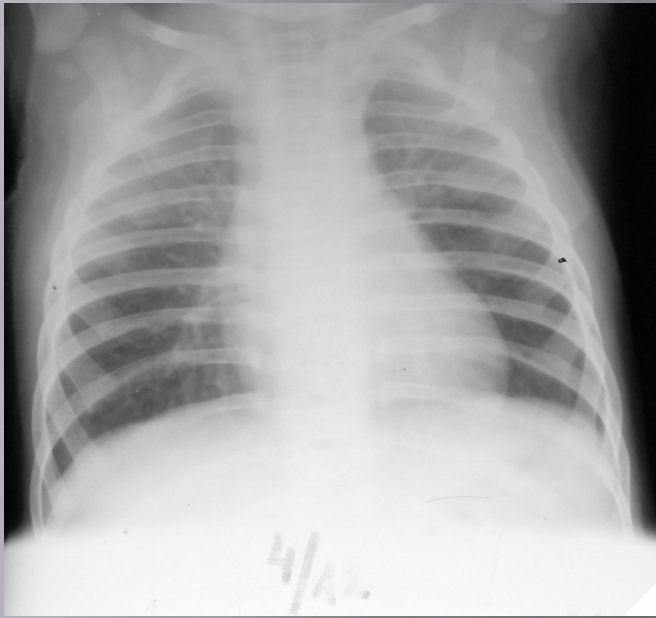
(OR BEDRIDDEN PATIENTS)

- position – supine
- beam direction – AP
- distans – 100-120 cm and less..

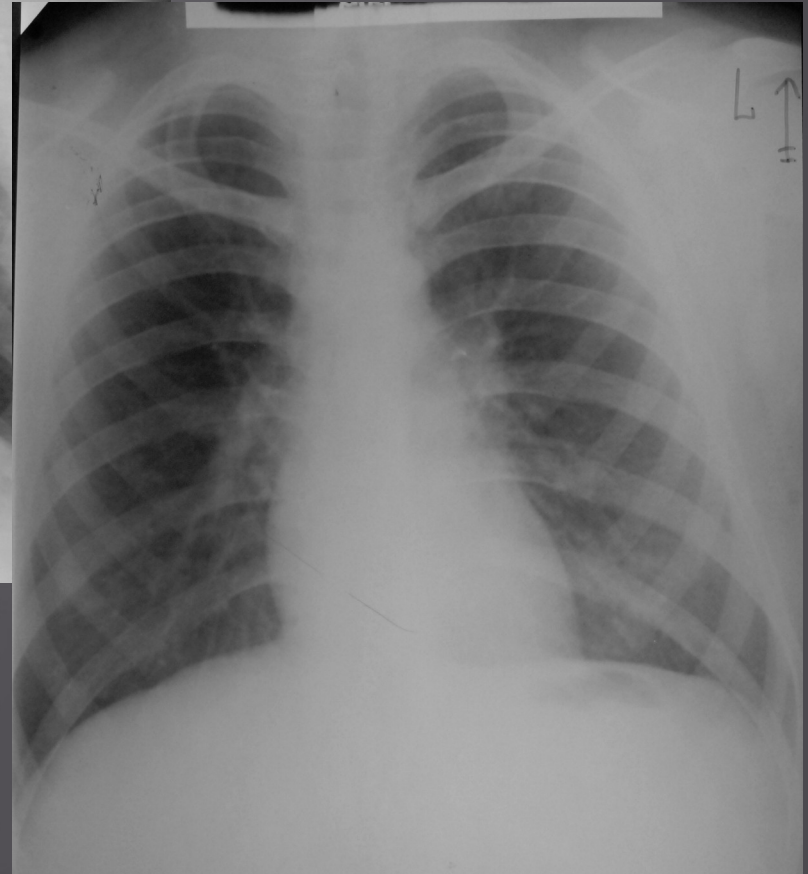
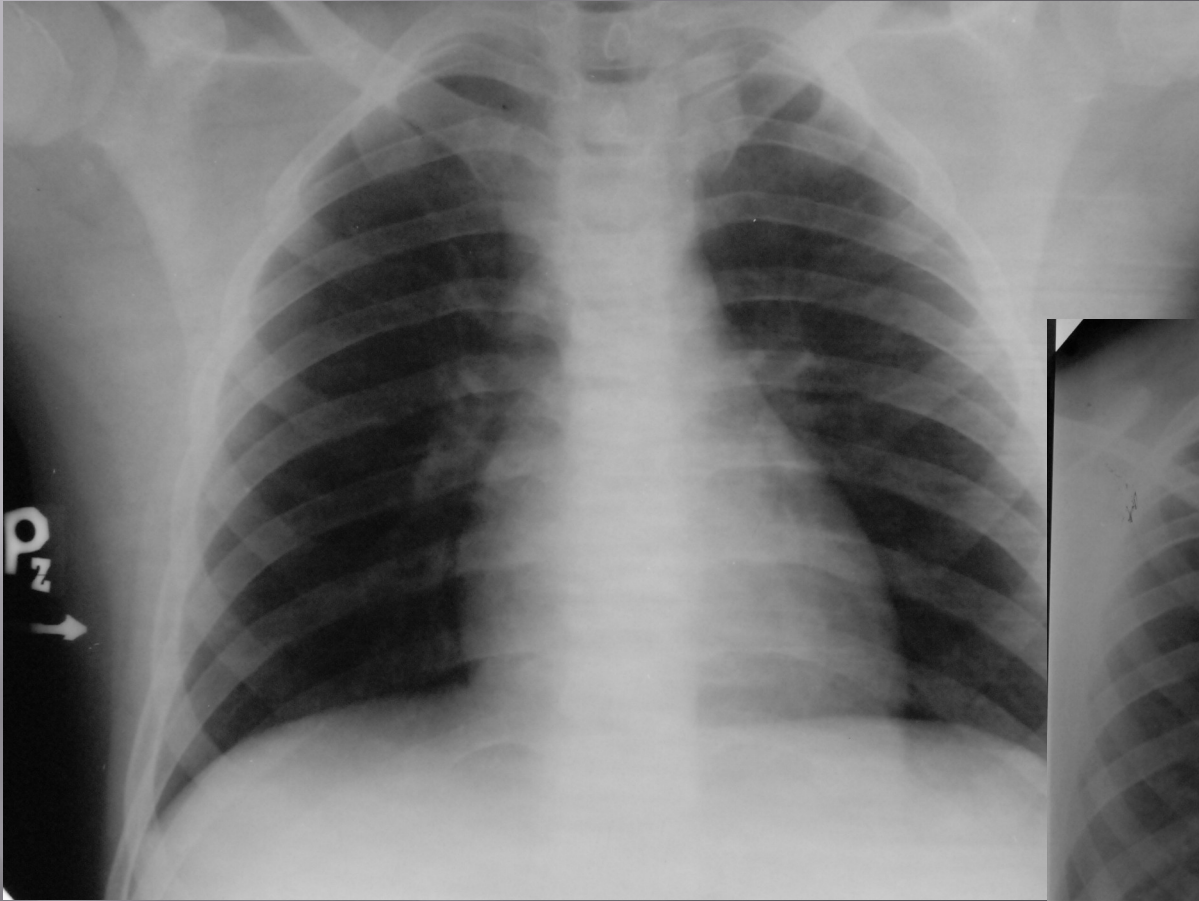


# GREATER MAGNIFICATION OCCURS WHEN STRUCTURES, SUCH AS THE HEART, ARE FARTHER FROM THE FILM !!!





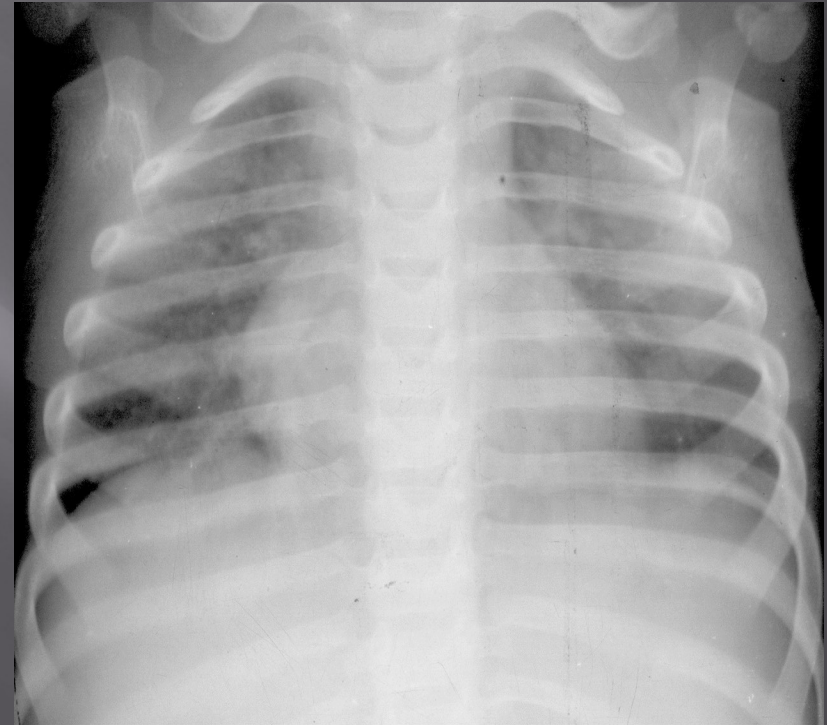
# POSITION



# THE DEGREE OF INSPIRATION

THE LUNG VOLUME DETERMINES  
WHAT IS SEEN ON THE FILM !!!

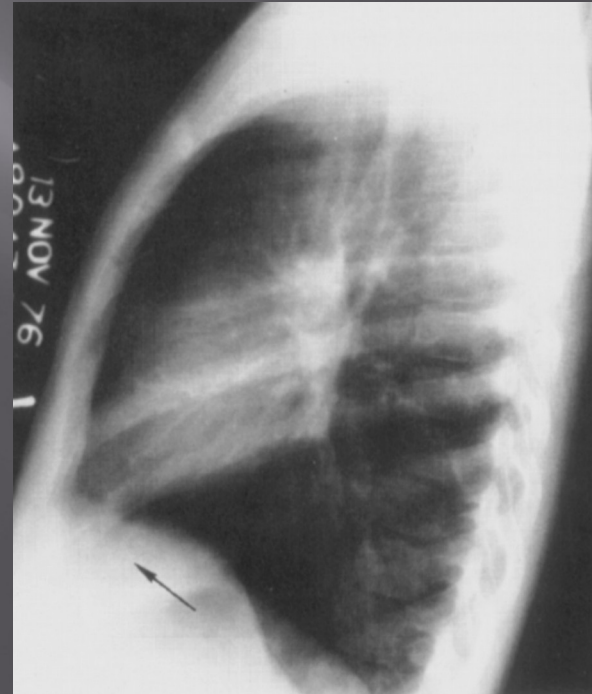
- THE HEART MAY APPEAR ENLARGED
- THE VESSELS MAY GIVE A FALSE IMPRESSION OF AN INFILTRATE
- THE RADIOGRAPH HAS A HAZY QUALITY





# THE HYPEREXPANDED CHEST:

LUNGS ARE BLACK (film not overexposed)  
ENTIRE HEART IS ABOVE DIAPHRAGM  
DIAPHRAGMS ARE FLAT (not dome-shaped)



# THE CRITERIA FOR A NORMAL LUNG VOLUME

- LESS THAN 1/3 OF THE HEART IS PROJECTED BELOW THE HEMIDIAPHRAGM
- THE DIAPHRAGM IS ROUNDED, AND THE 7<sup>th</sup> ANTERIOR RIB INTERSECTS THE DIAPHRAGM
- THE LUNGS ARE AIR FILLED (black )



# ROTATION

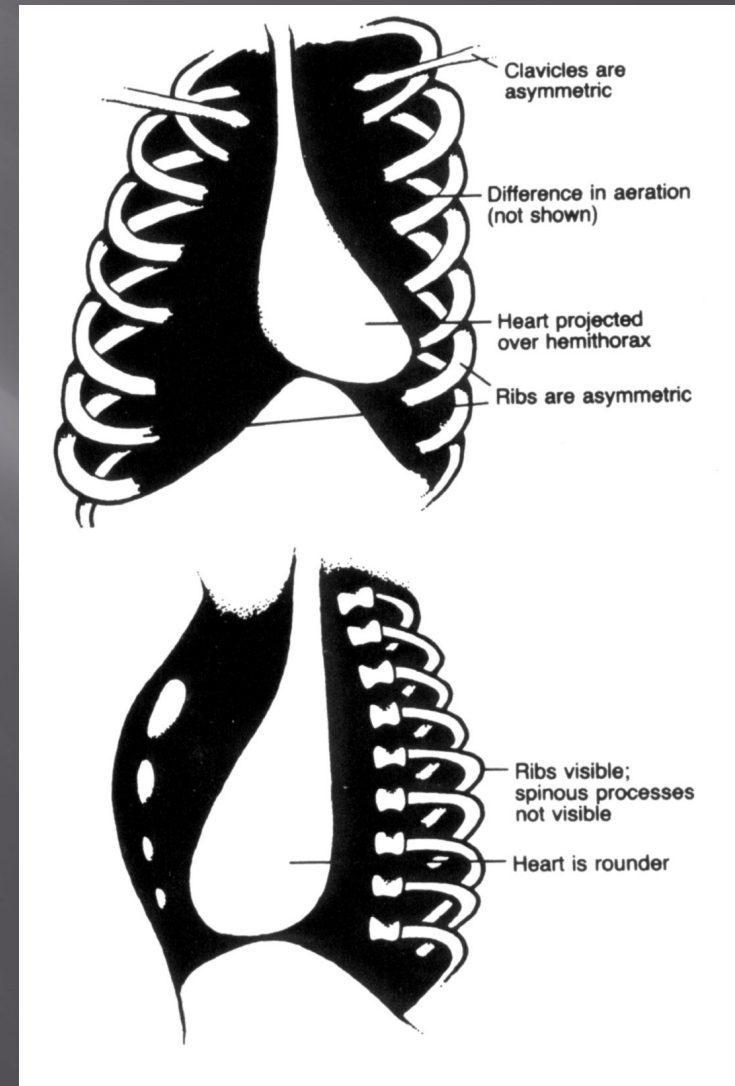
## THE ROTATED CHEST FILM:

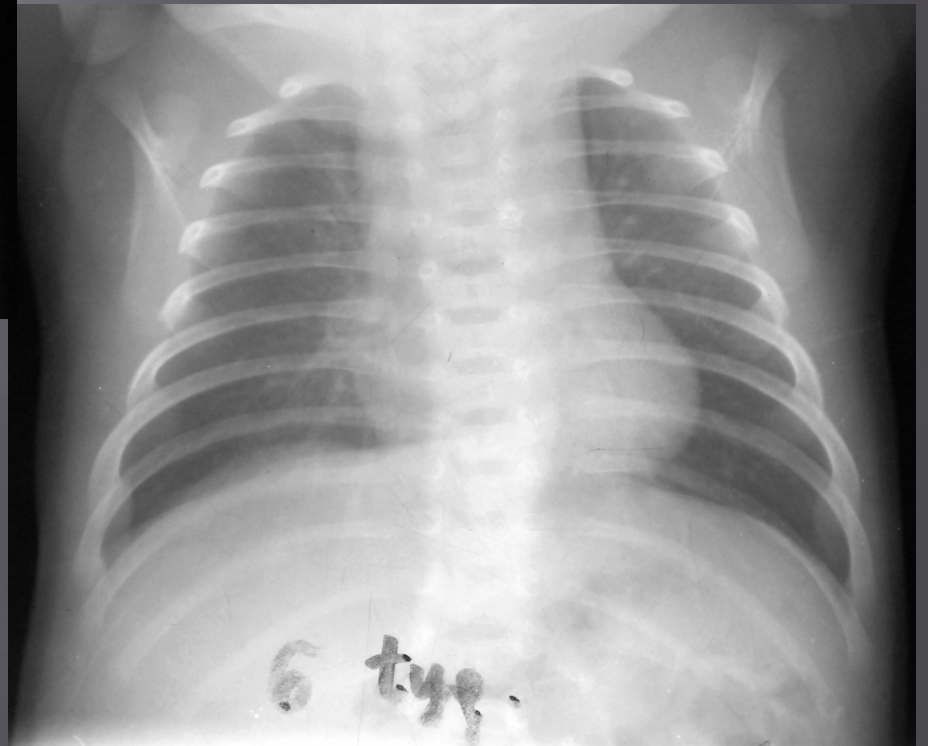
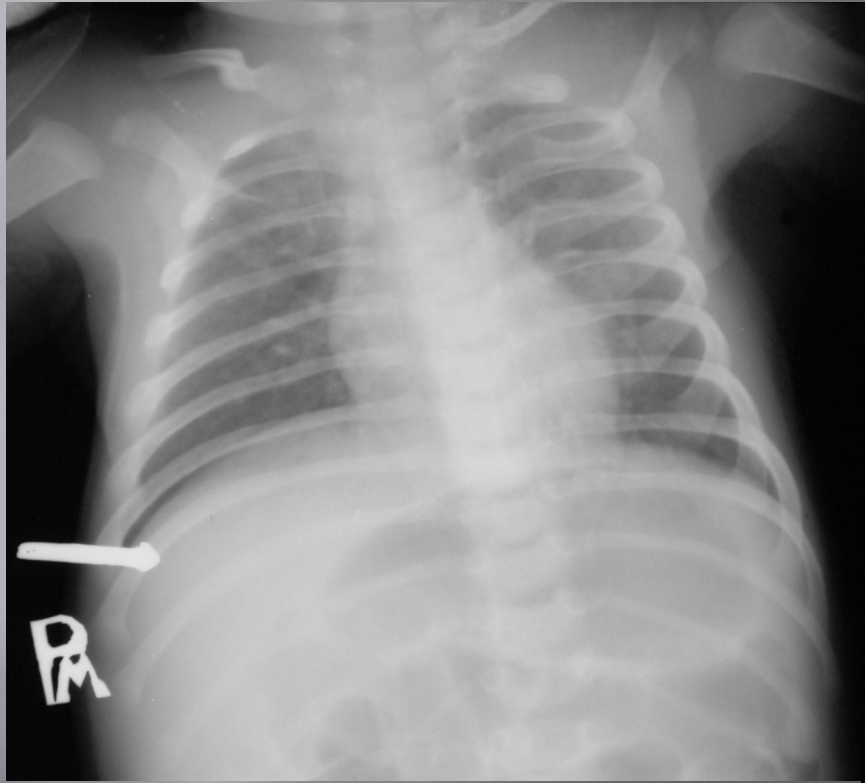
### *Frontal view*

1. CLAVICLES ARE ASYMMETRIC
2. DIFFERENCE IN AERATION
3. HEART PROJECTED OVER HEMITHORAX
4. RIBS ARE ASYMMETRIC

### *Lateral view*

5. RIBS VISIBLE;  
SPINOUS PROCESSES  
NOT VISIBLE
6. HEART IS ROUNDER





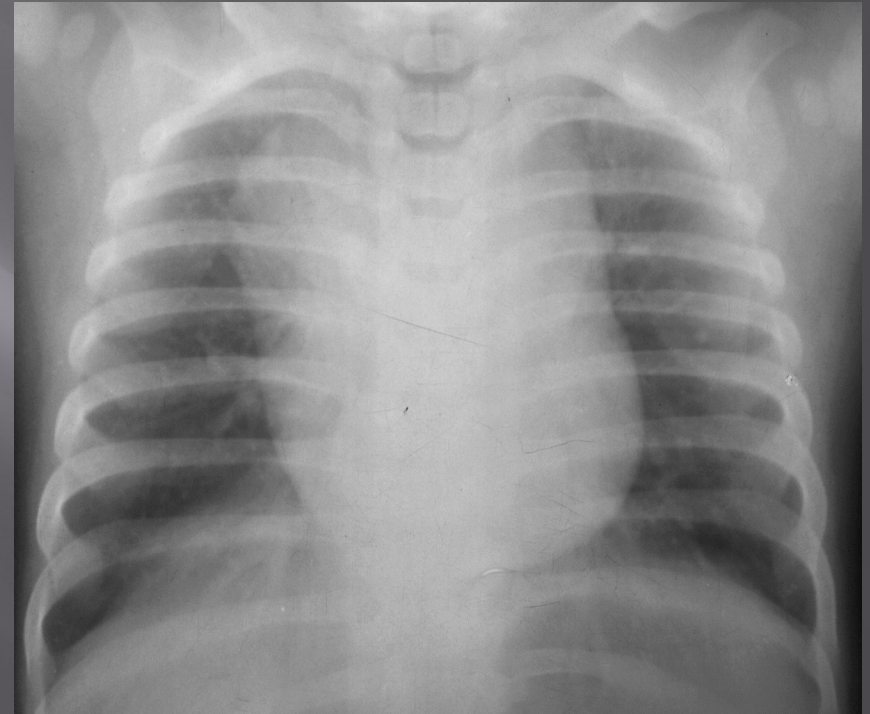
# THYMUS

THIS GLAND CAN SIMULATE :

- ⇒CARDIAC ENLARGEMENT
- ⇒LOBAR COLLAPSE
- ⇒PULMONARY INFILTRATES
- ⇒MEDIASTINAL MASSES

PROMINENT -  
IN MANY CHILDREN UNTIL 4-5  
YEARS OF AGE

A PROBLEM IS WHEN -  
IT IS STILL PROMINENT OVER THE  
AGE OF 5



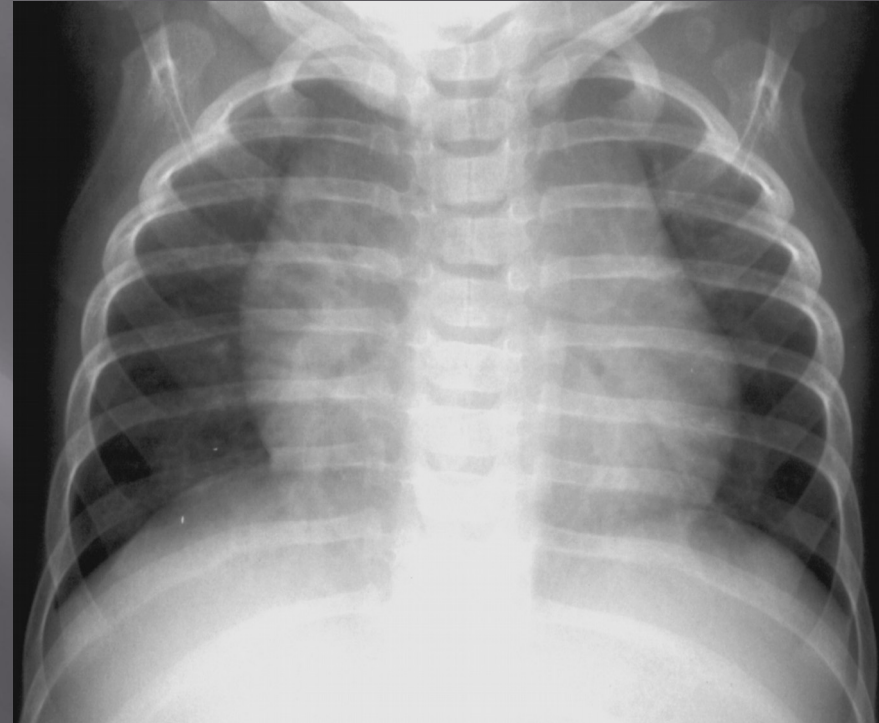
# THYMUS

MAY OCCUPY THE ENTIRE  
ANTERIOR THORAX !!!  
IT USUALLY SHRINKS :

- ◆ AS THE CHILD GETS  
OLDER
- ◆ DURING PERIODS OF  
„STRESS”

IF AN ABNORMALITY  
IS SUSPECTED IN THE MEDIASTINUM

- US, CT or MR is performed



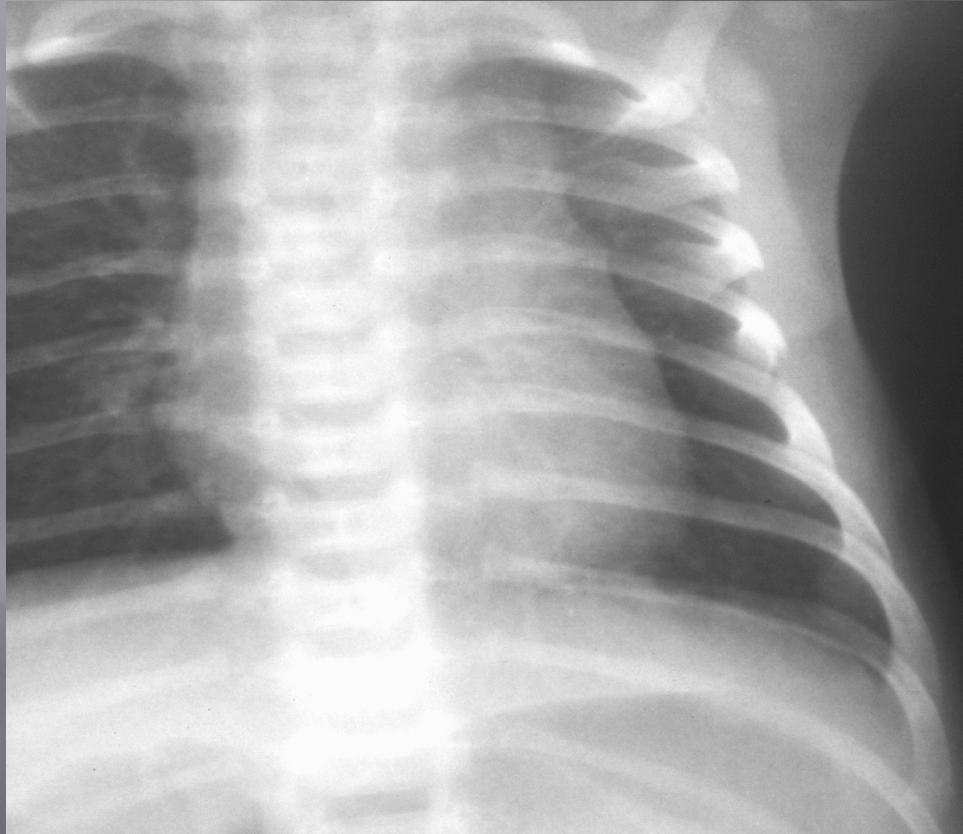
# THYMUS

”Sail sign”



# THYMUS

”Wave sign”





Map 6  
SynRg 60dB  
Persist Med  
Rate Med  
D Opt:Res  
W 0 Pg 0  
ol 0 Pg 0



2.02cm  
2.98cm

US - anterior mediastinum



3.54cm  
2.62cm

Thymus

# INTERPRETING THE FILM ( A, B, C, D's)

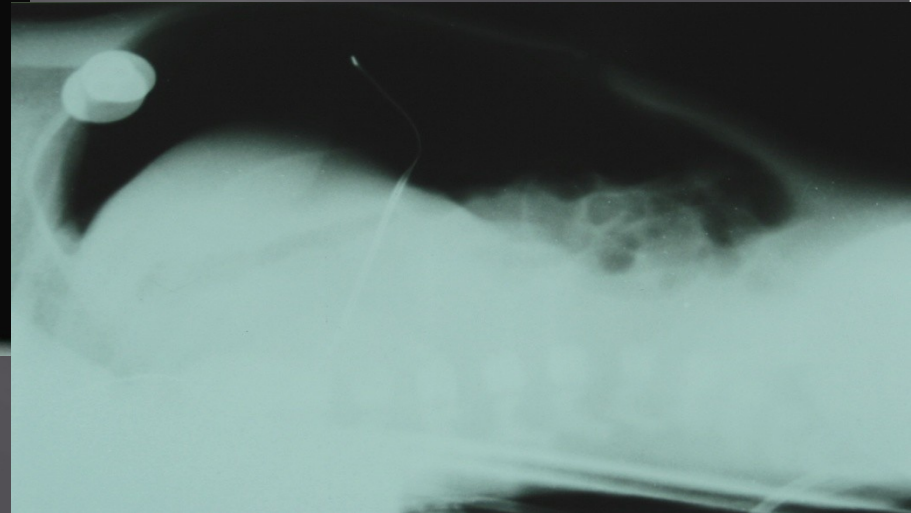
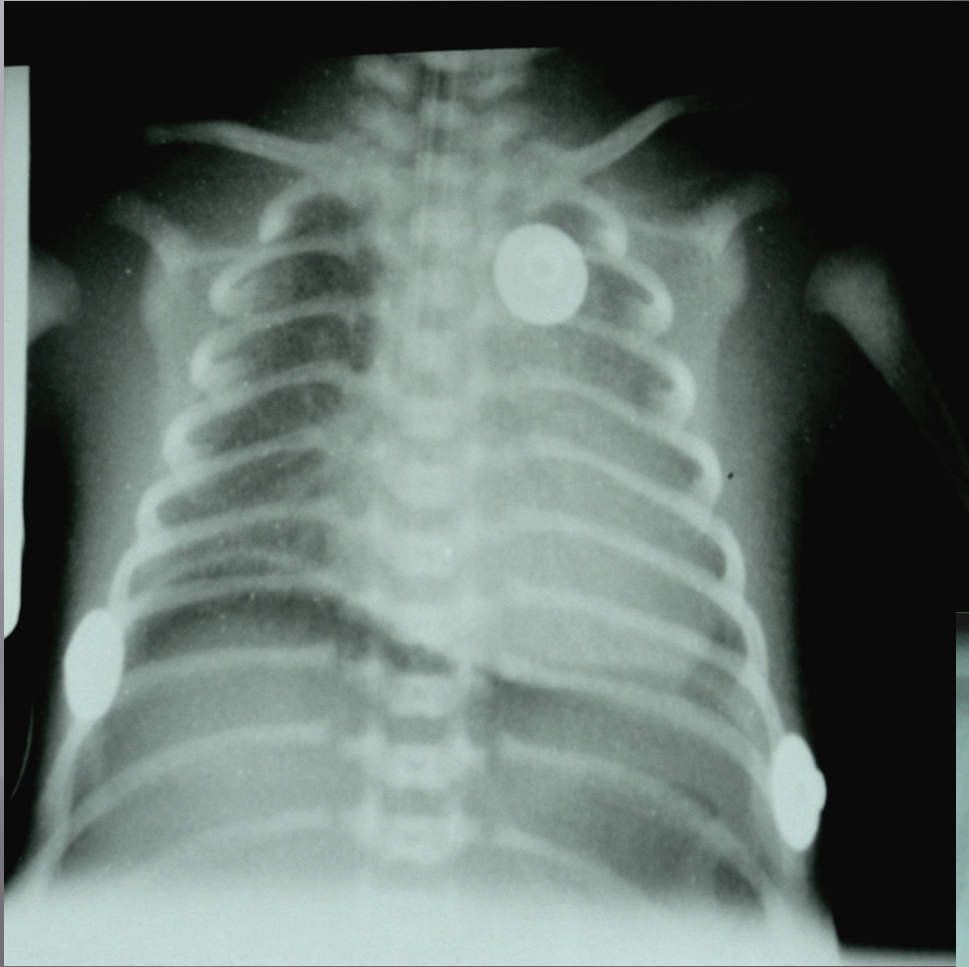
**A** = ABDOMEN

**B** = BONES & SOFT TISSUES

**C** = CHEST - airways, mediastinum, lungs

**D** = Diaphragm

**A = ABDOMEN**



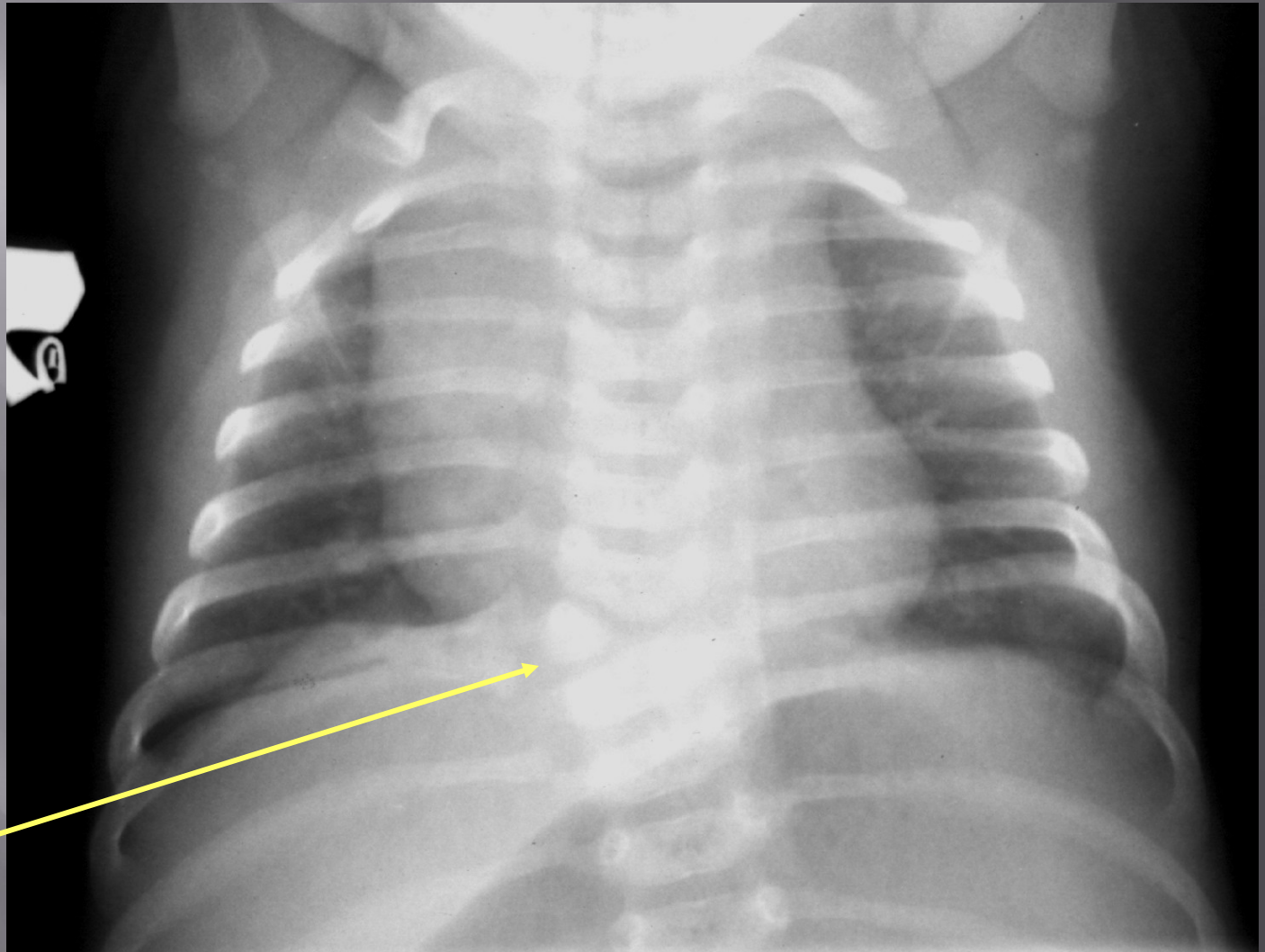
# B = BONES & SOFT TISSUES

## BONES

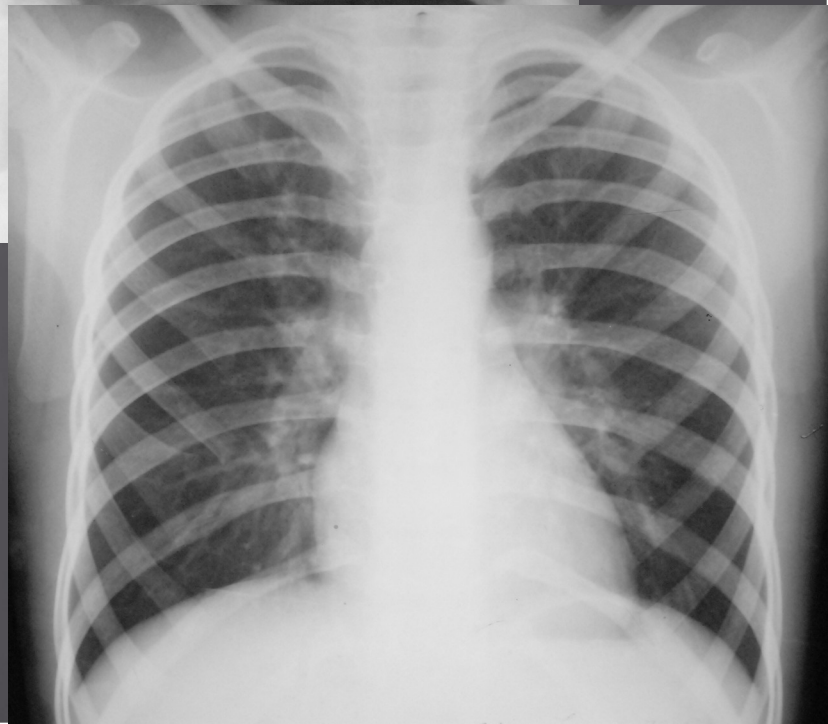
- ⇒ FRACTURES
- ⇒ CONGENITAL ABNORMALITIES
- ⇒ BONE DESTRUCTION

## SOFT TISSUES

- ⇒ SWELLING (neck, thorax, abdomen)
- ⇒ FOREIGN BODY
- ⇒ CALCIFICATIONS
- ⇒ MULTIPLE ARTIFACTS  
(hair braids, breast nipples, bandages, skin folds)



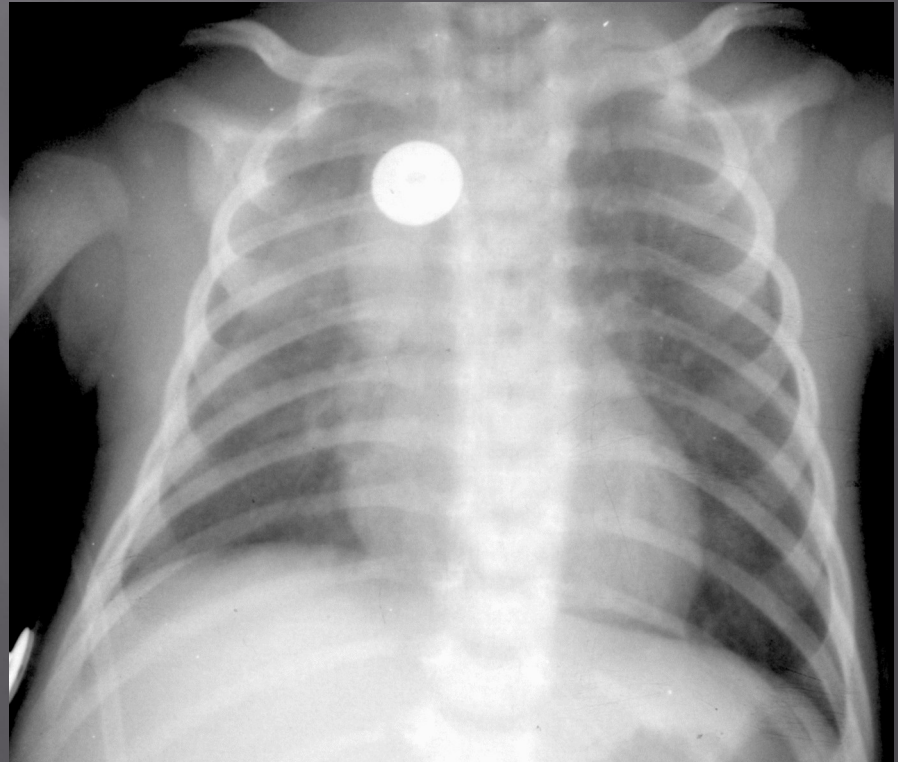
**CONGENITAL ABNORMALITY OF THE VERTEBRAL BODY & RIBS**

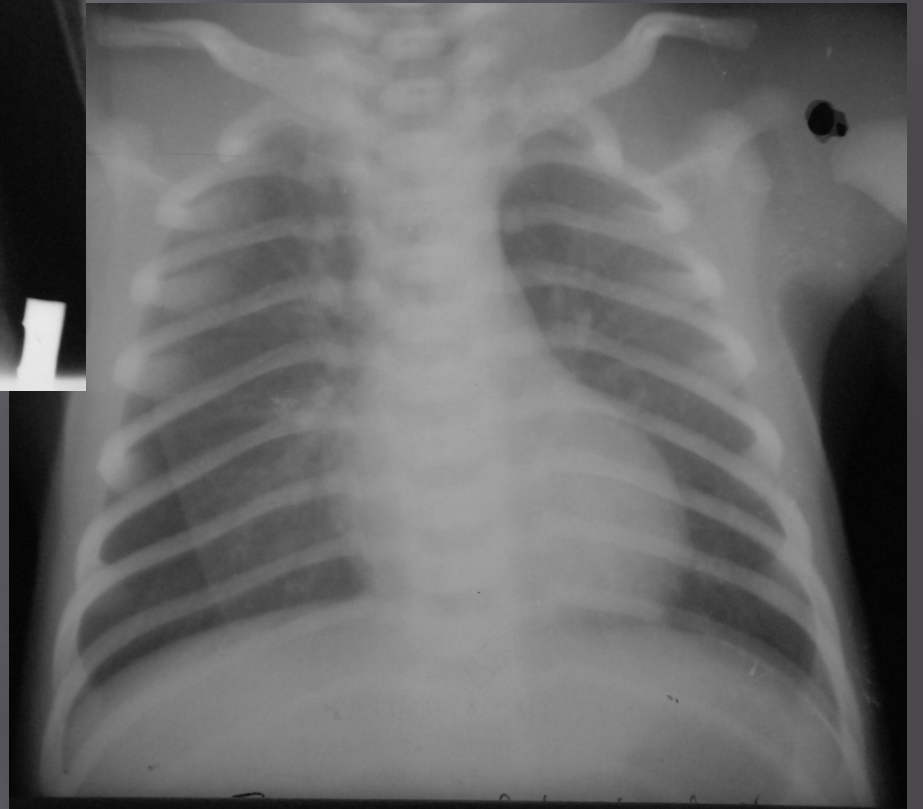
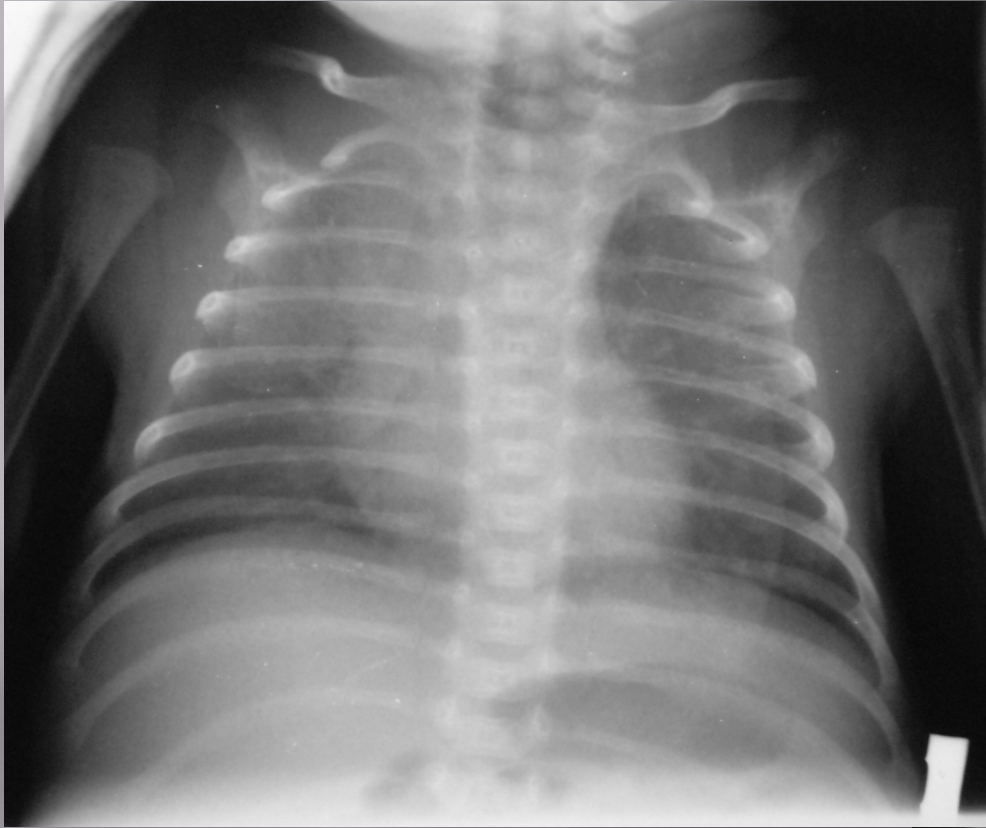


# ARTEFACTS

## SKIN FOLDS

- frequently seen in young infants
- *must be differentiated from pneumothoraces*



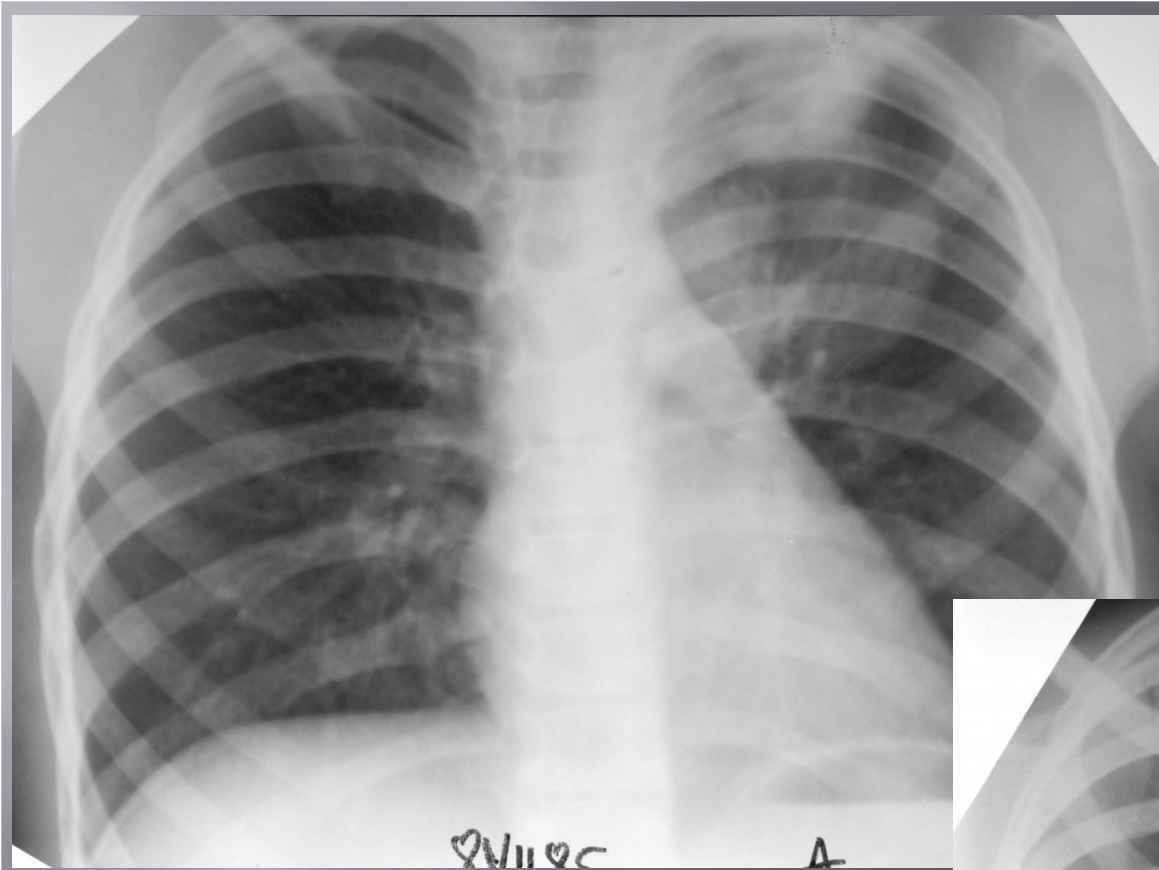




# ARTEFACTS

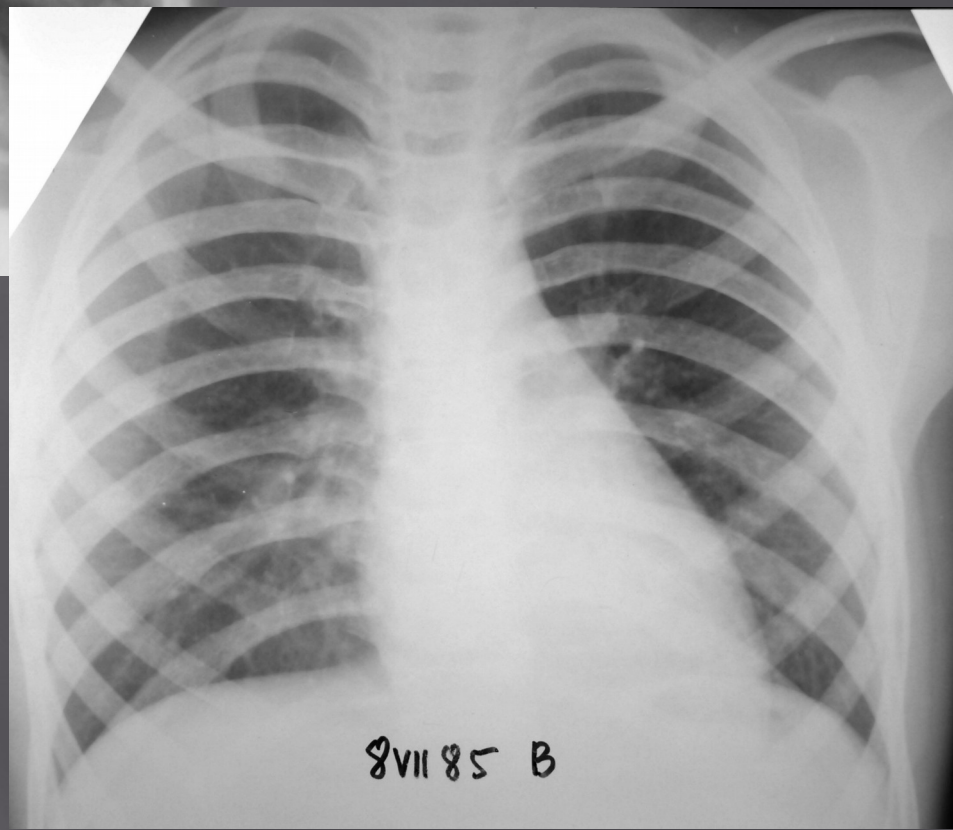
HAIR BRAID



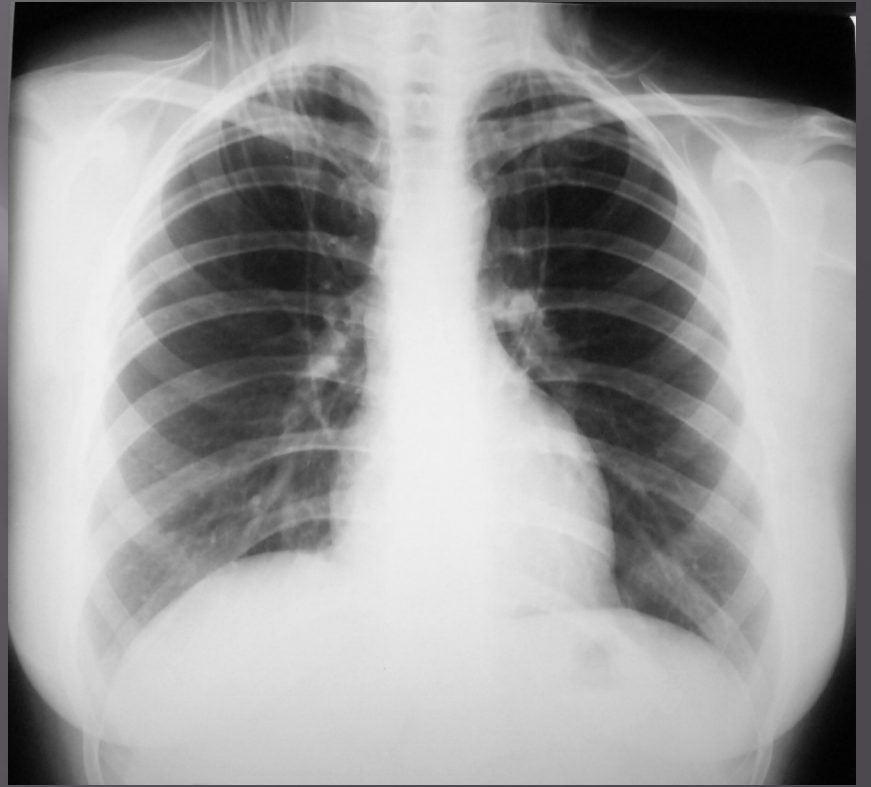


8VII85

A



8VII85 B

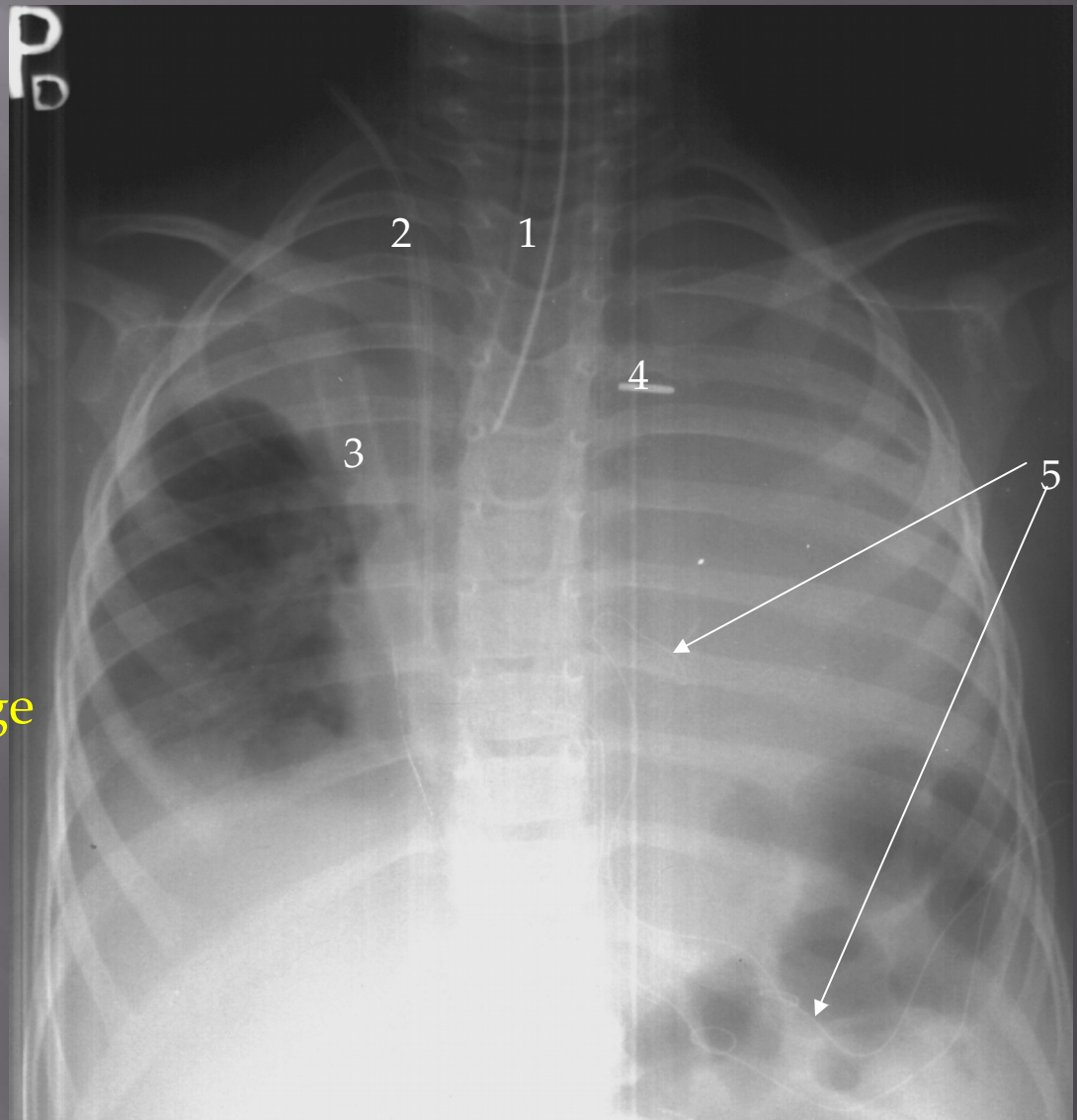


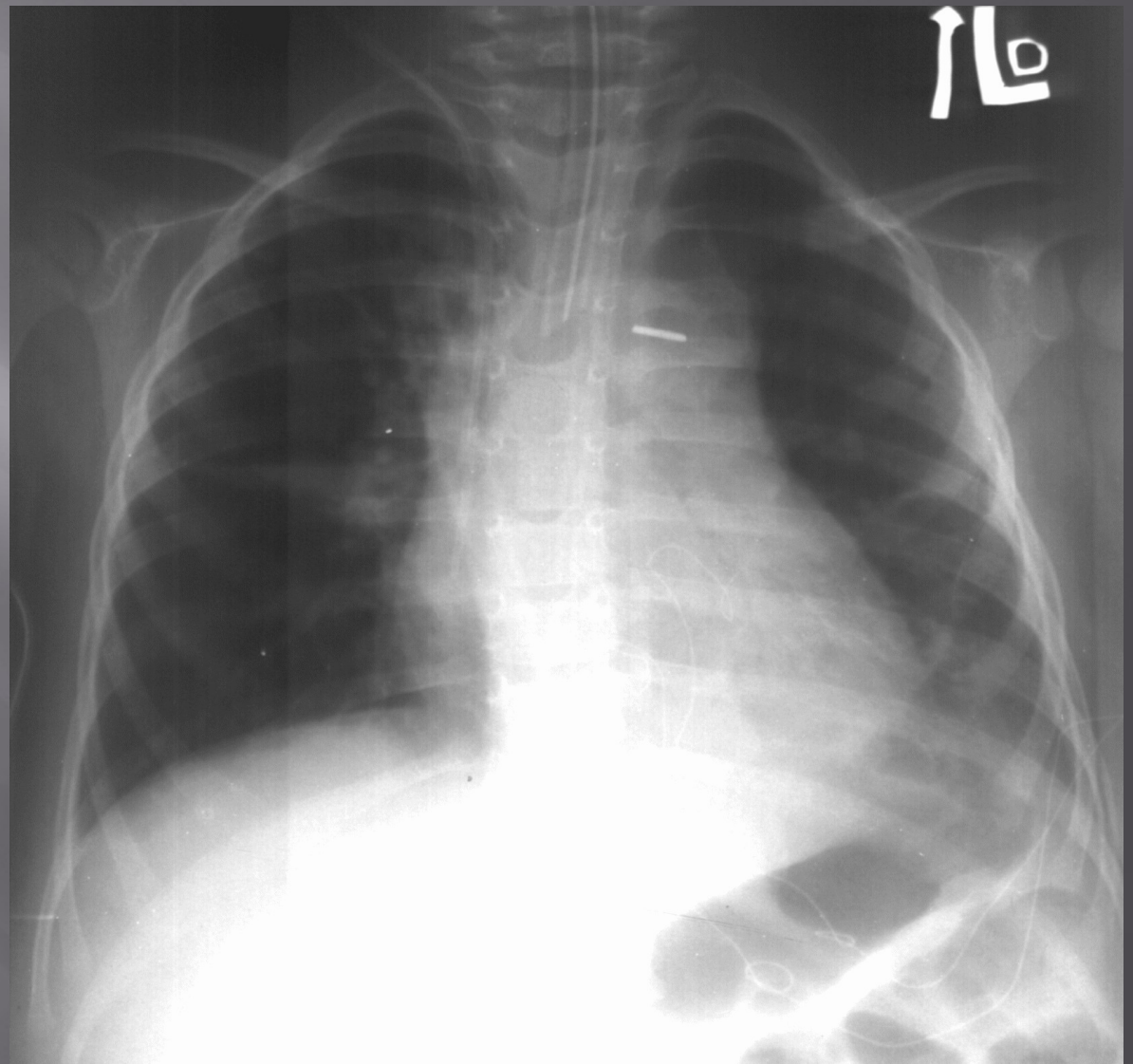
CHEST X-RAY AFTER  
CARDIOSURGERY  
OPERATION

CHECK ALL THE  
TUBES & CATHETERS !!!

GIVE THEM NAMES :

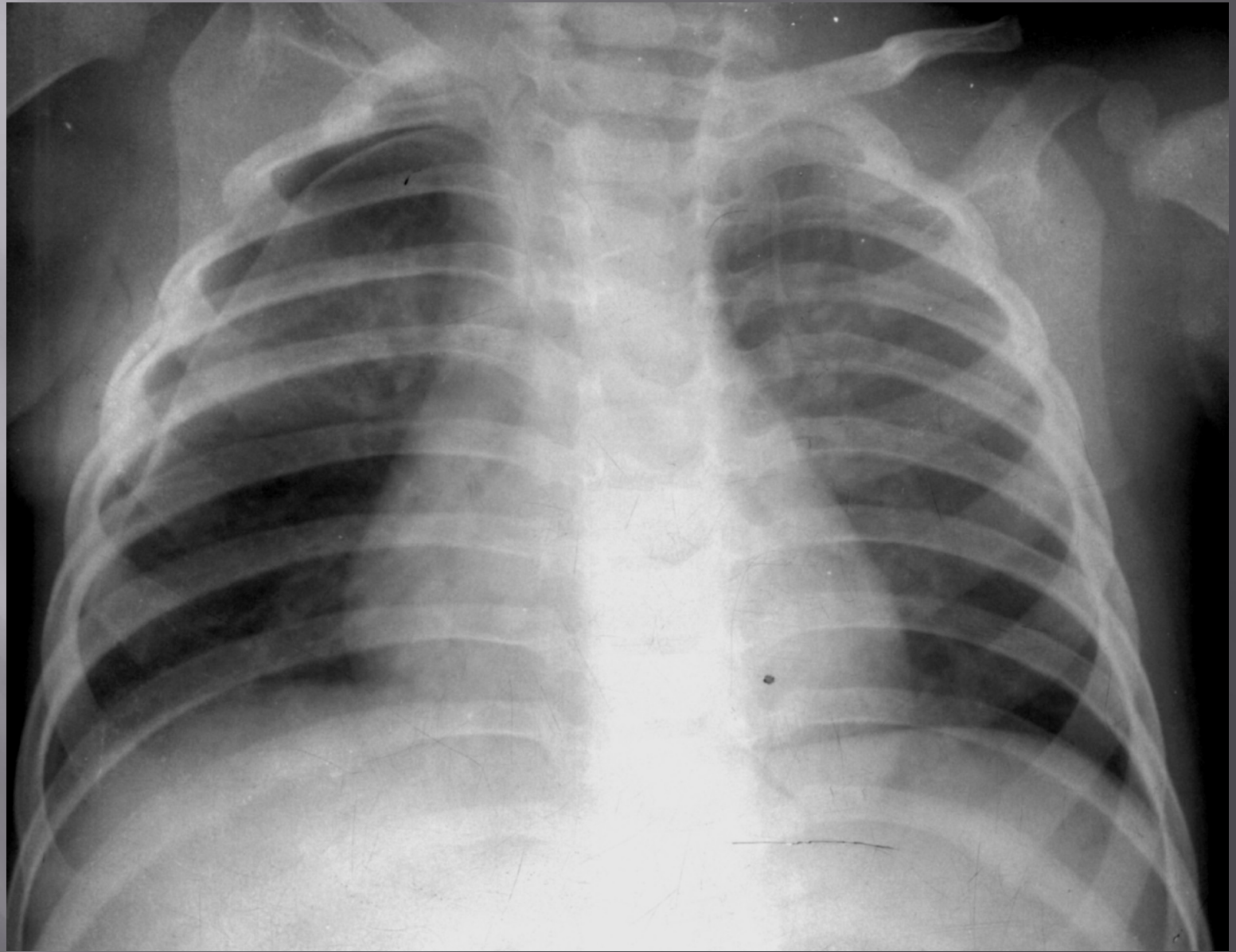
- 1 Endotracheal tube
- 2 Central venous catheter
- 3 Tube for pleural drainage
- 4 Metal clip
- 5 Electrodes



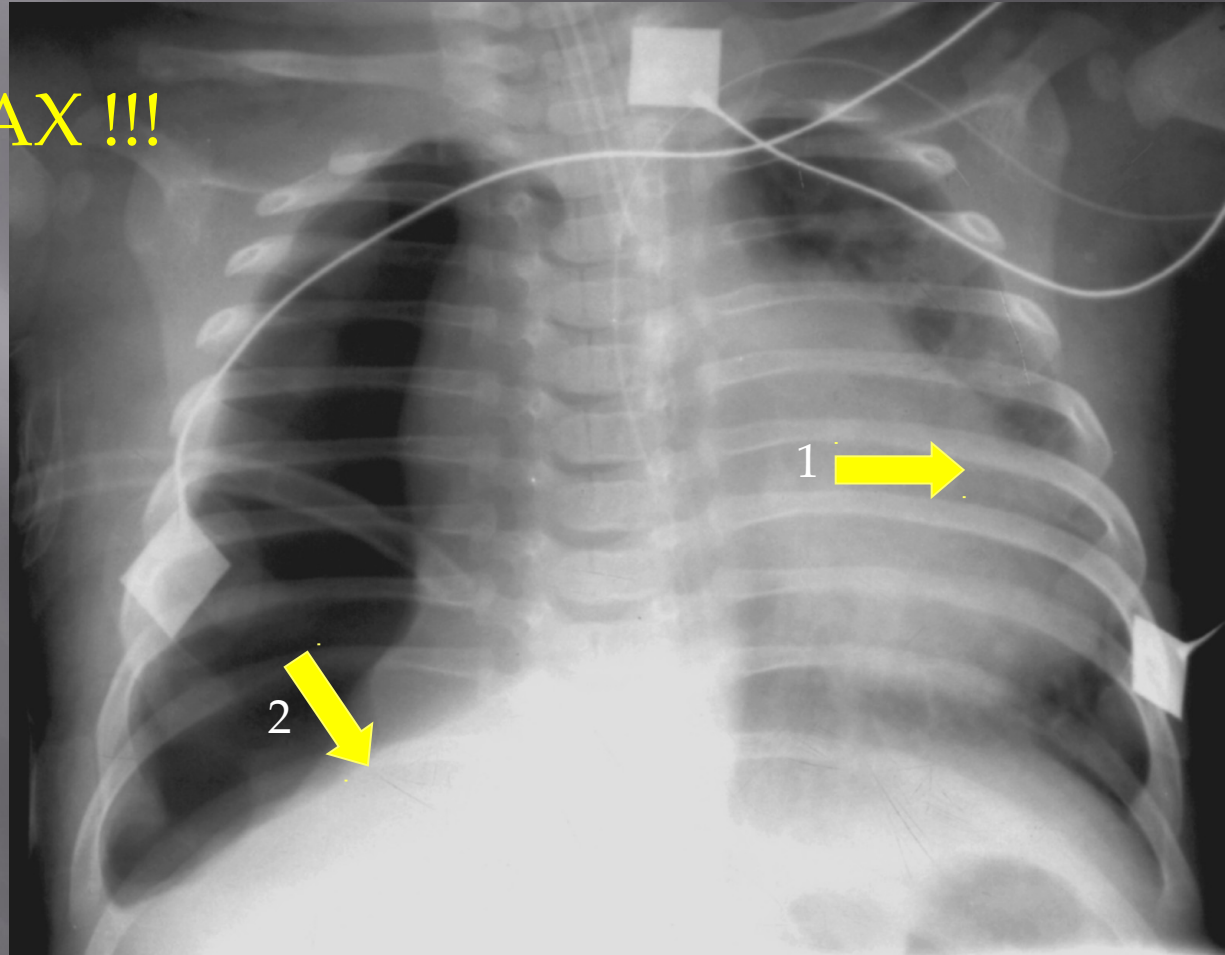


ENDOTRACHEAL TUBE IS  
POSITIONED CORRECTLY NOW - *the same patient*

## II. COMMON PATHOLOGIC CONDITIONS

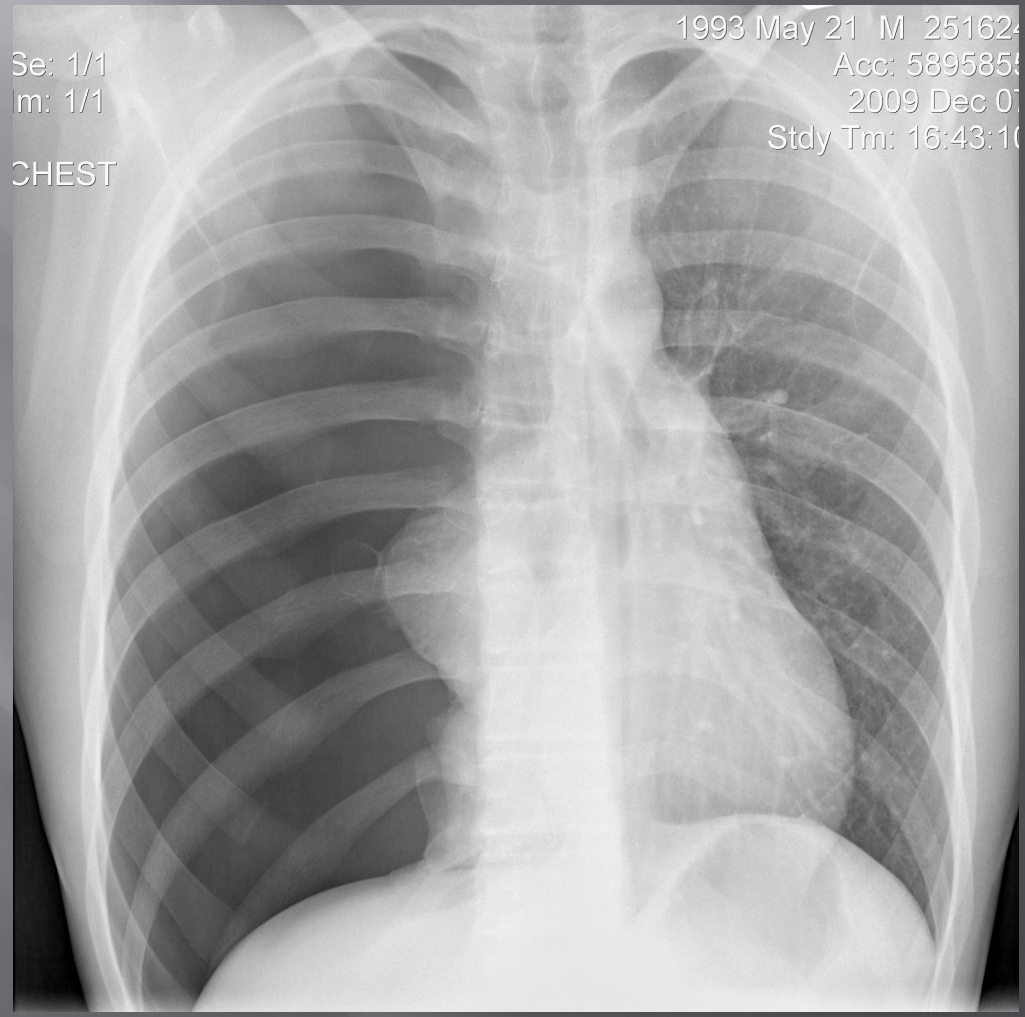


# TENSION PNEUMOTHORAX !!!



1. SHIFT OF THE MEDIASTINUM AWAY FROM THE MIDLINE
2. FLATTENING OF THE DIAPHRAGM ON THE AFFECTED SIDE





1993 May 21 M 251624

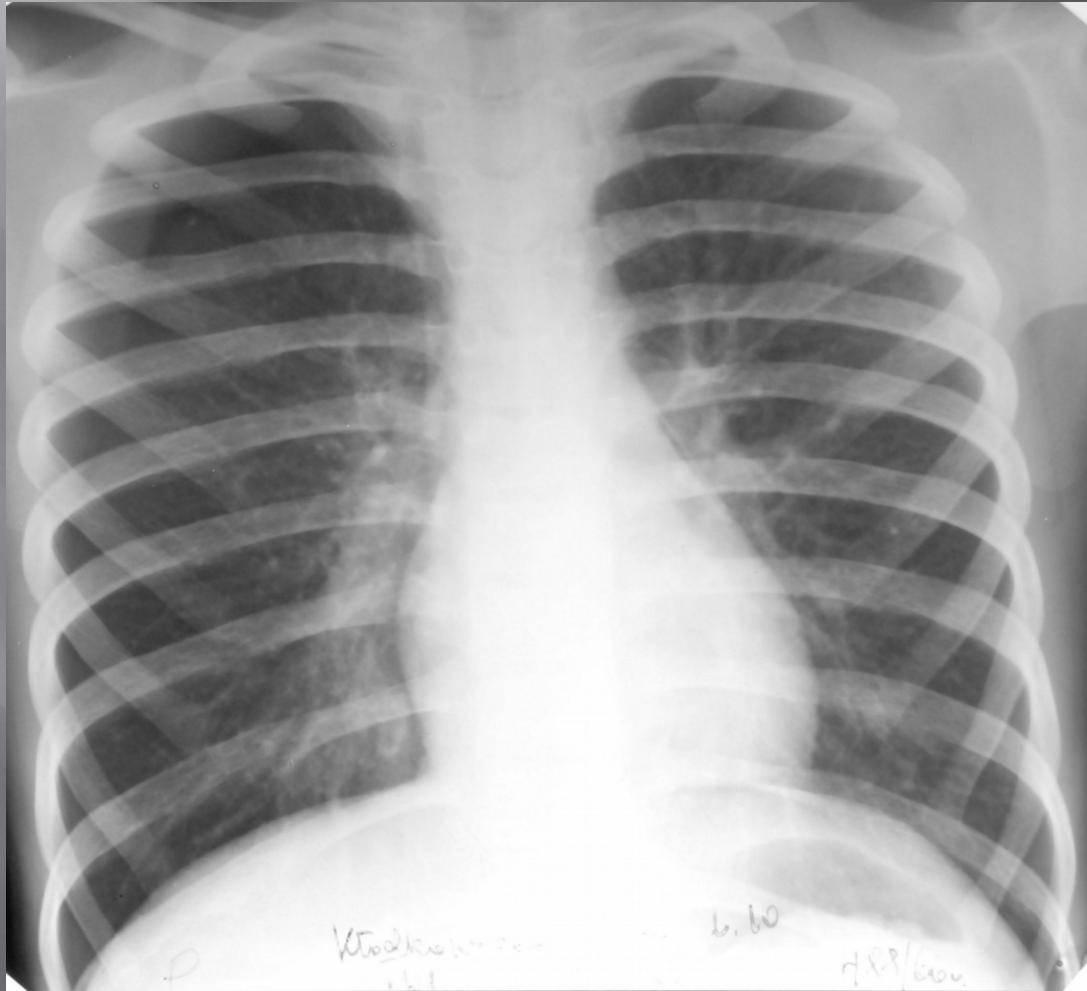
Acc: 5895854

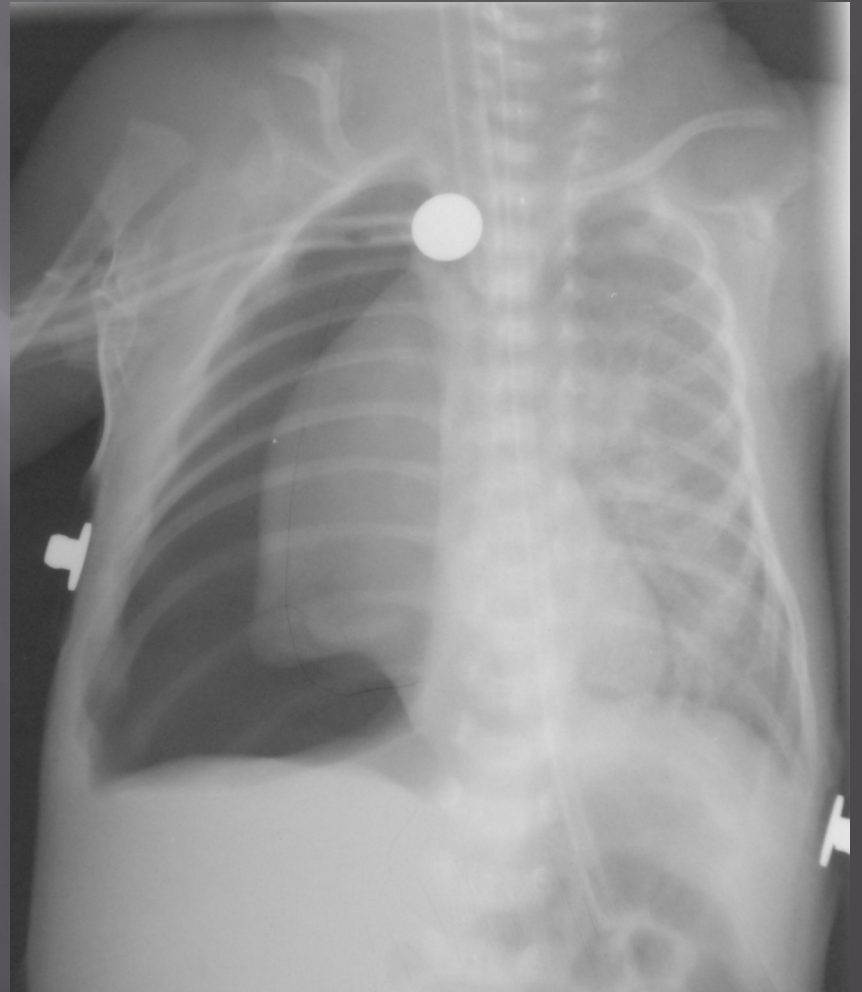
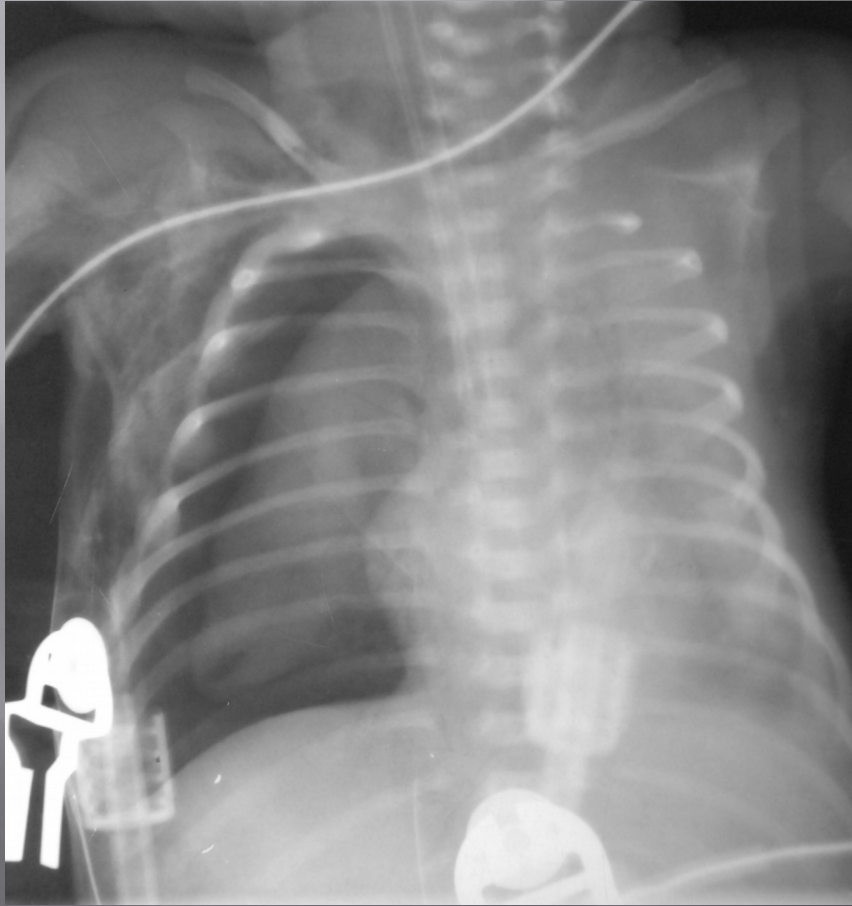
2009 Dec 07

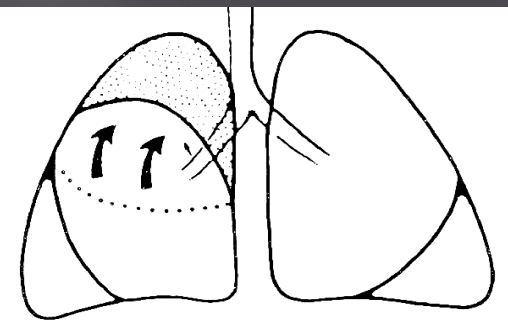
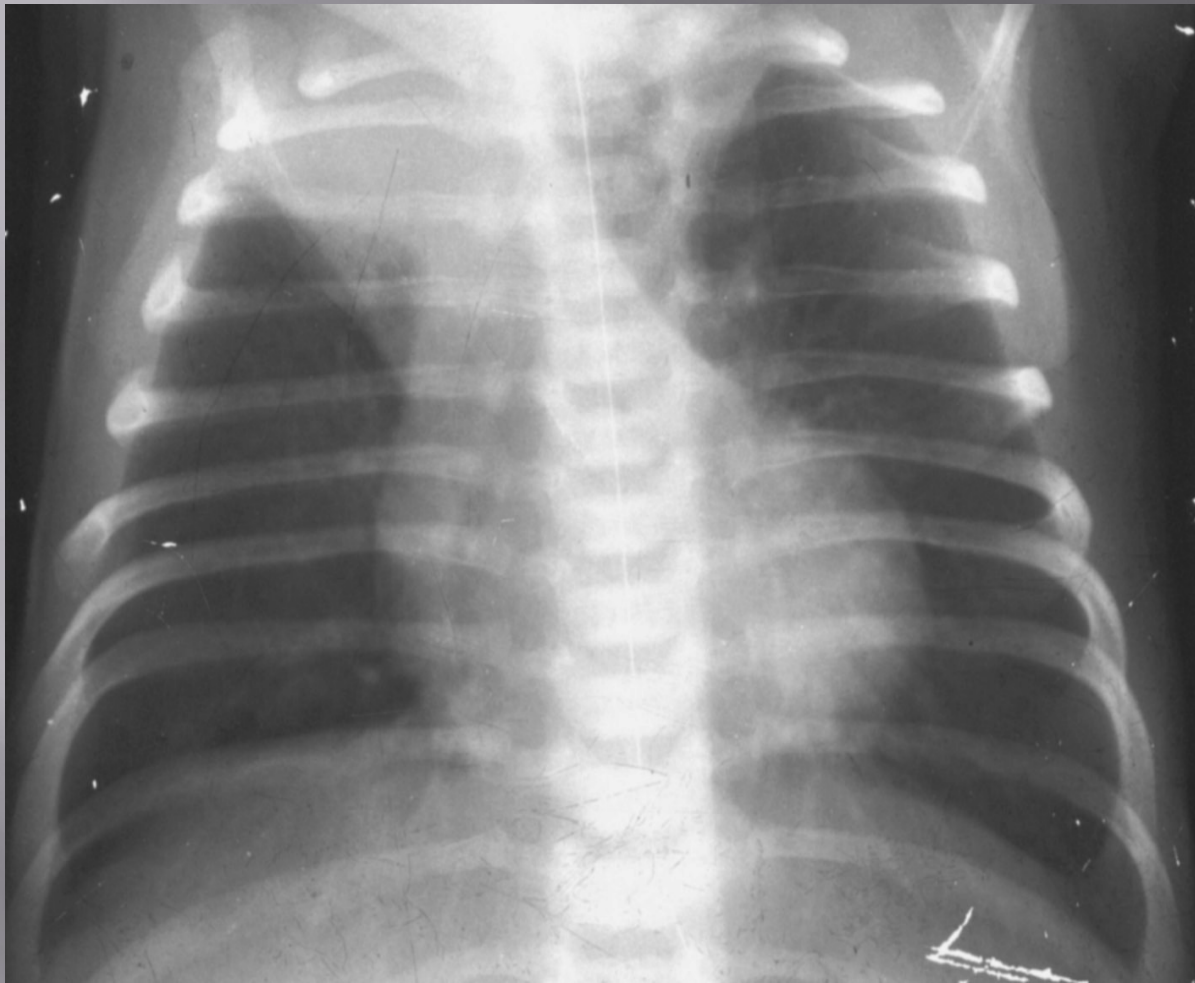
Stdy Tm: 16:43:10

Se: 1/1  
m: 1/1

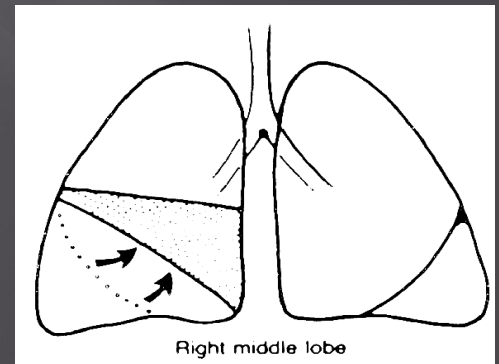
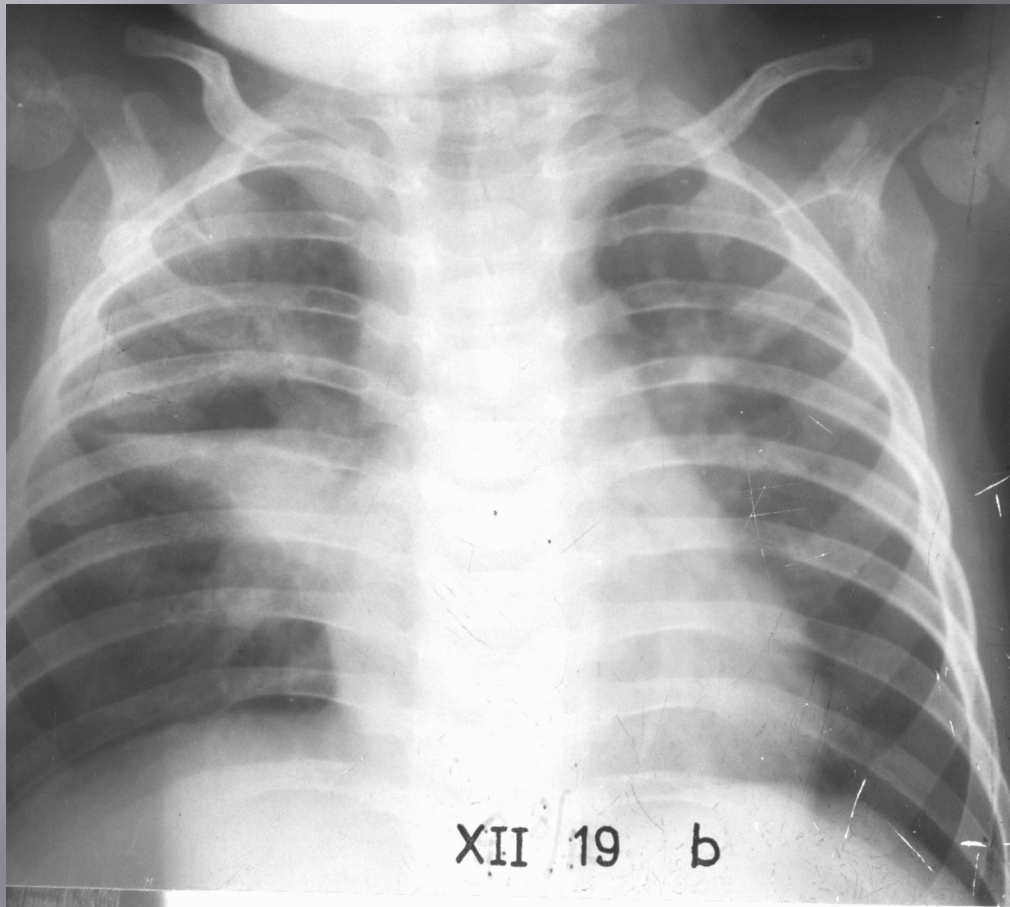
CHEST

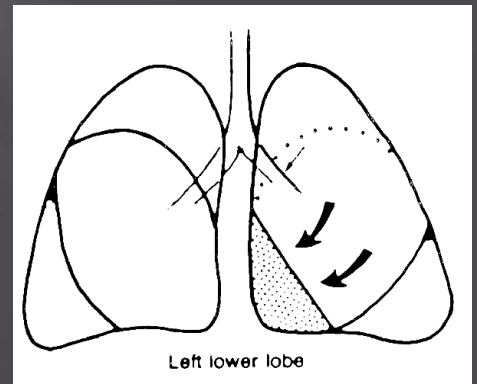
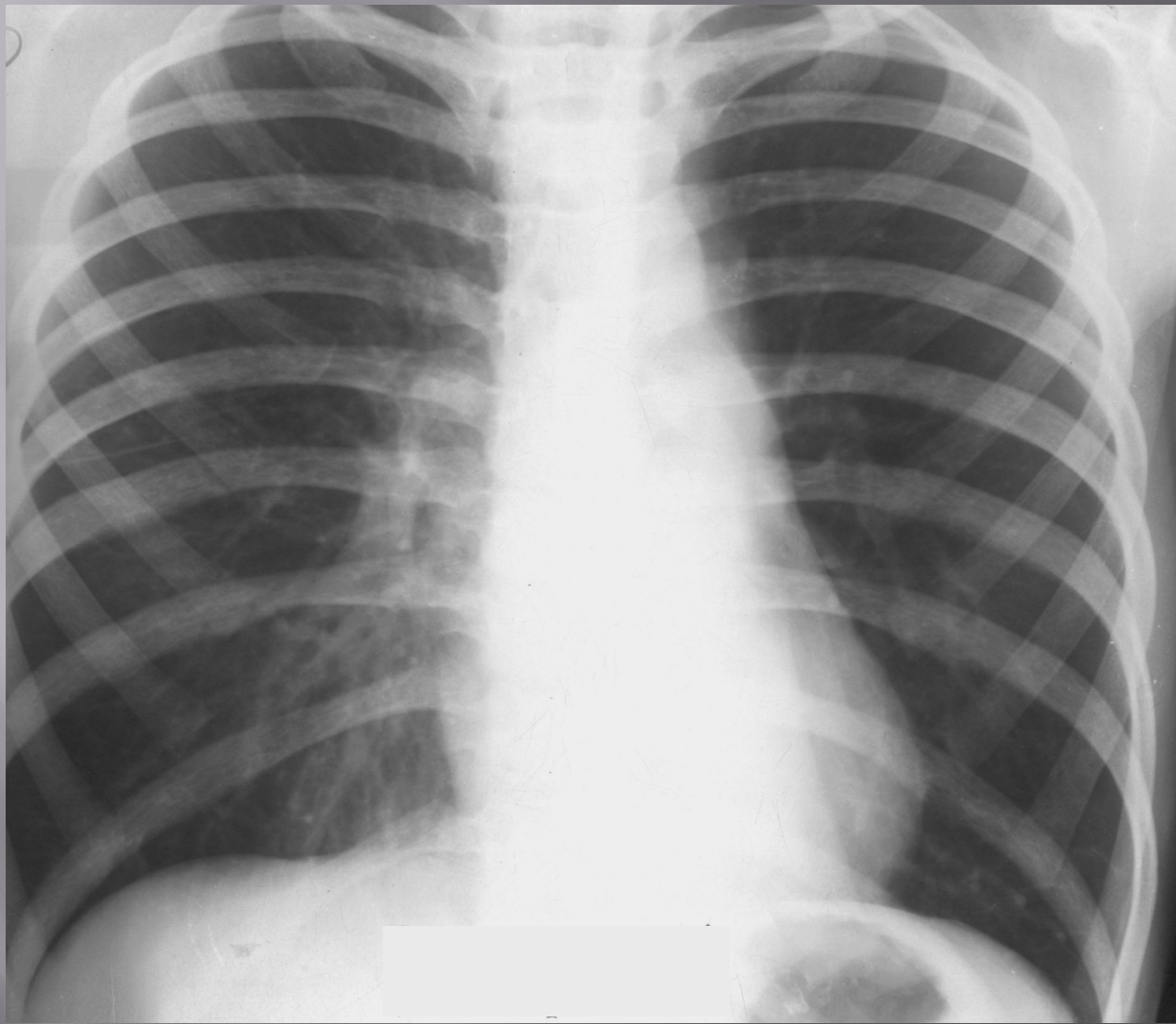






Right upper lobe





## LOBAR COLLAPSE (ATELECTASIS)



MUCUS PLUGGING

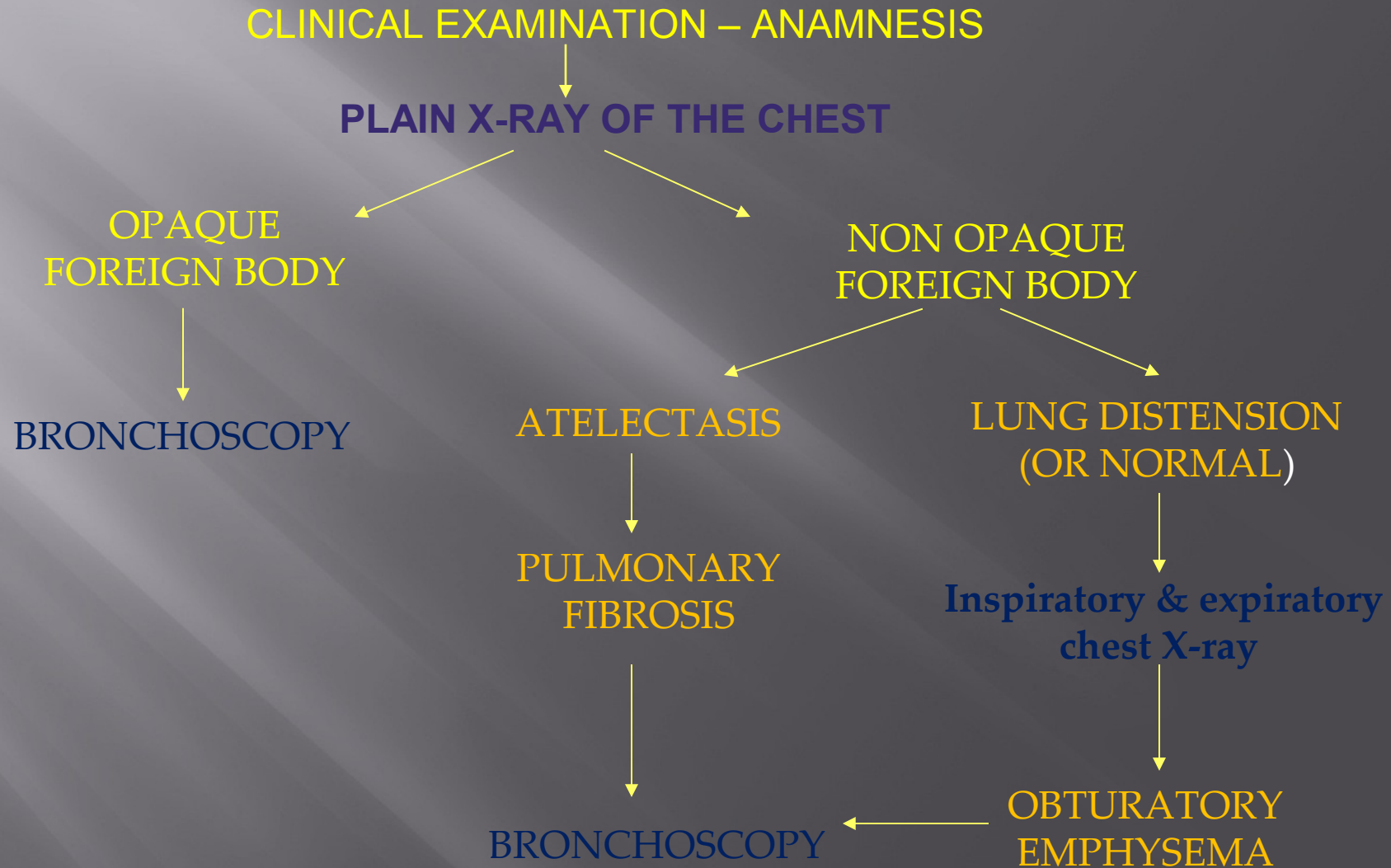
(asthmatic, postoperative patients)

FOREIGN BODIES

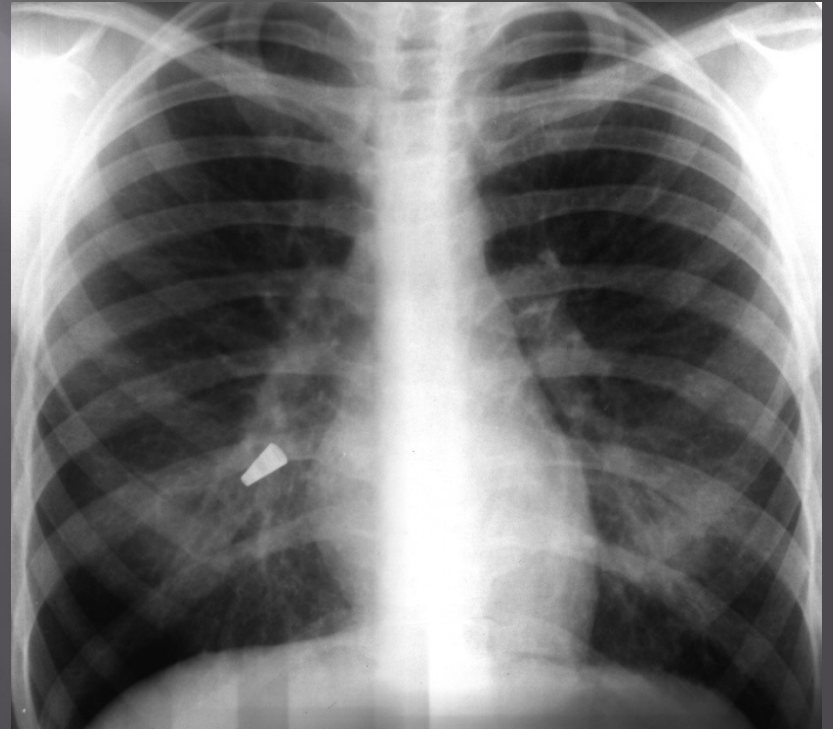
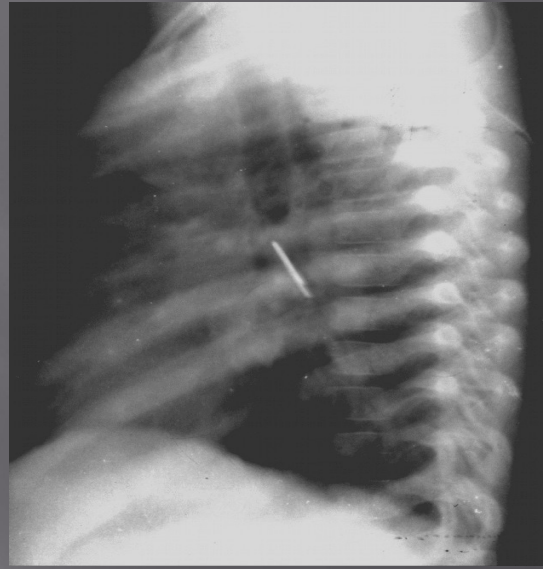
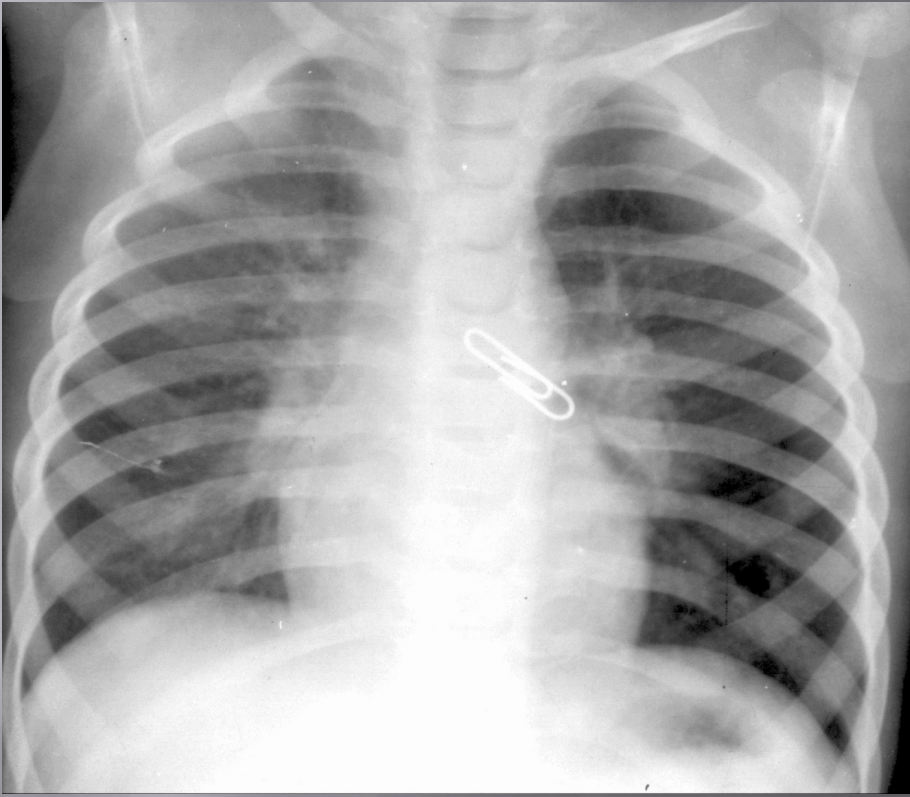
LYMPH NODES ( TBC, LYMPHOMA)

EXTRINSIC MASSES (BRONCHOGENIC CYSTS)

# FOREIGN BODY IN THE RESPIRATORY TRACT DIAGNOSTIC ALGORITHM

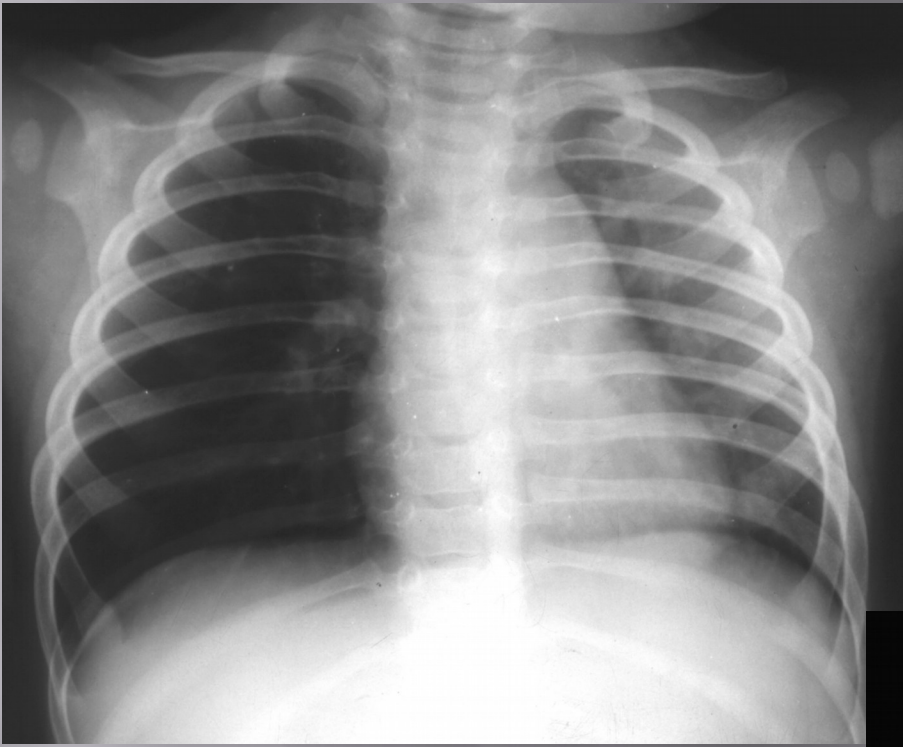




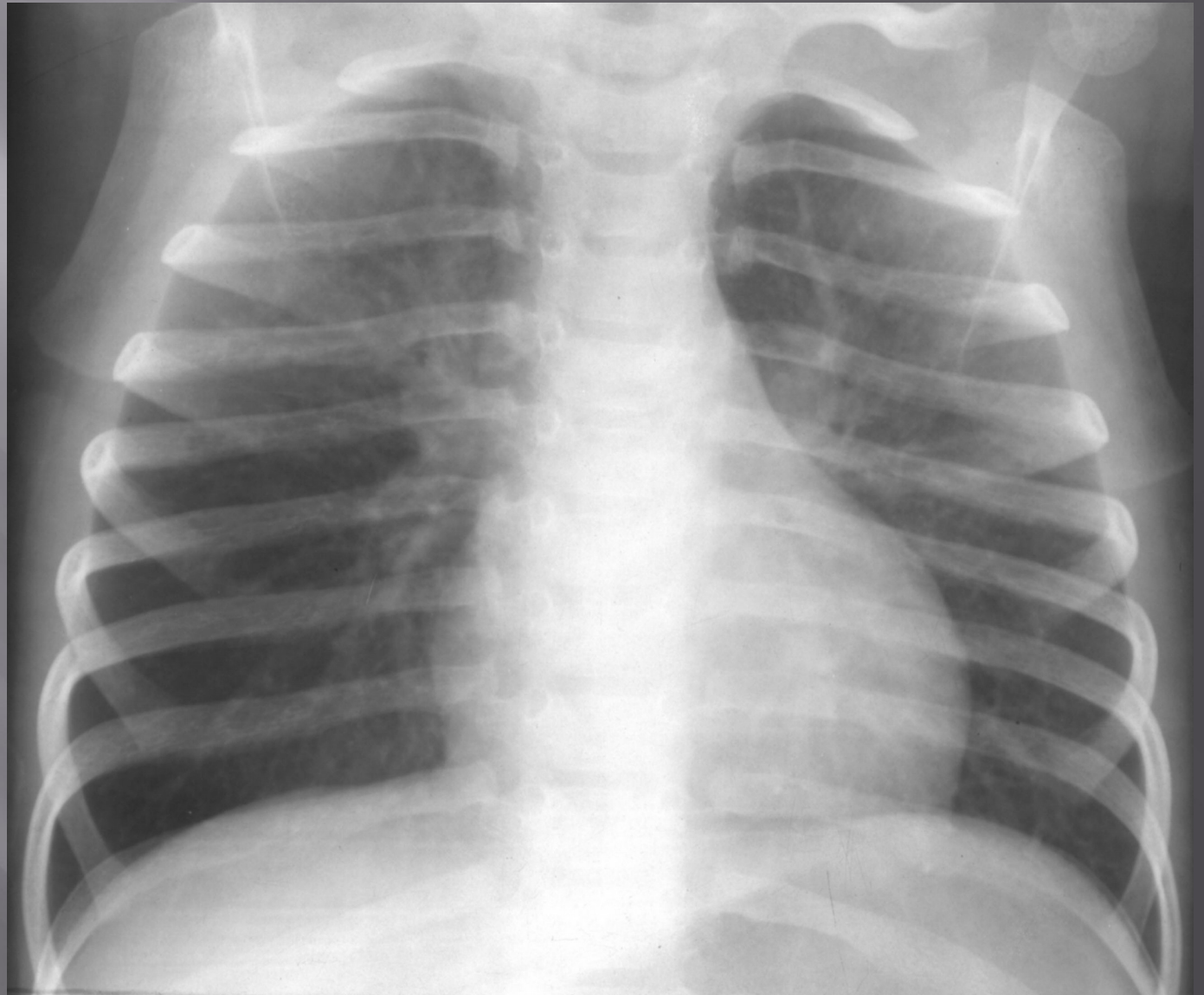


OPAQUE  
FOREIGN BODY

# Obturator emphysema

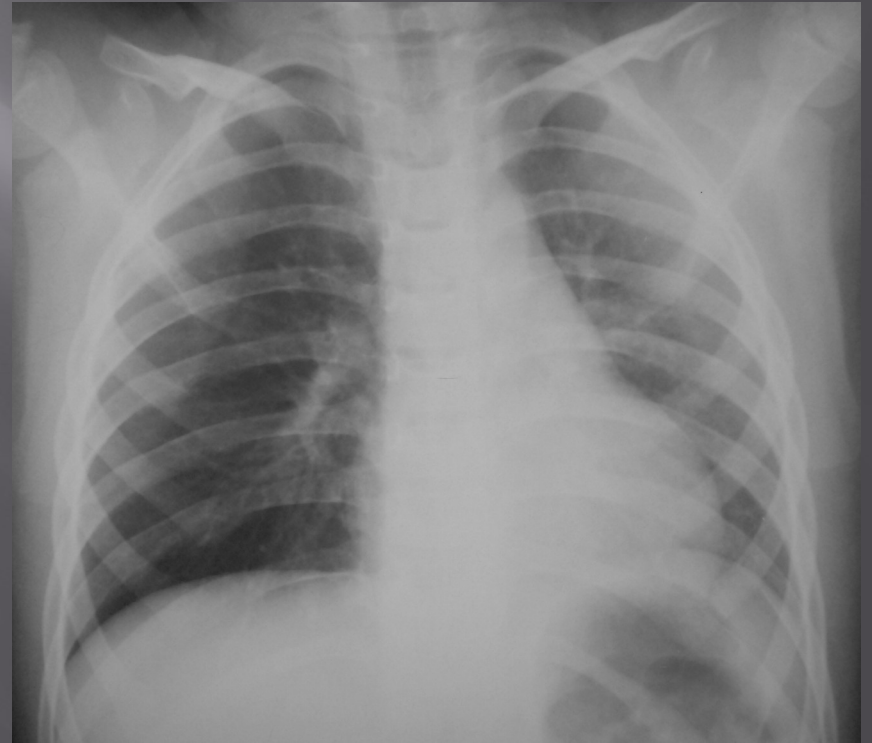


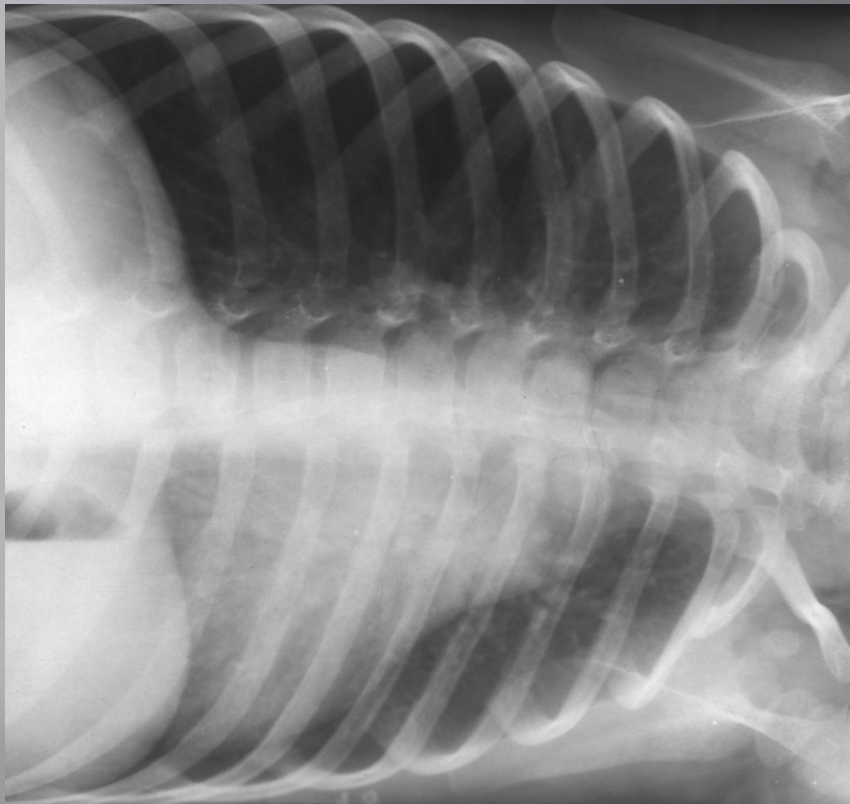
Expired chest film  
- after bronchoscopy



NON-OPAQUE FOREIGN BODY ?

# INSPIRATORY & EXPIRATORY FILMS





LEFT  
DECUBITUS



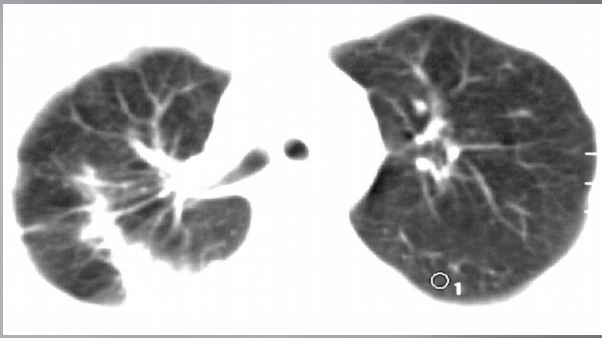
RIGHT  
DECUBITUS

Hyper expanded!!!

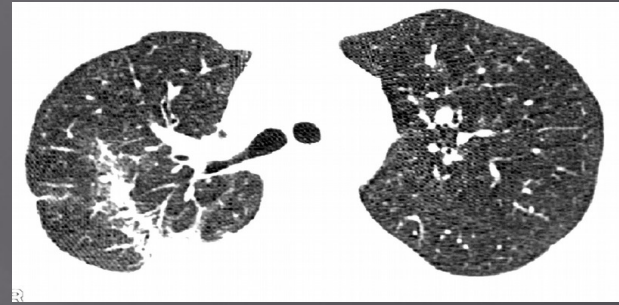
BRONCHOGRAPHY  
- BRONCHIECTASIS;  
LOBAR FIBROSIS

(after foreign body aspiration)





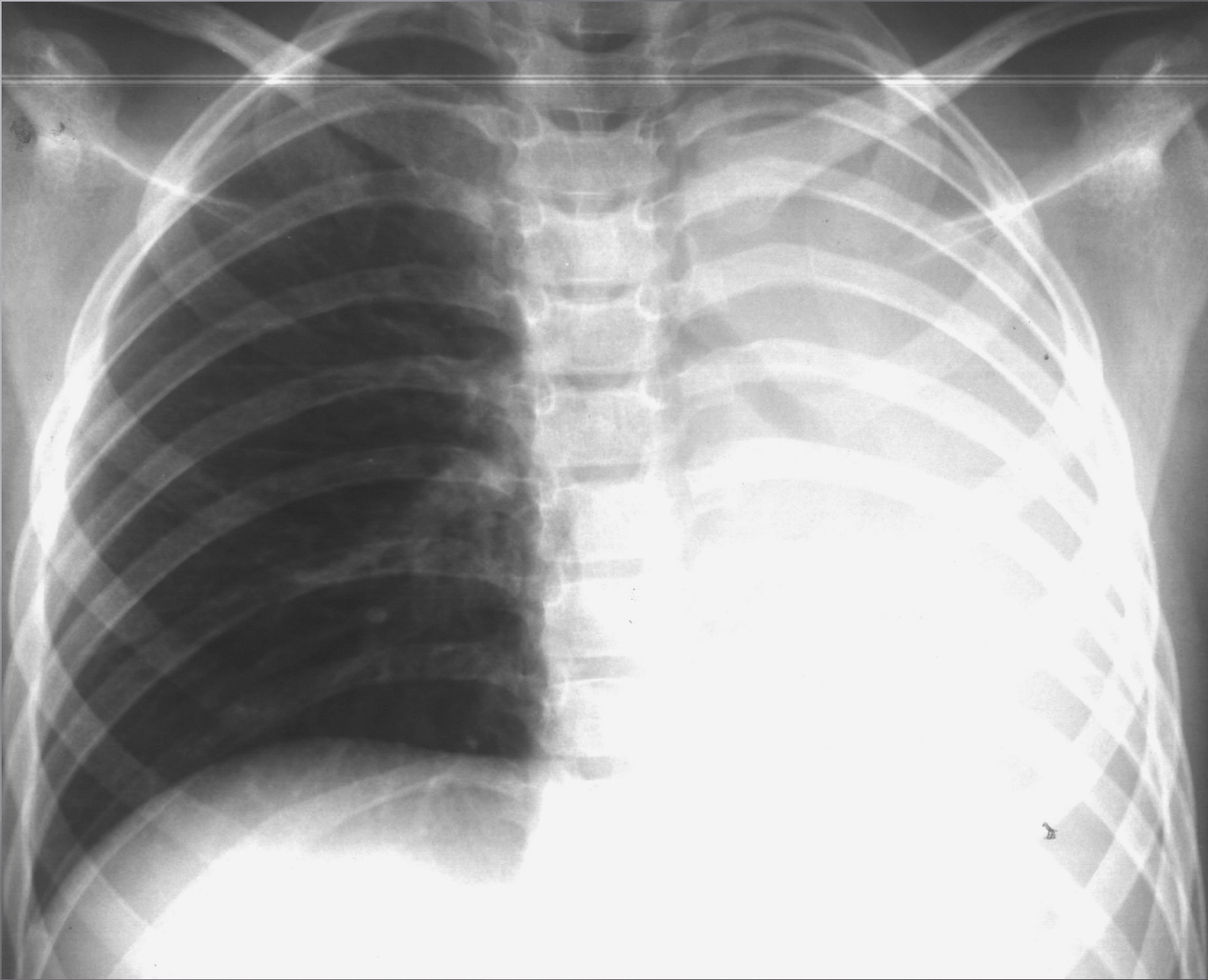
Helical CT



HRCT



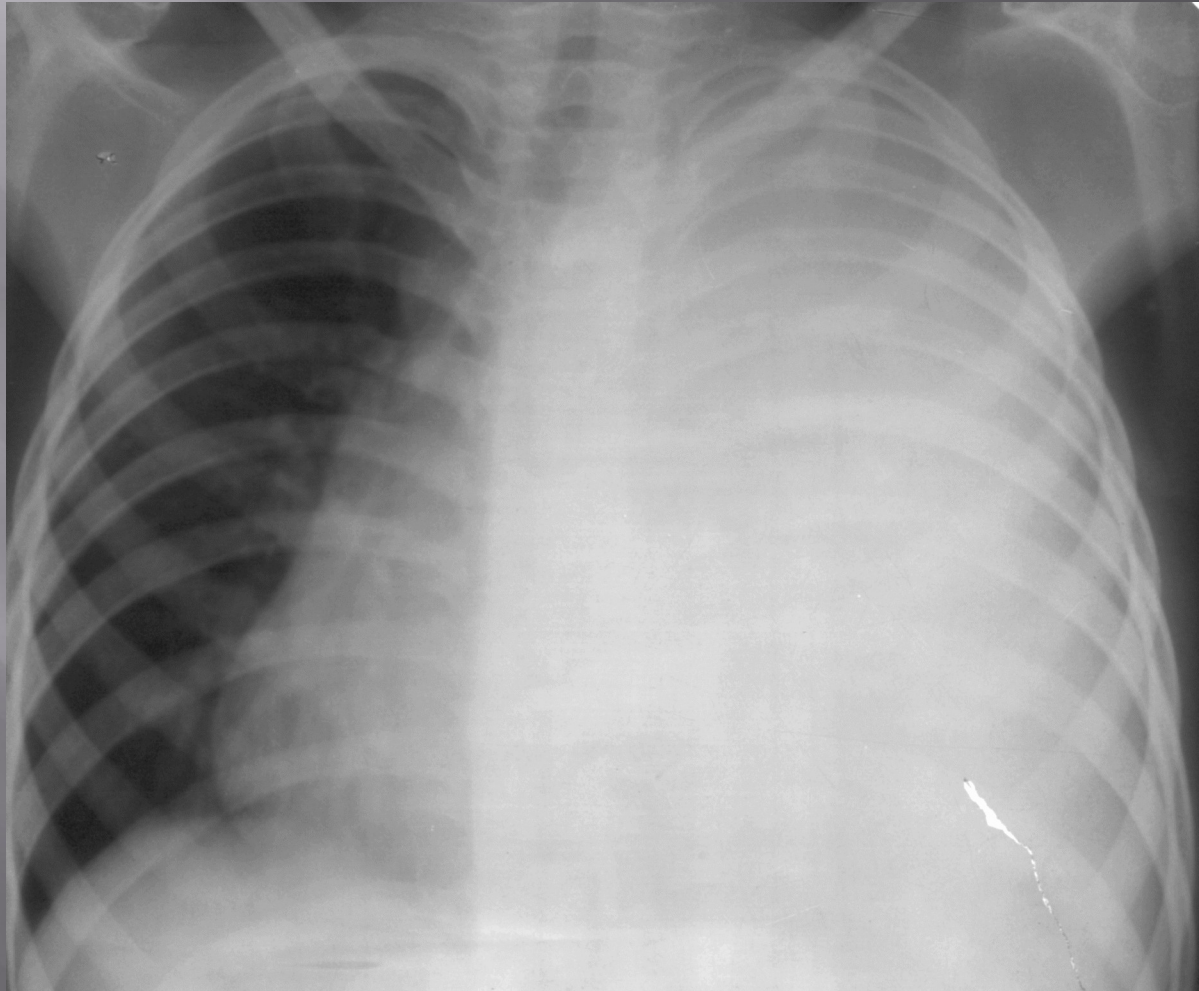
HRCT - High Resolution Computed Tomography



Left lung collapse



# PLEURAL EFFUSION



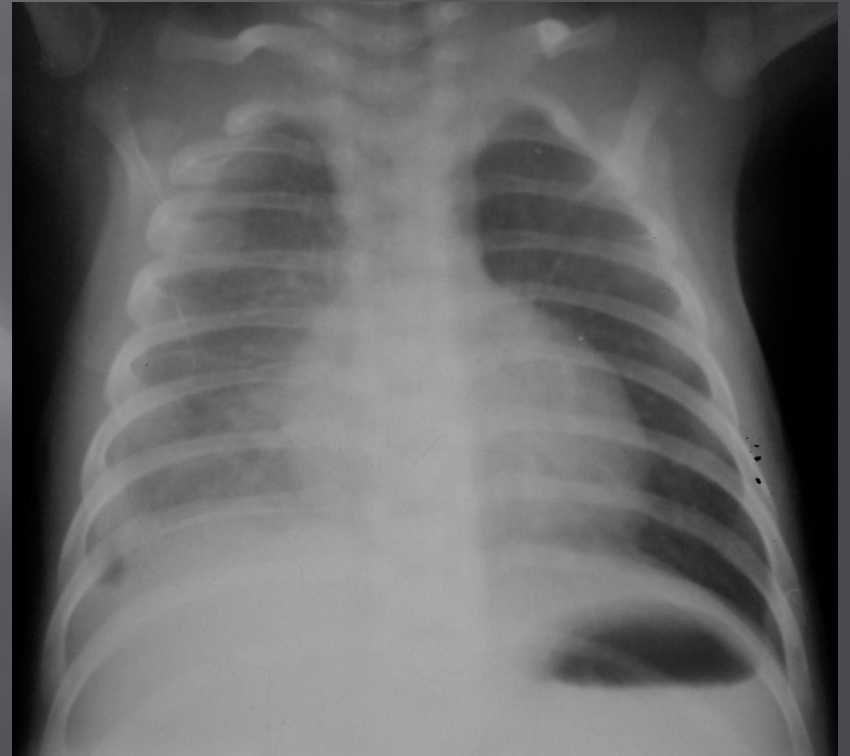
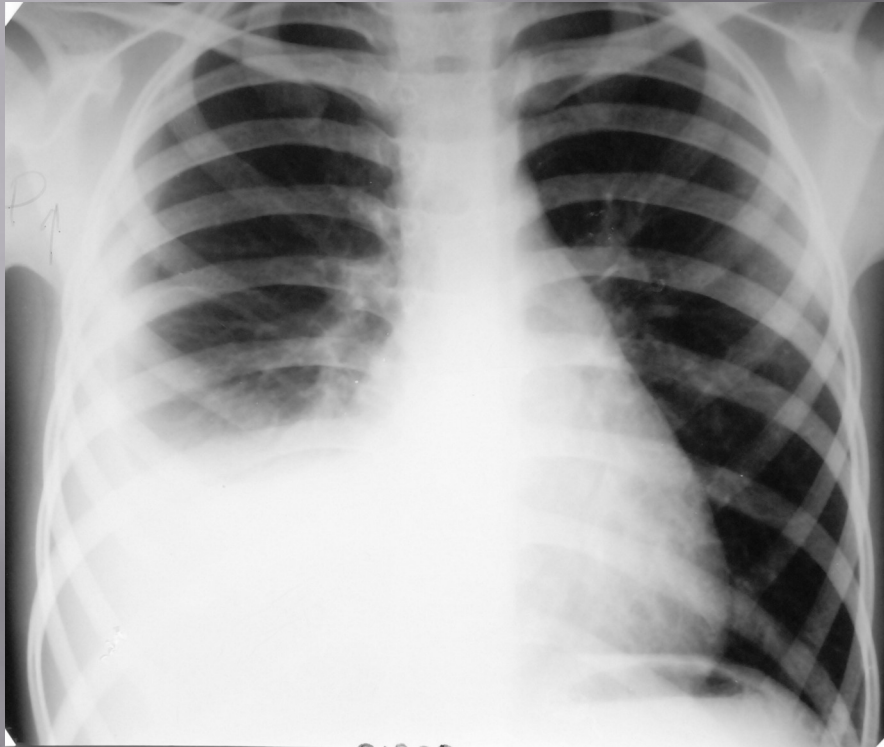
## Pleural effusion

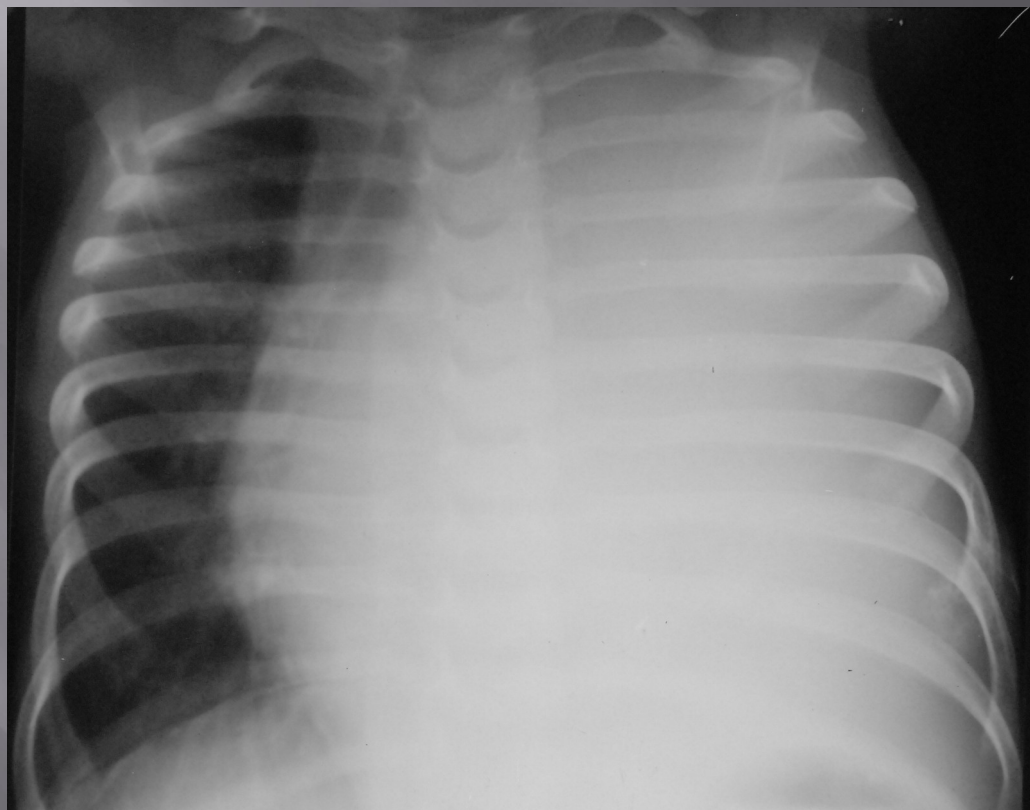


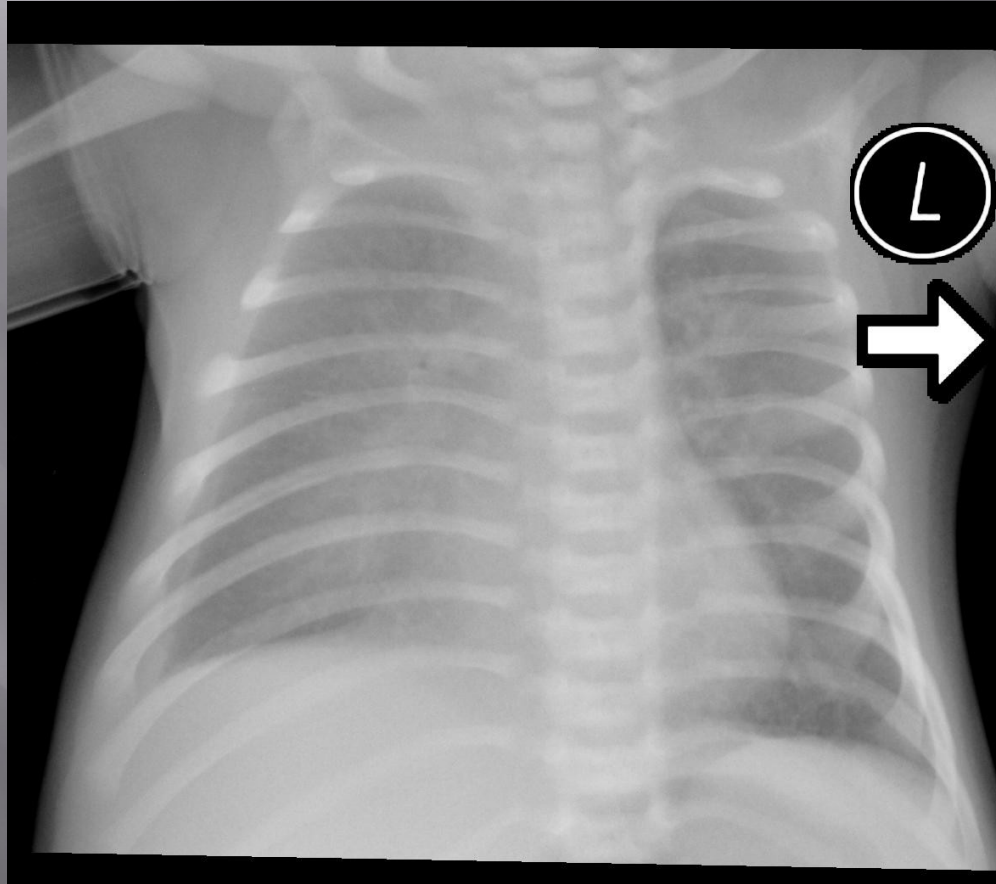
Pneumonia



Lymphatic effusion

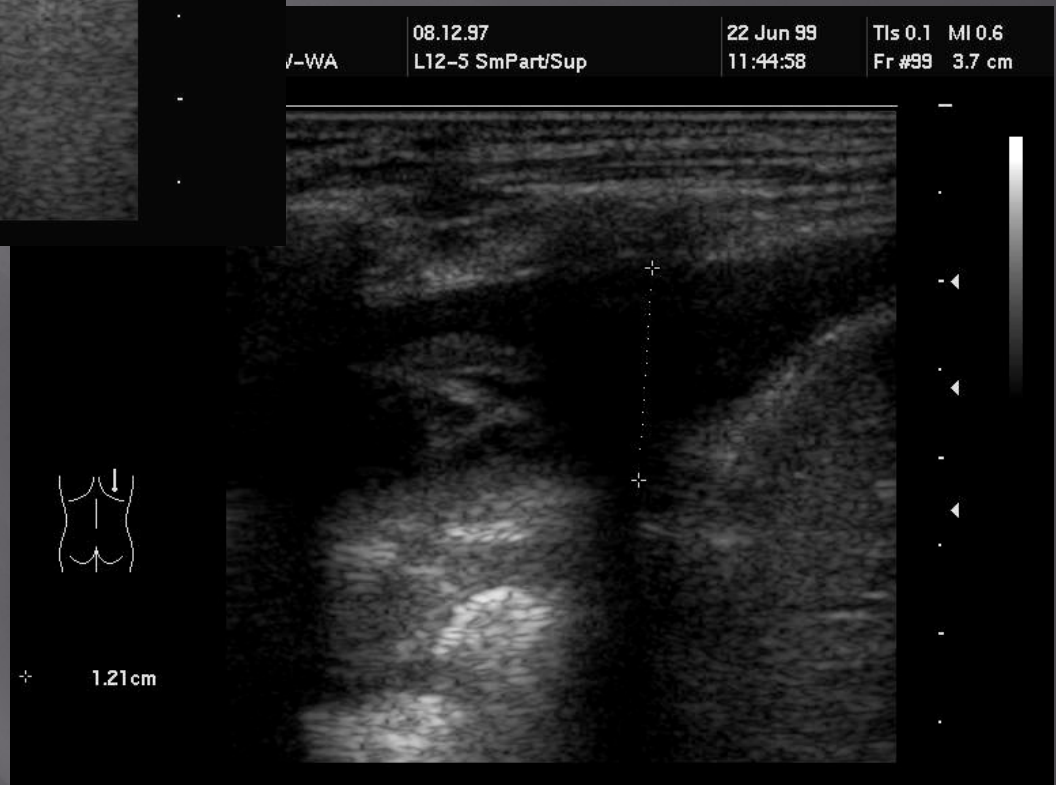








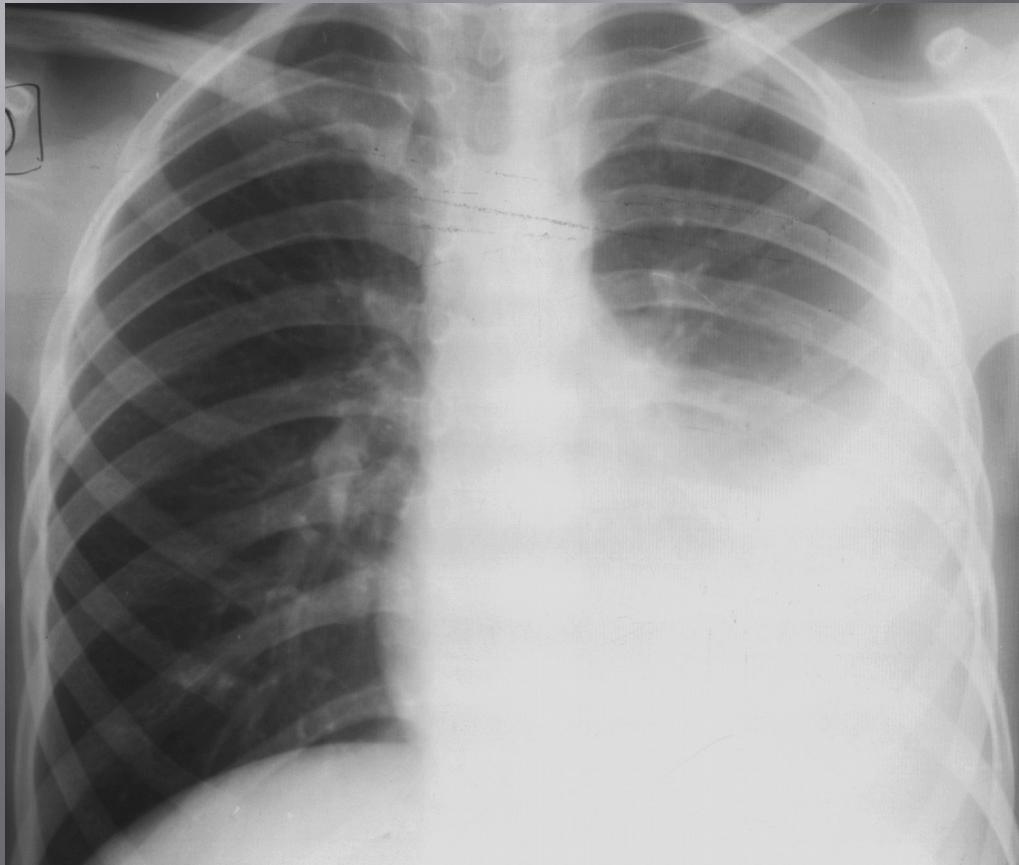
# PLEURAL EFFUSION - US



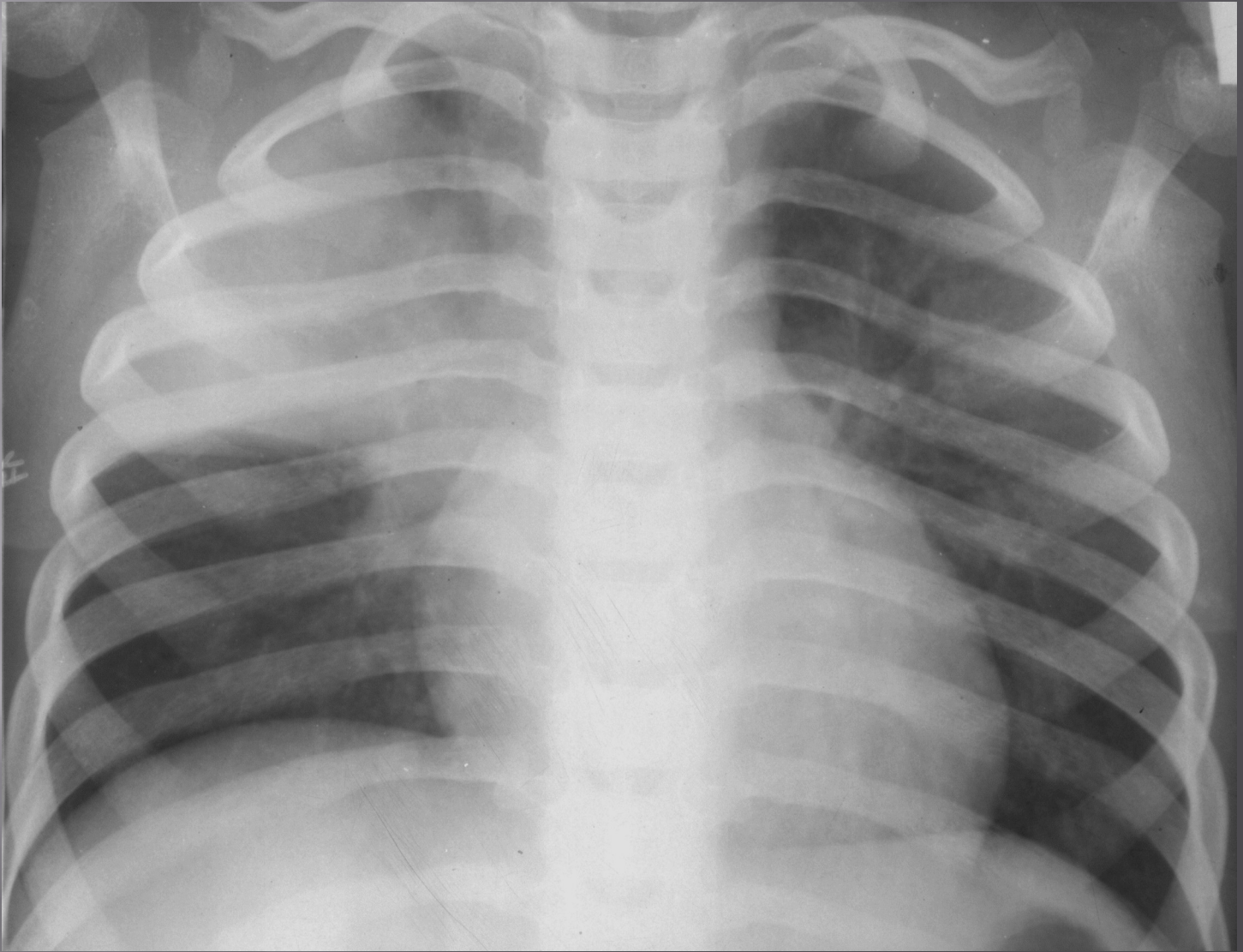
## THE SILHOUETTE SIGN



THE MARGINS ARE FUZZY OR OBLITERATED BECAUSE  
THE LUNG ADJACENT TO THESE MARGINS IS  
ABNORMAL



Pleural effusion  
„Ellis – Damoiseau“ line

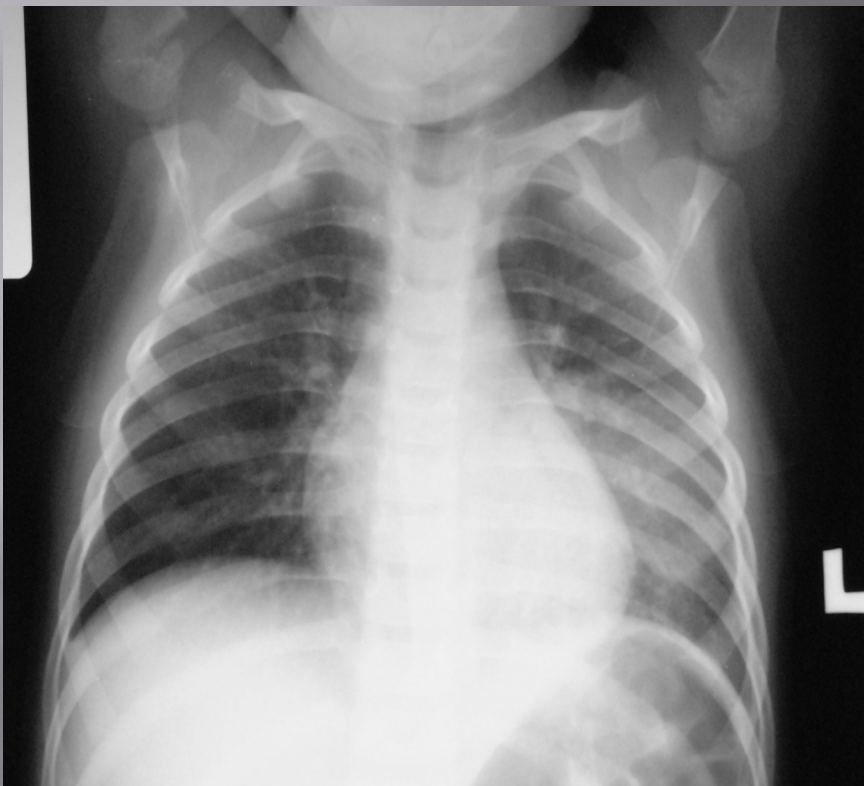


PNEUMONIA - UNKNOWN ETIOLOGY (BACTERIAL)

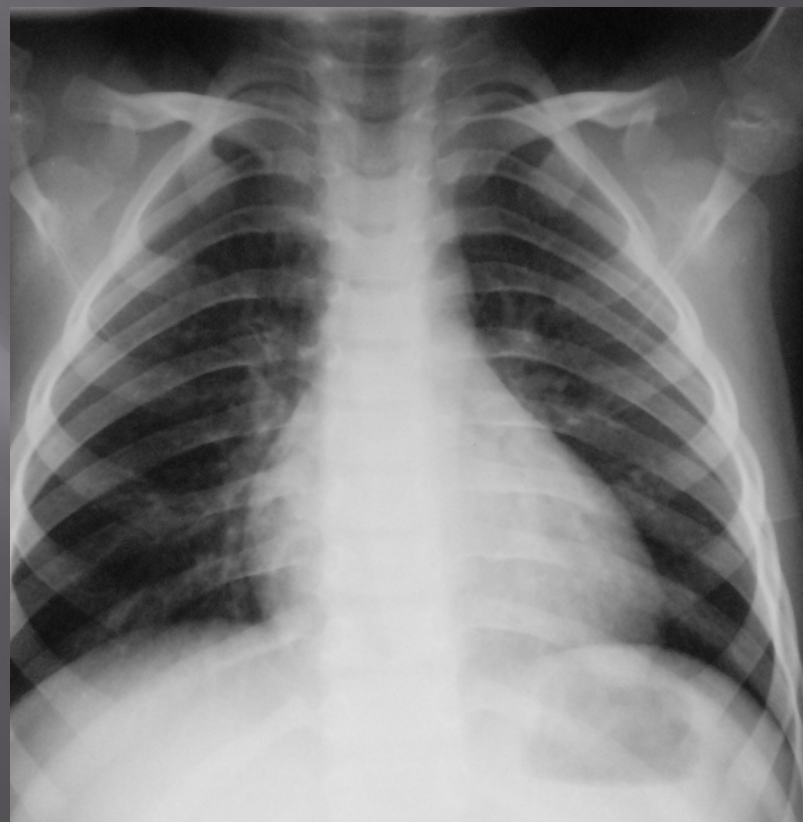


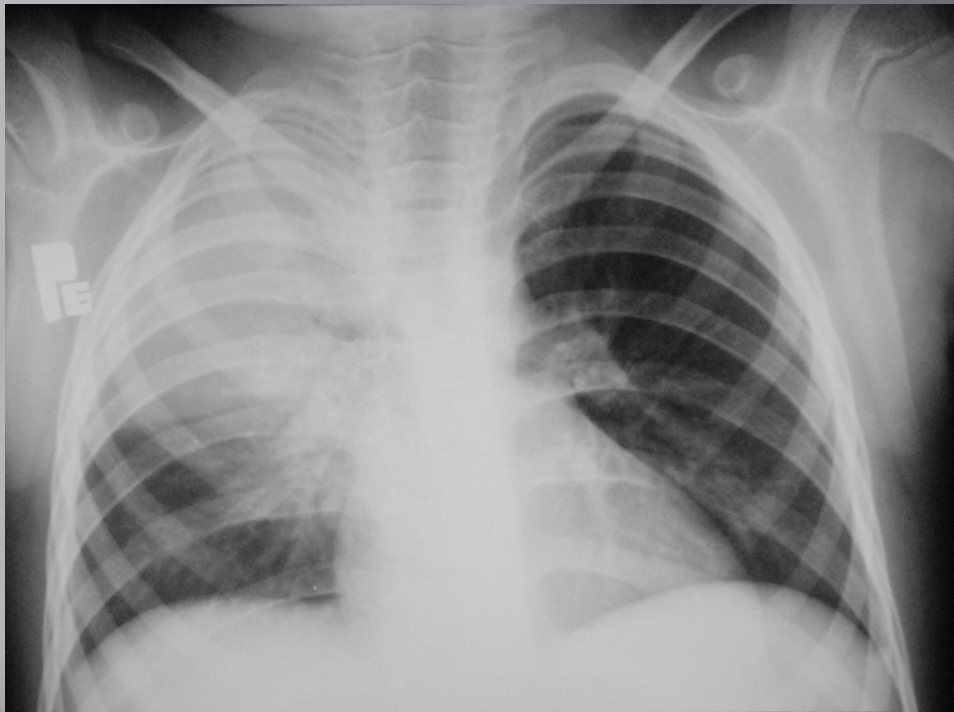
# PNEUMONIA

- BEFORE

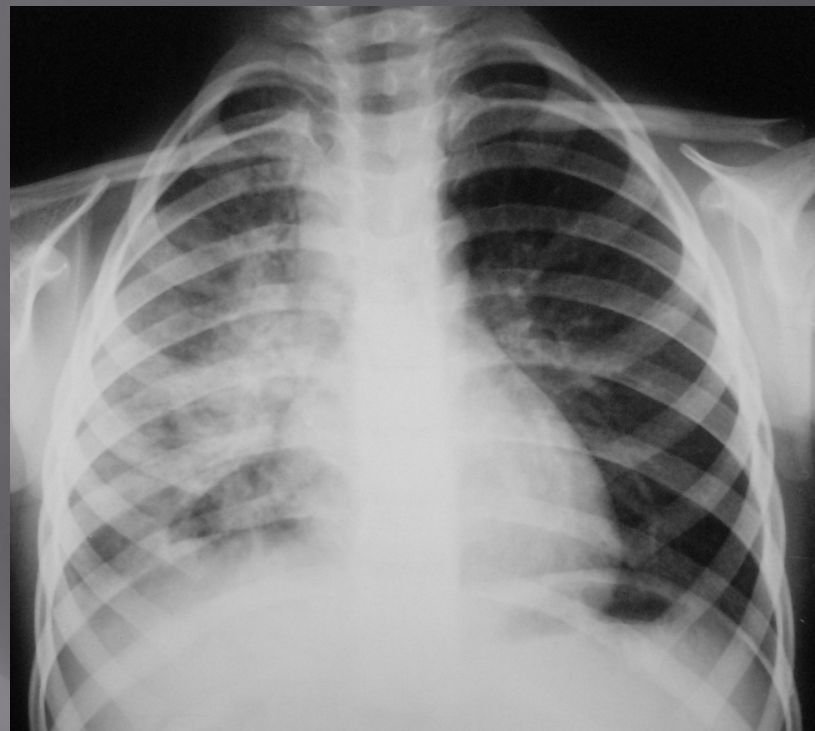


- AFTER ANTIBIOTIC  
TREATMENT



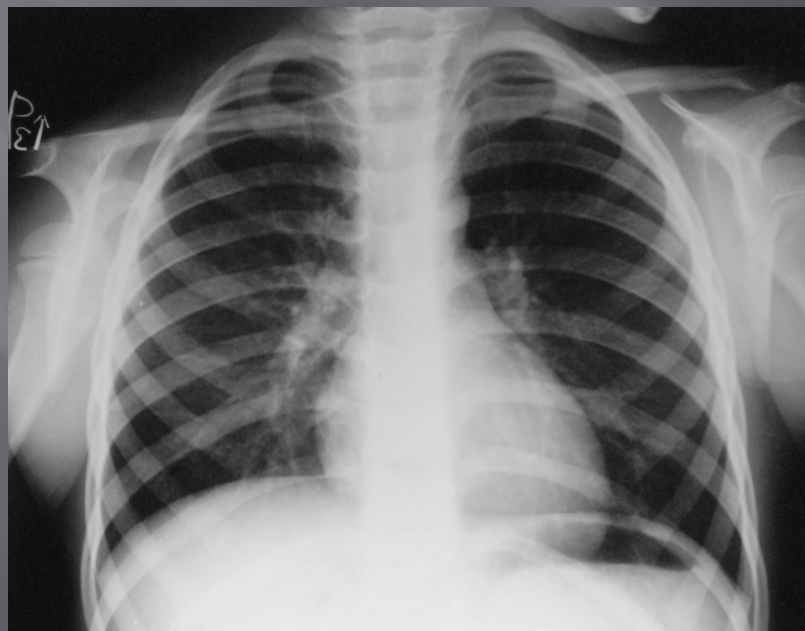


1.



2.

3 DAYS LATER



3.

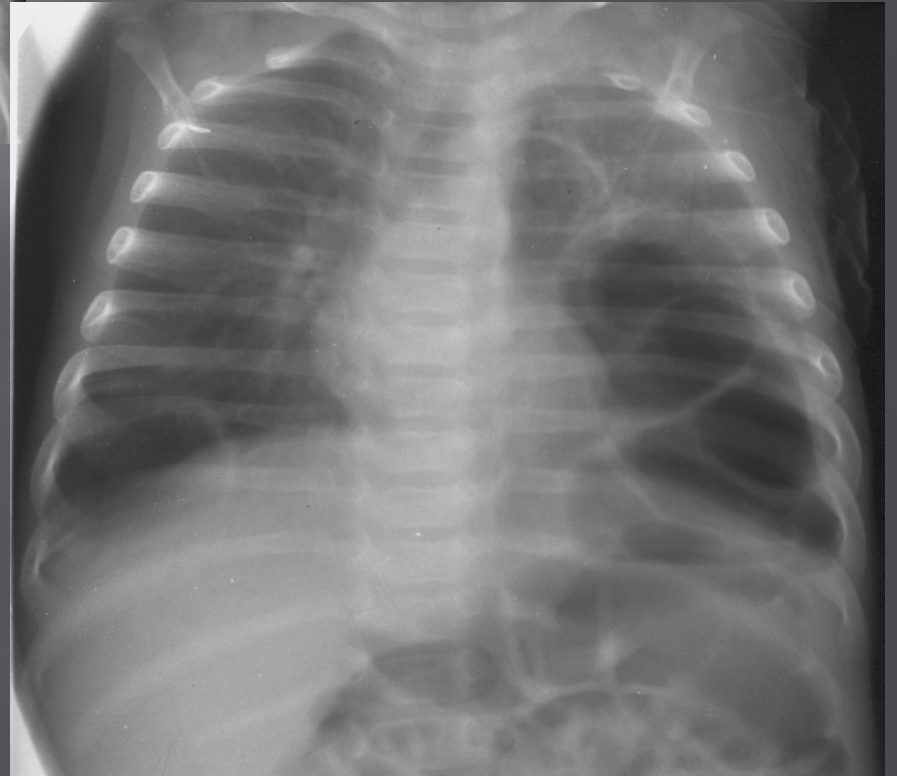
10 DAYS LATER

**PNEUMONIA**

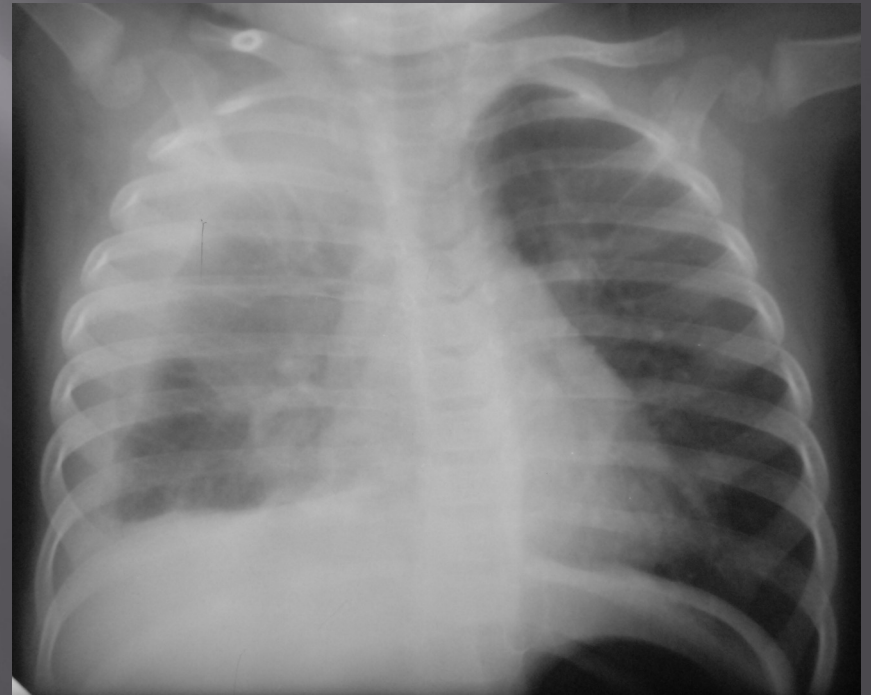


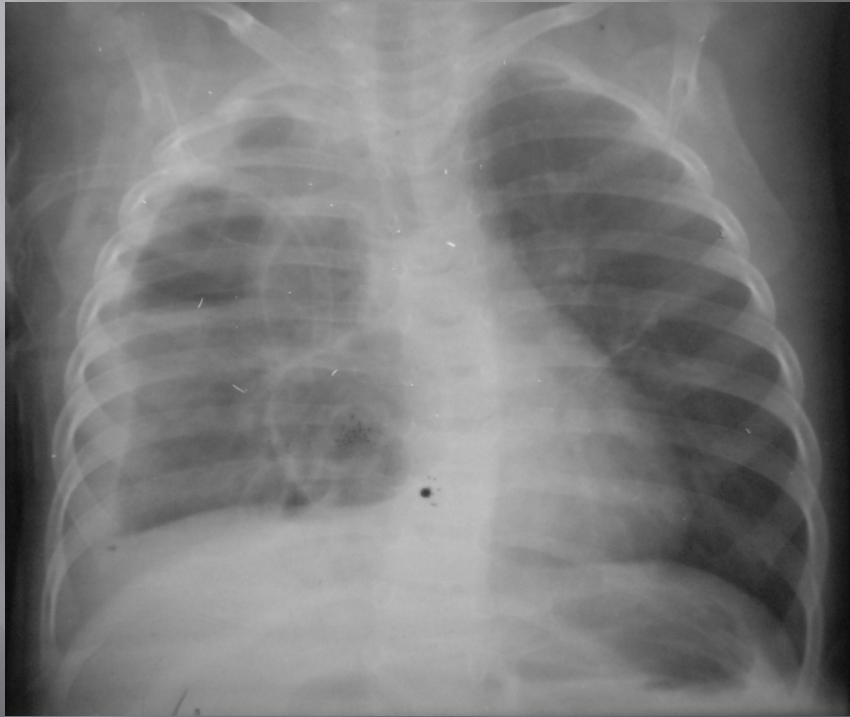
# STAPHYLOCOCCAL PNEUMONIA

5 DAYS  
LATER

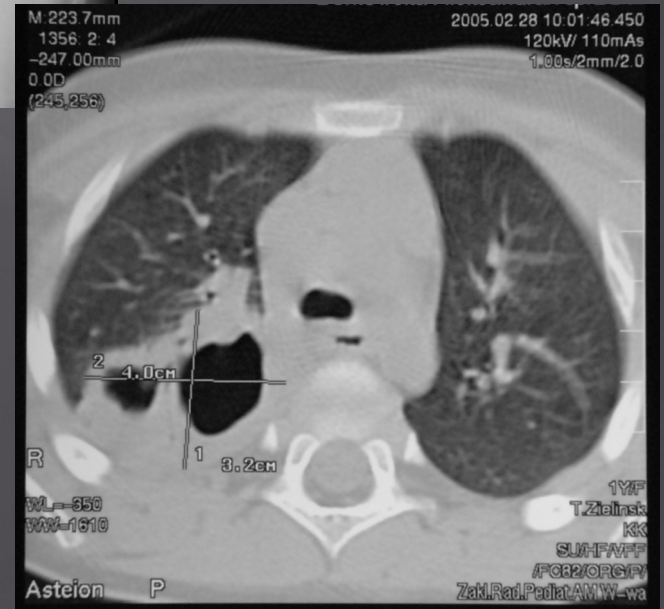
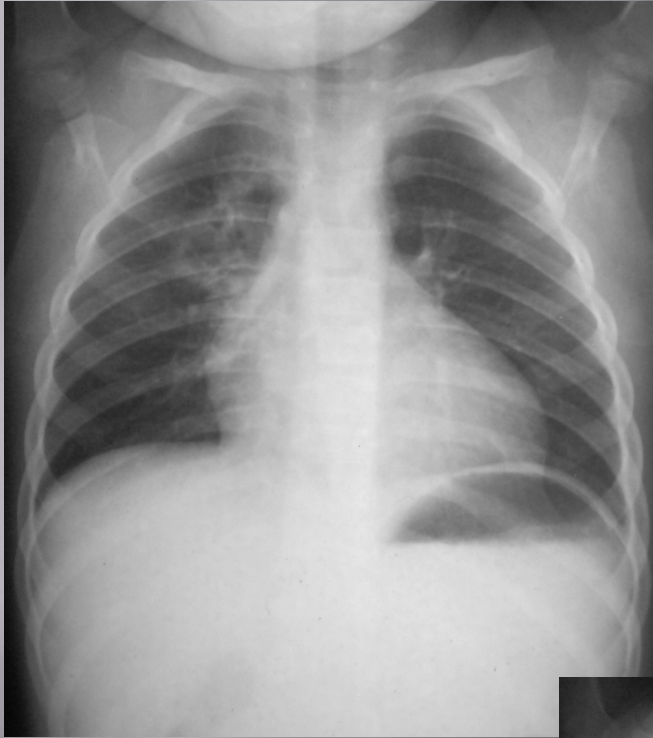


## S. AUREUS PNEUMONIA

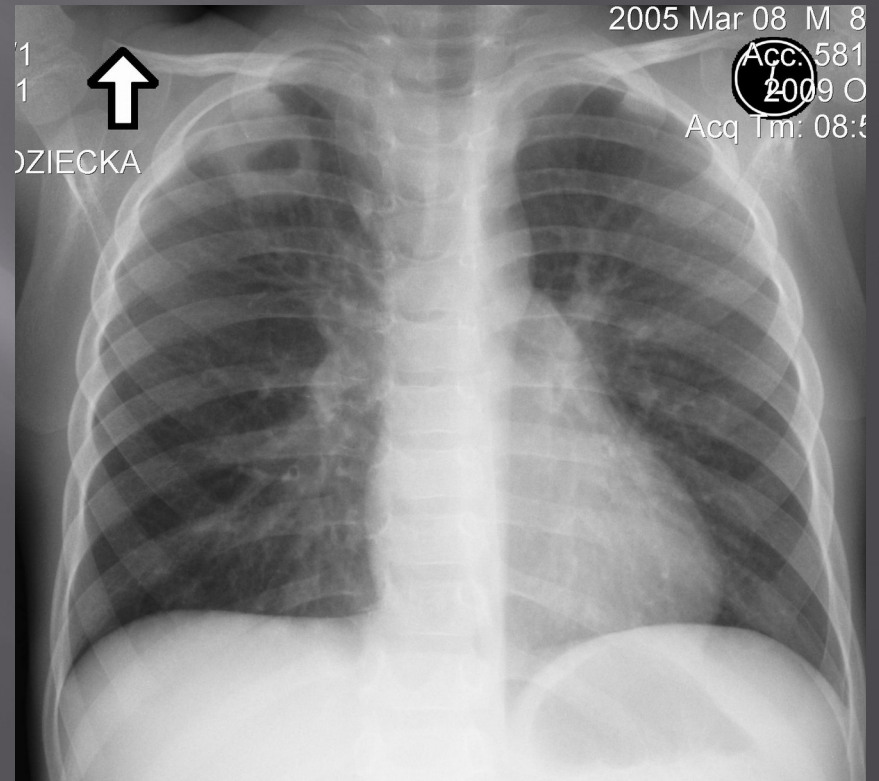
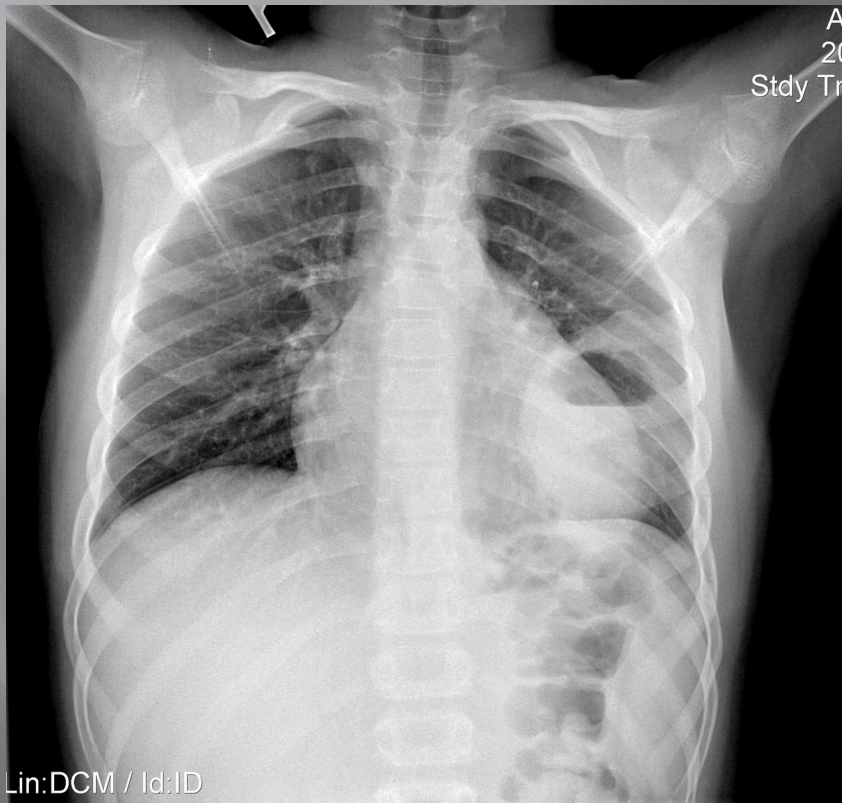


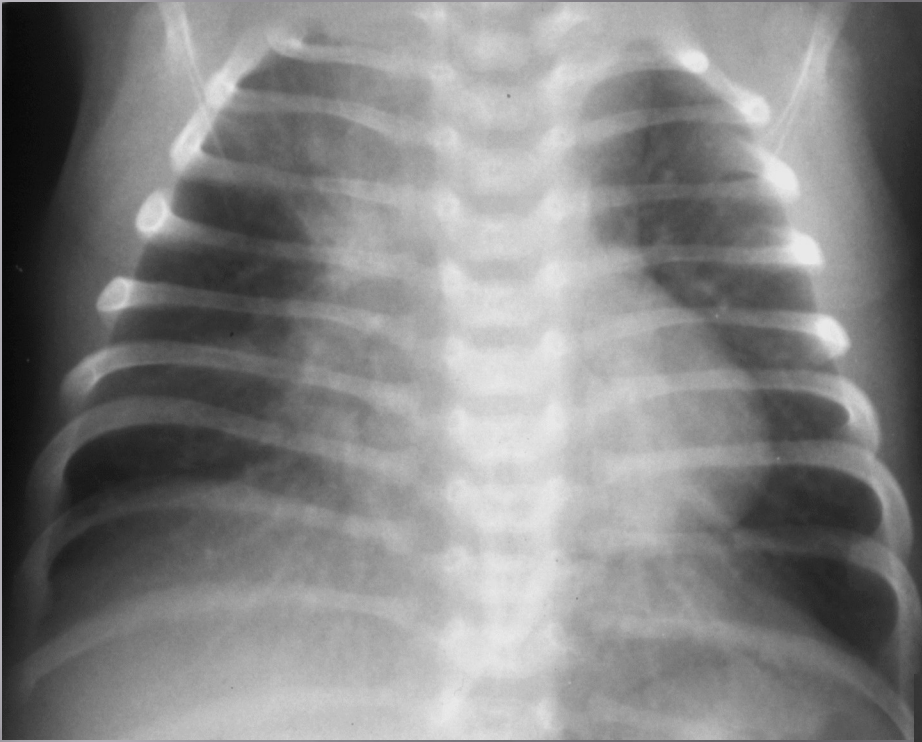


# LUNG ABSCESS

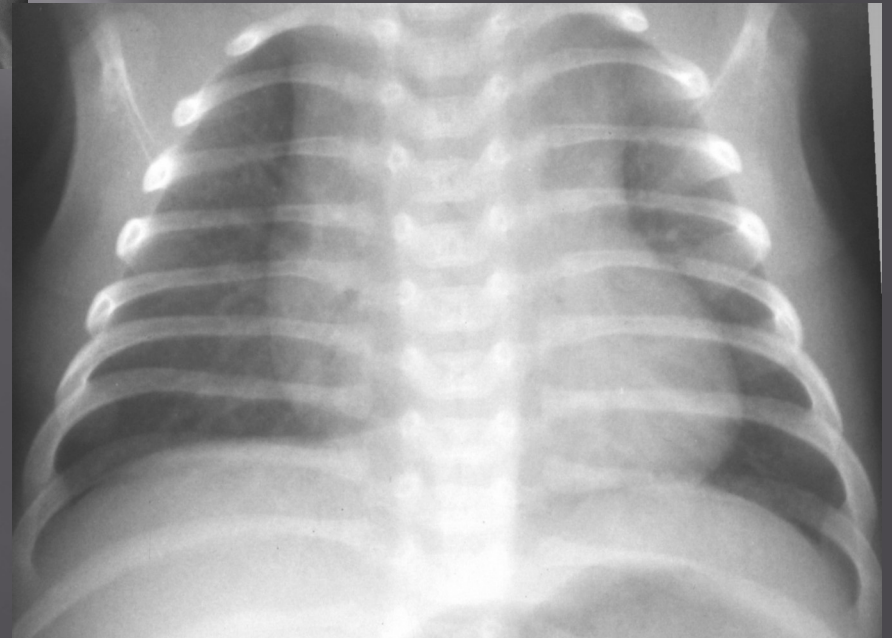


# Pulmonary cavities necrotic meta / abscess





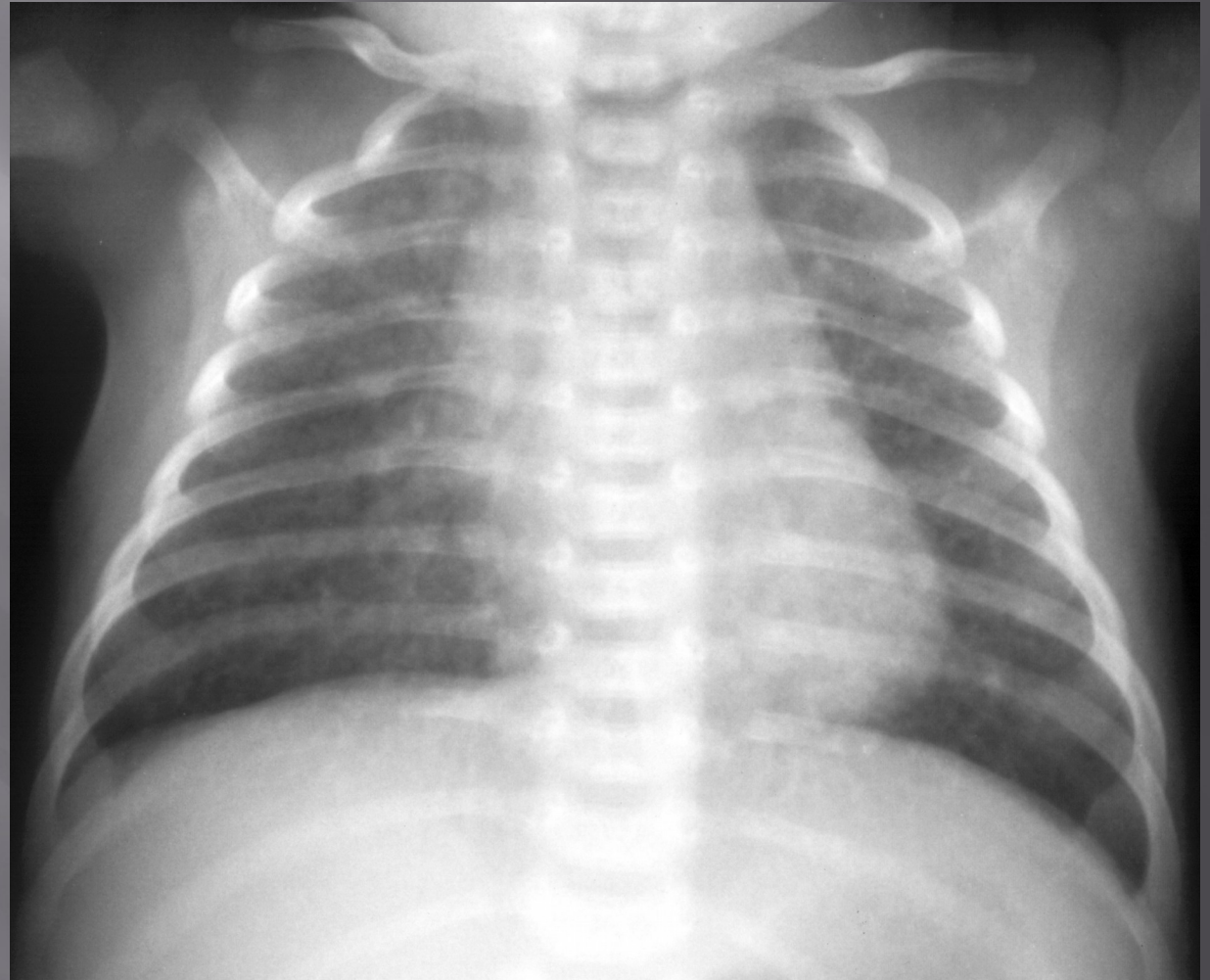
**RSV**  
**pneumonia**  
**(viral)**



**AFTER**  
**THERAPY**



CMV



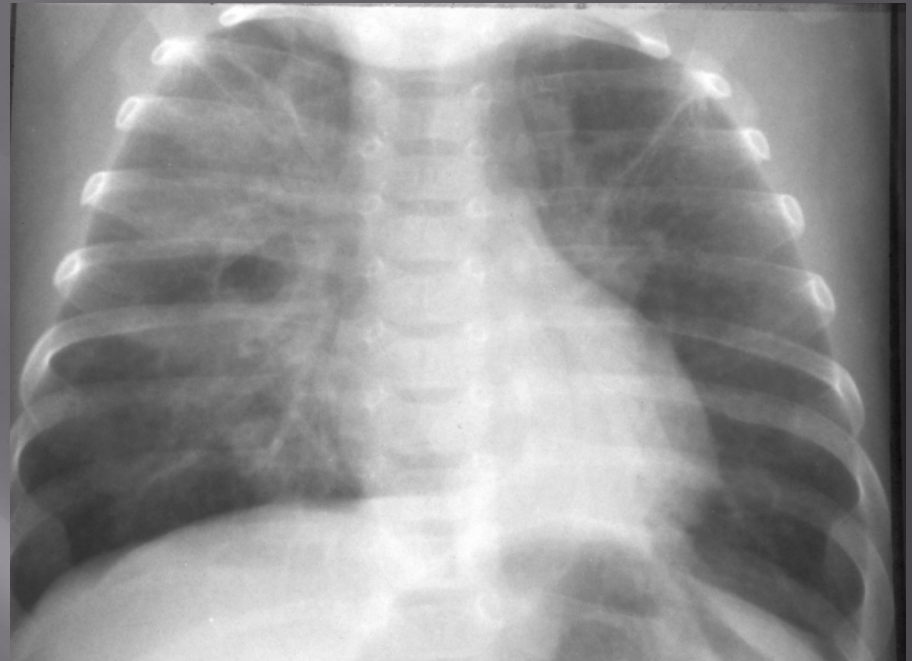
Interstitial changes

# ASPIRATION PNEUMONIA

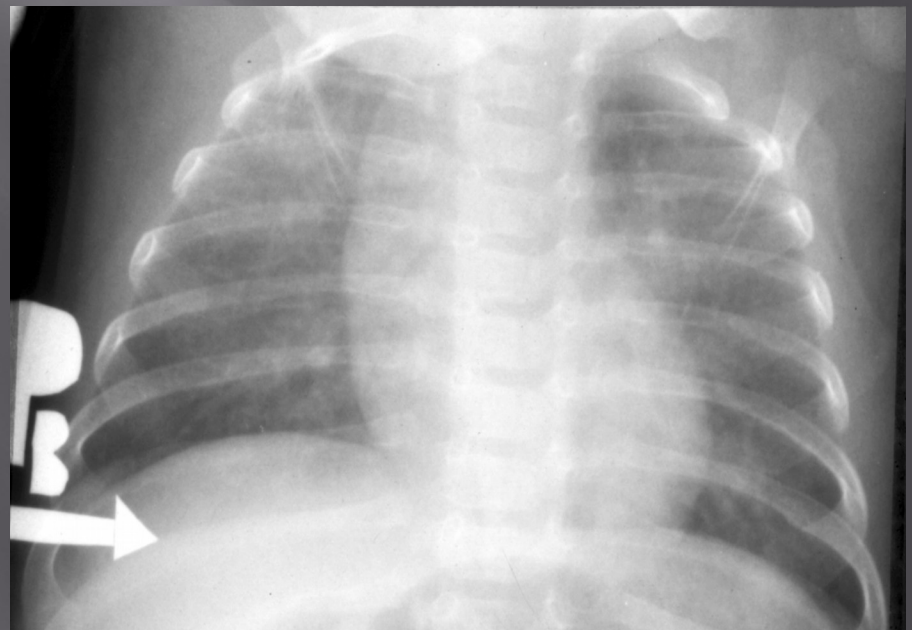
- full-term newborn

-hyperinflated peripheral parts

-massive parenchymal densities

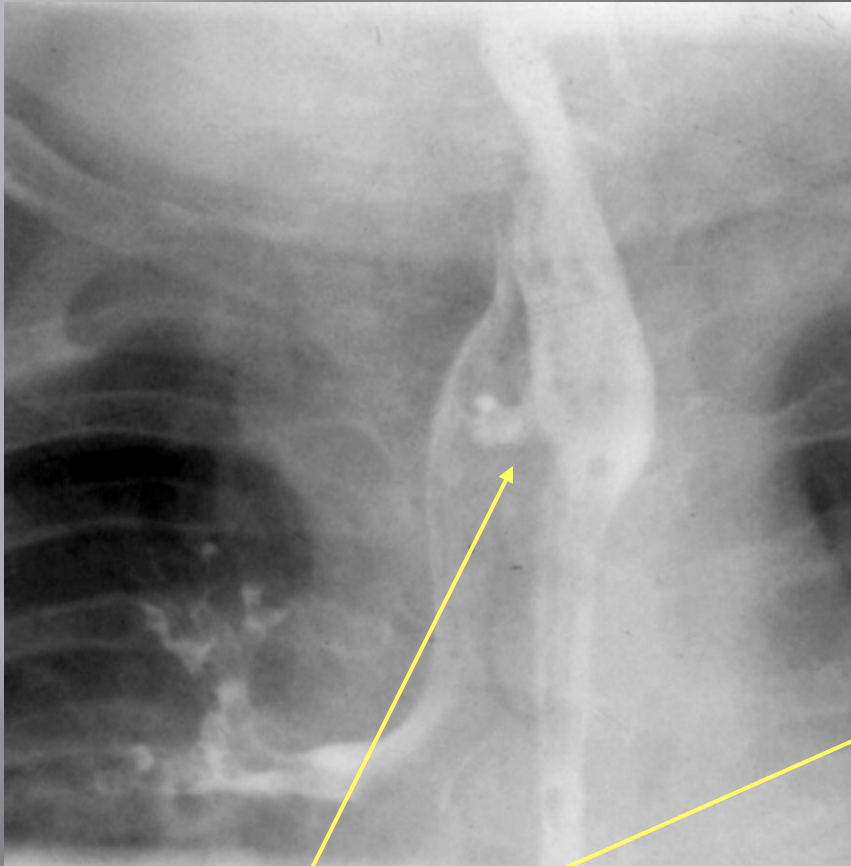


**AFTER THERAPY**





Gastroesophageal reflux

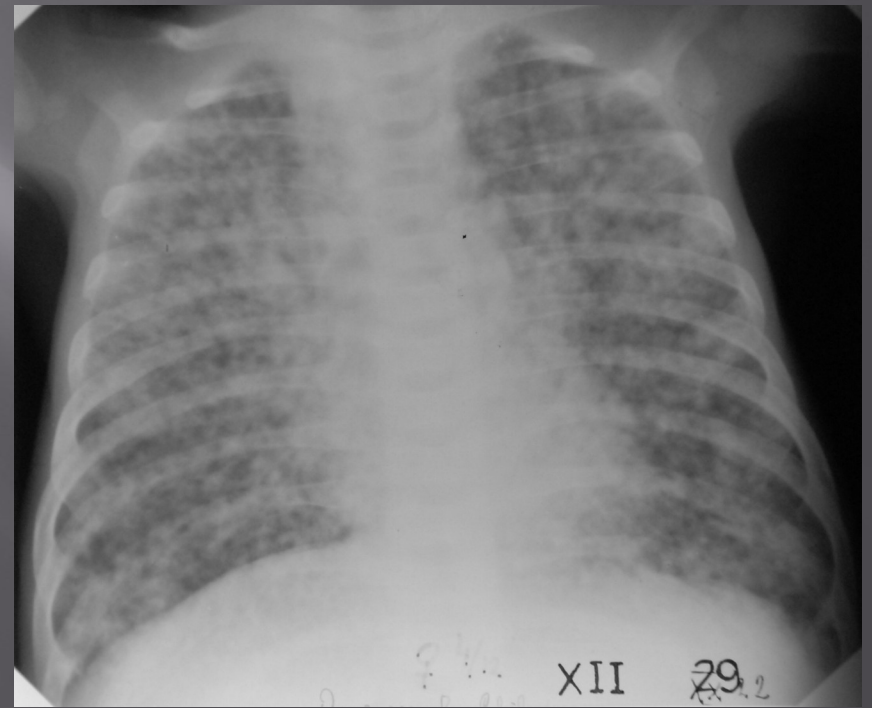


Tracheoesophageal fistula  
in a child with chronic pneumonia

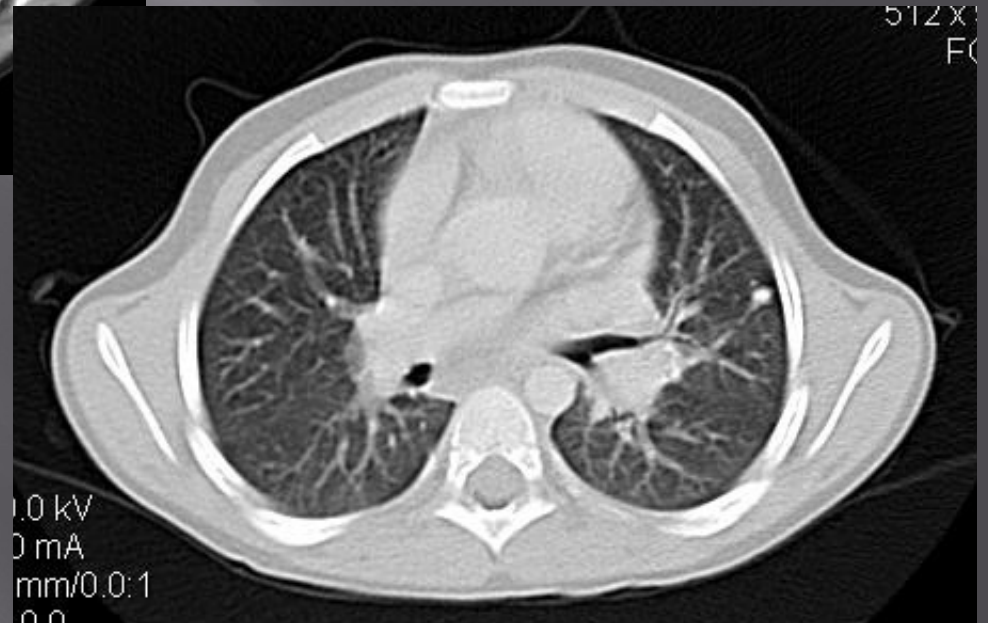
# Tuberculosis



# TB



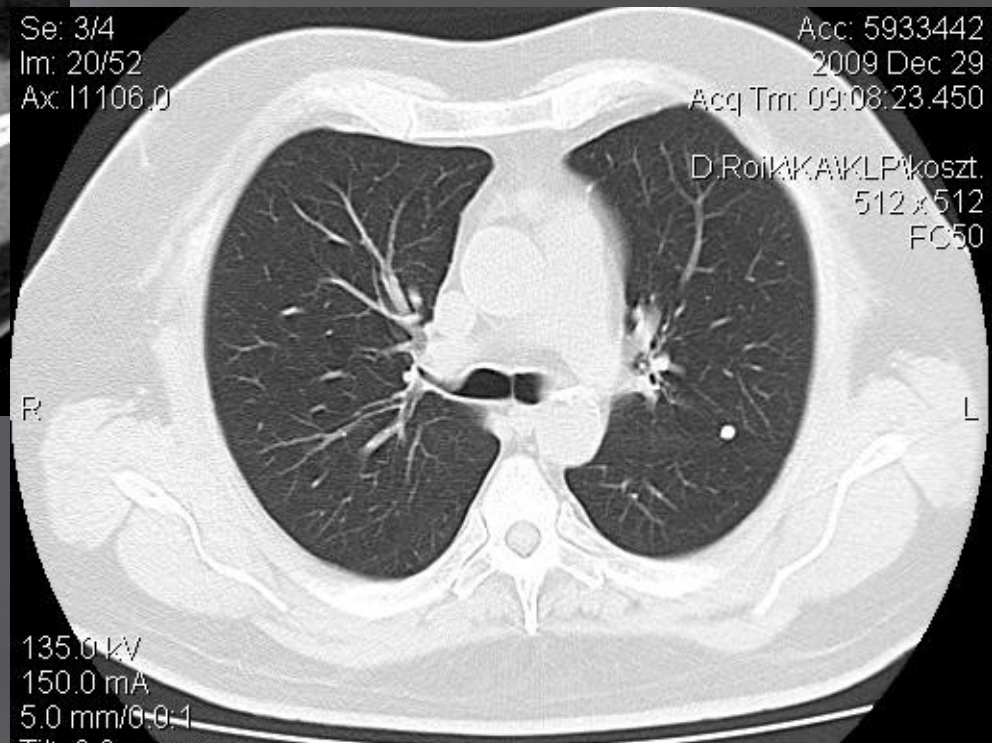
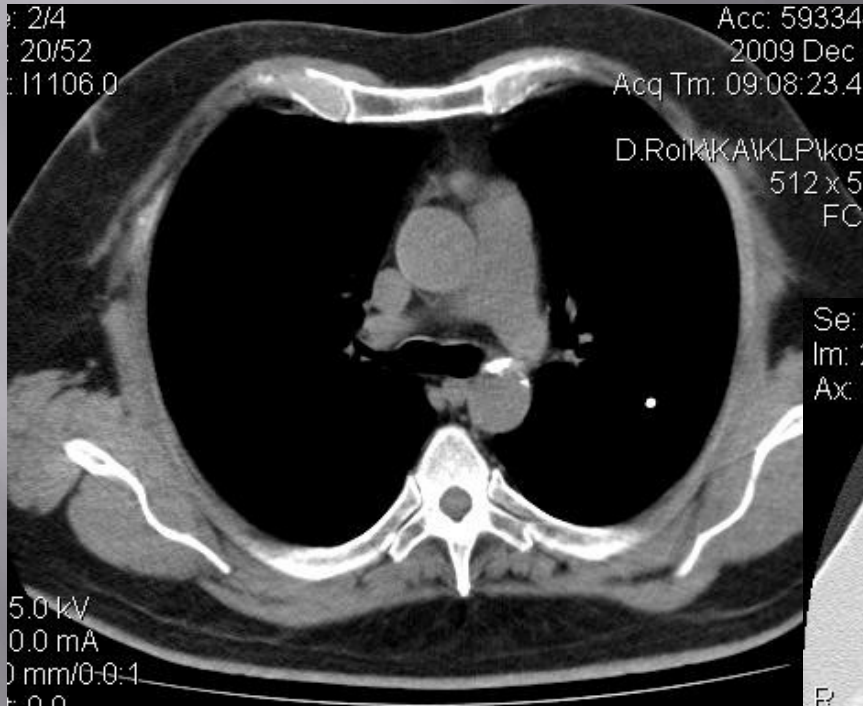
# TB – 4 y.o. boy

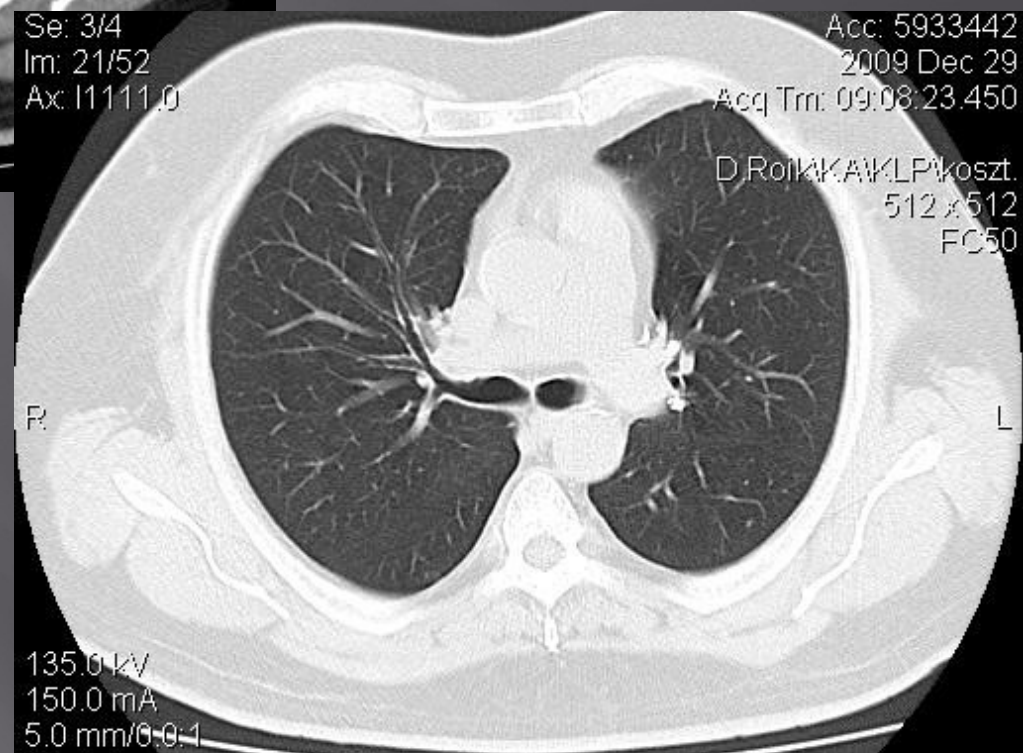
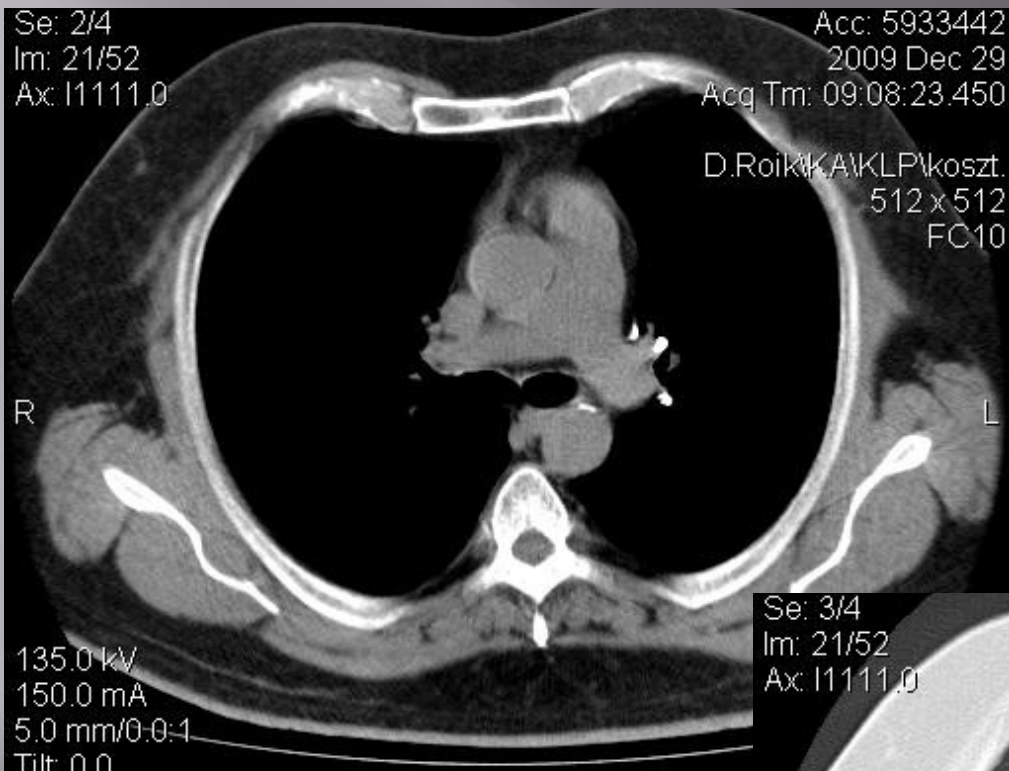






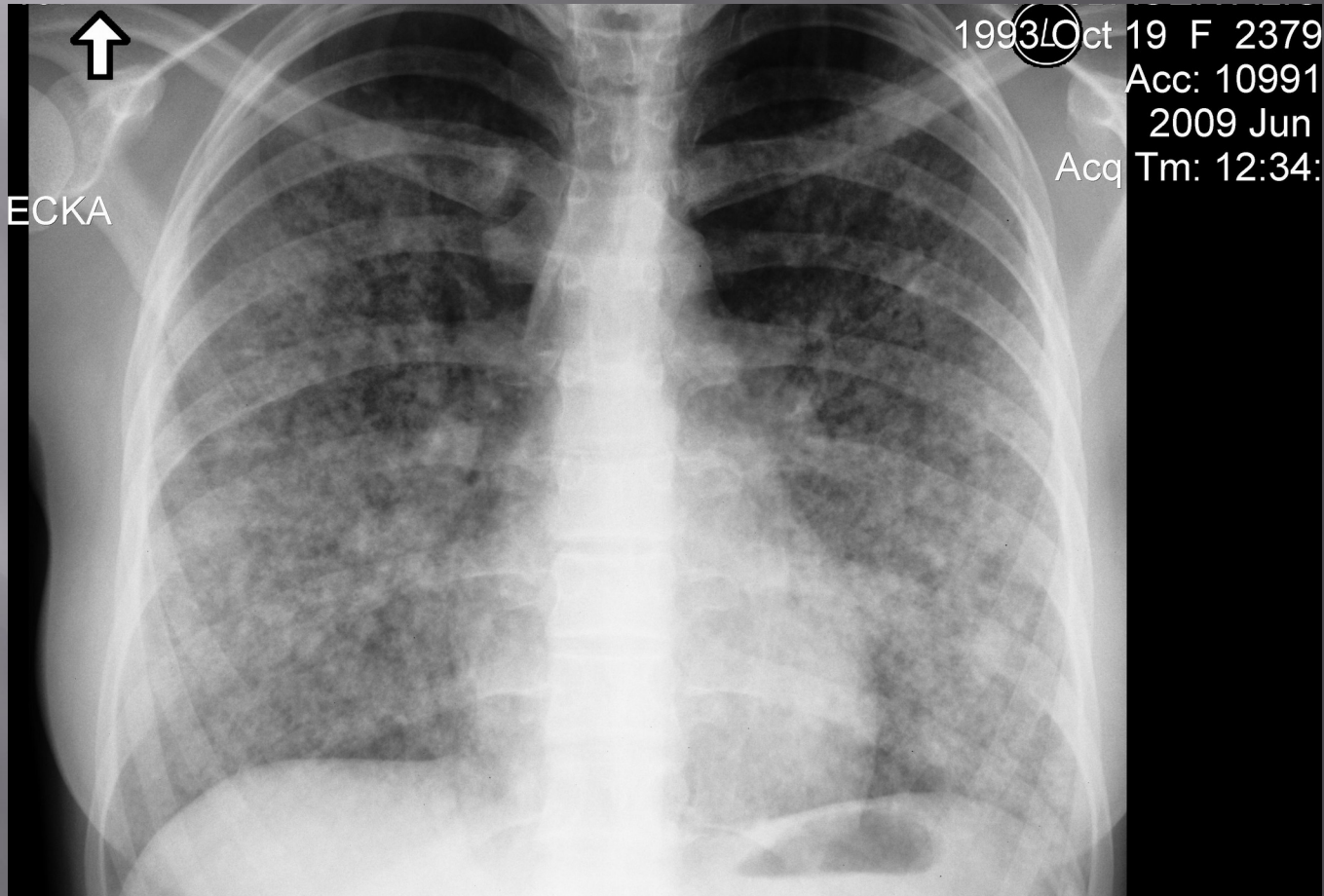
# TB – 61 y.o. male





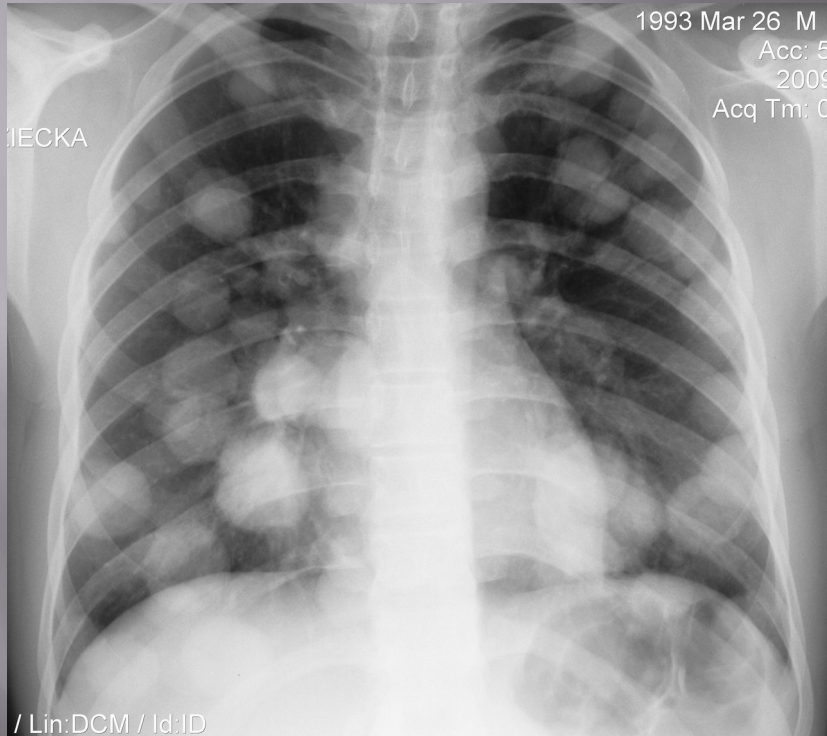
# TB MILIARIS

16 y.o. girl



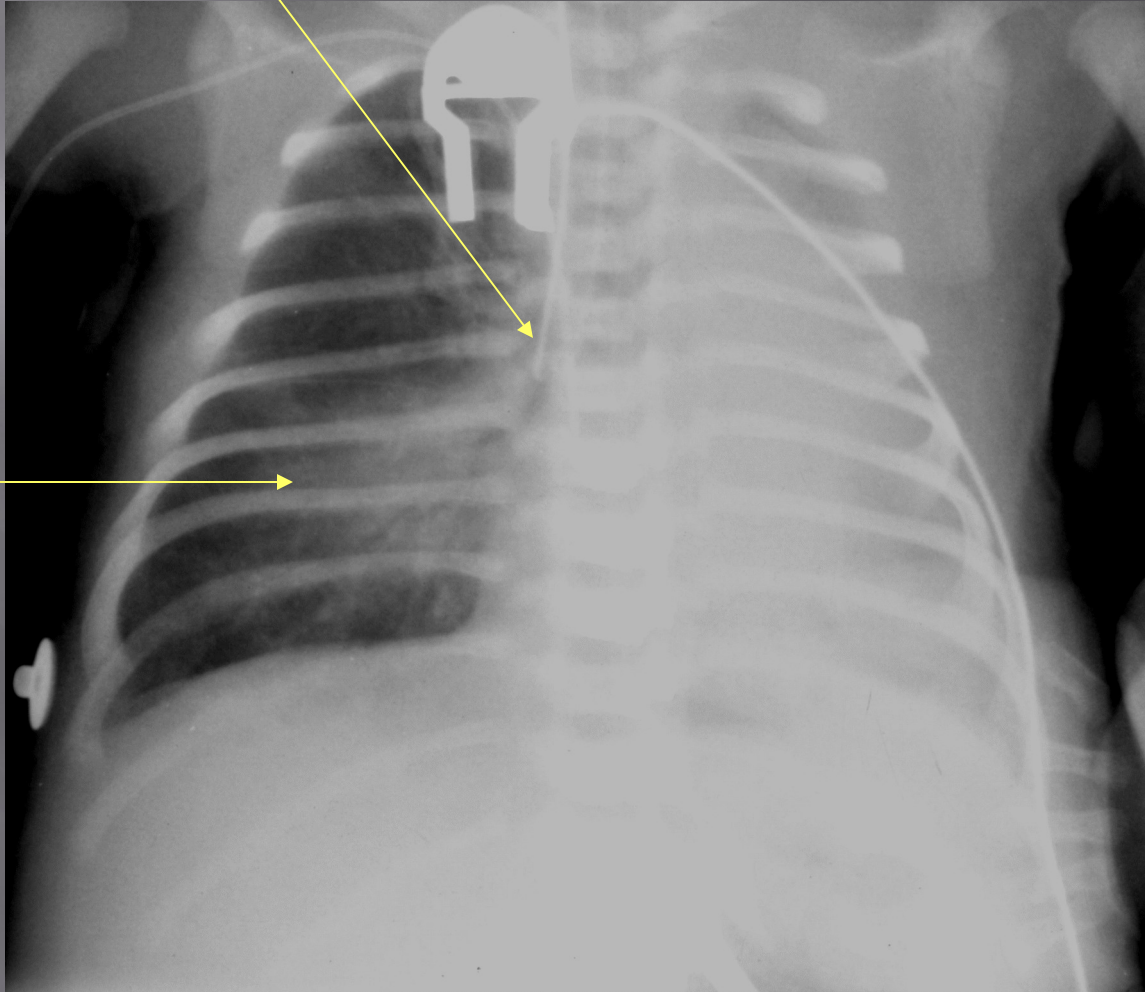
# META from testis choriocarcinoma

## 16 y.o. male



# WILMS TU - meta





?

?

# III. LUNG DISEASE IN NEONATE

# ETIOLOGY OF ACUTE RESPIRATORY INSUFFICIENCY IN NEWBORNS

## PULMONARY

## OTHERS

### premature

RDS  
TTN  
pneumonia  
congenital  
abnormalities

### full-term

TTN  
MAS  
pneumonia  
congenital  
abnormalities

- CNS
- congenital heart diseases
- metabolic
- hematology disorders
- congenital abnormalities

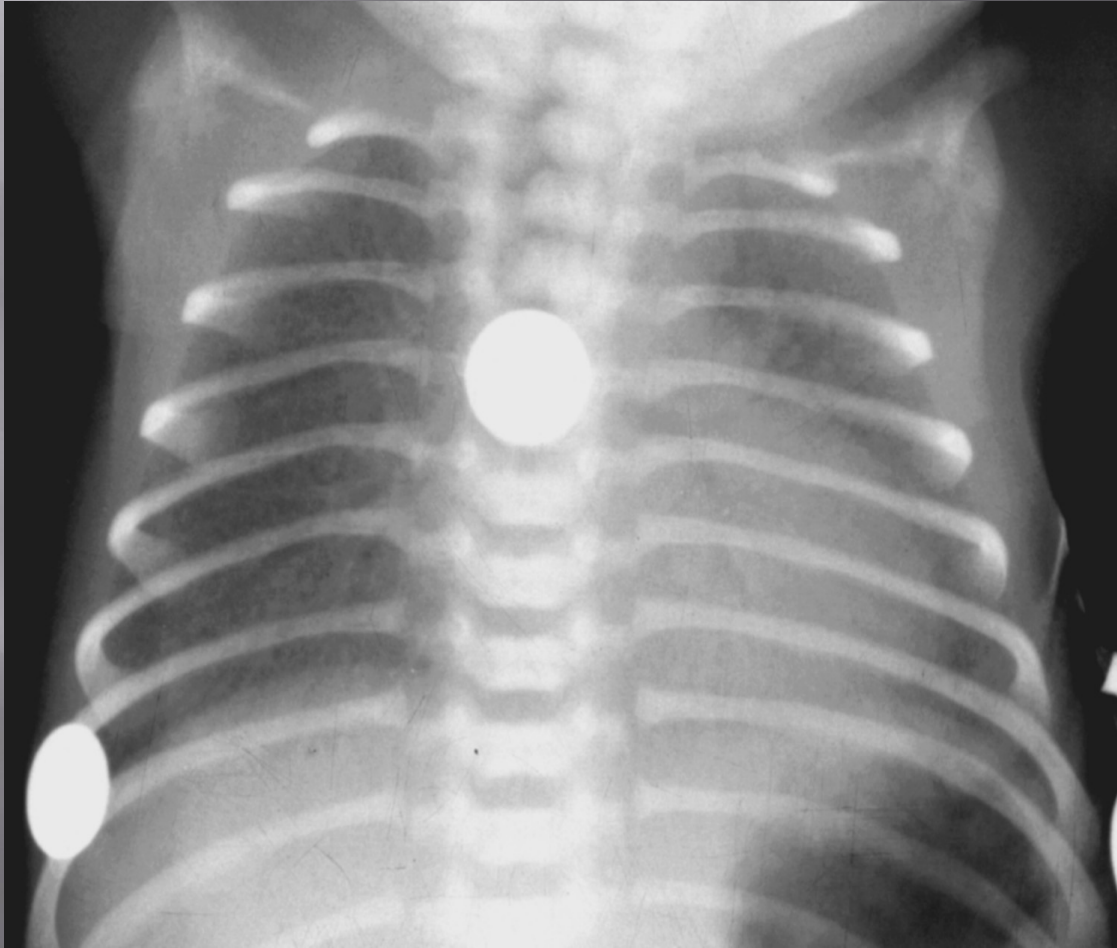
TTN- transient tachypnoe of the newborn = wet lung syndrome (retained fetal fluid)  
MAS - meconium aspiration syndrome



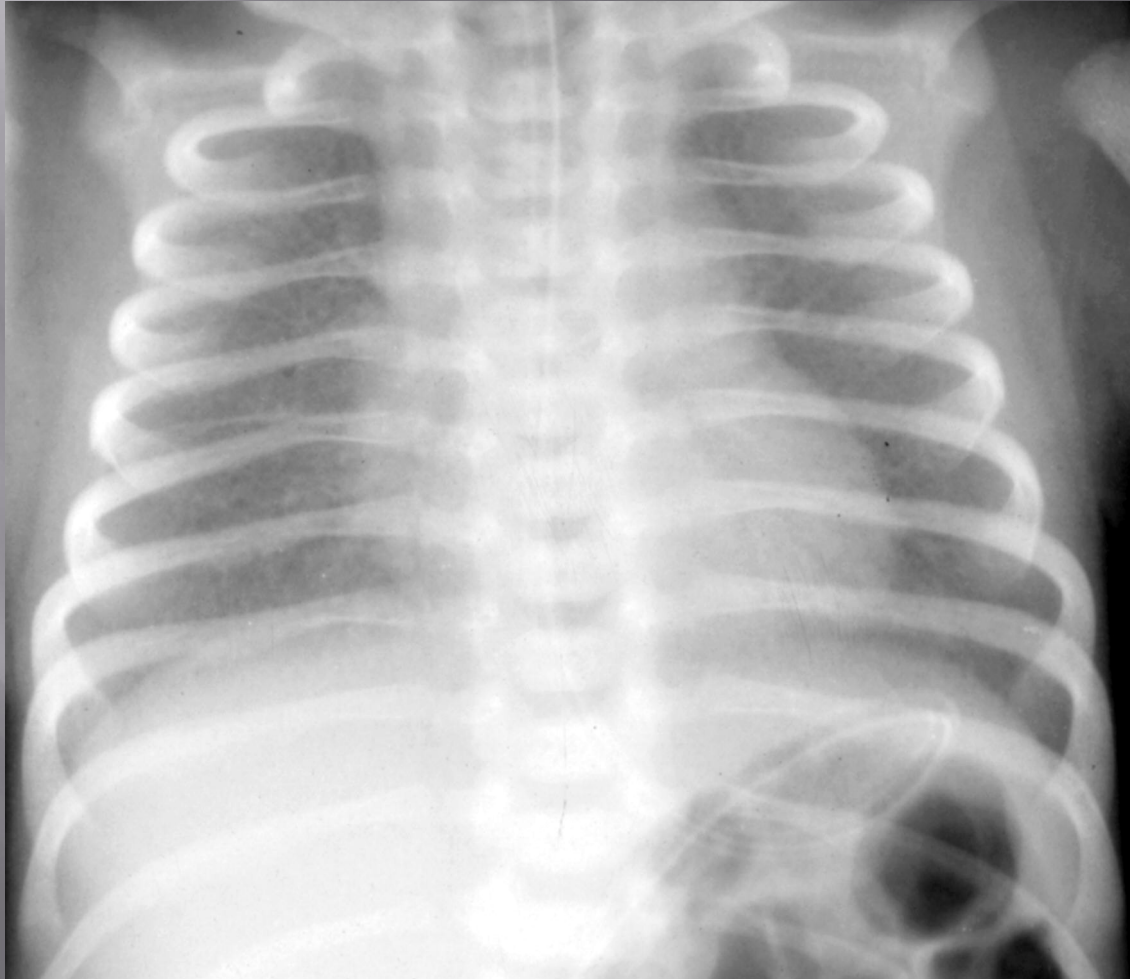
# RDS / HMD

- I degree      fine reticulogranular densities
- II degree     fine densities, leak bronchogram
- III degree    diffuse opacities; marked underaeration of both lung, bronchogram, borders of the heart and diaphragm are obliterated
- IV degree    no aerated lung („ground glass appearance“)

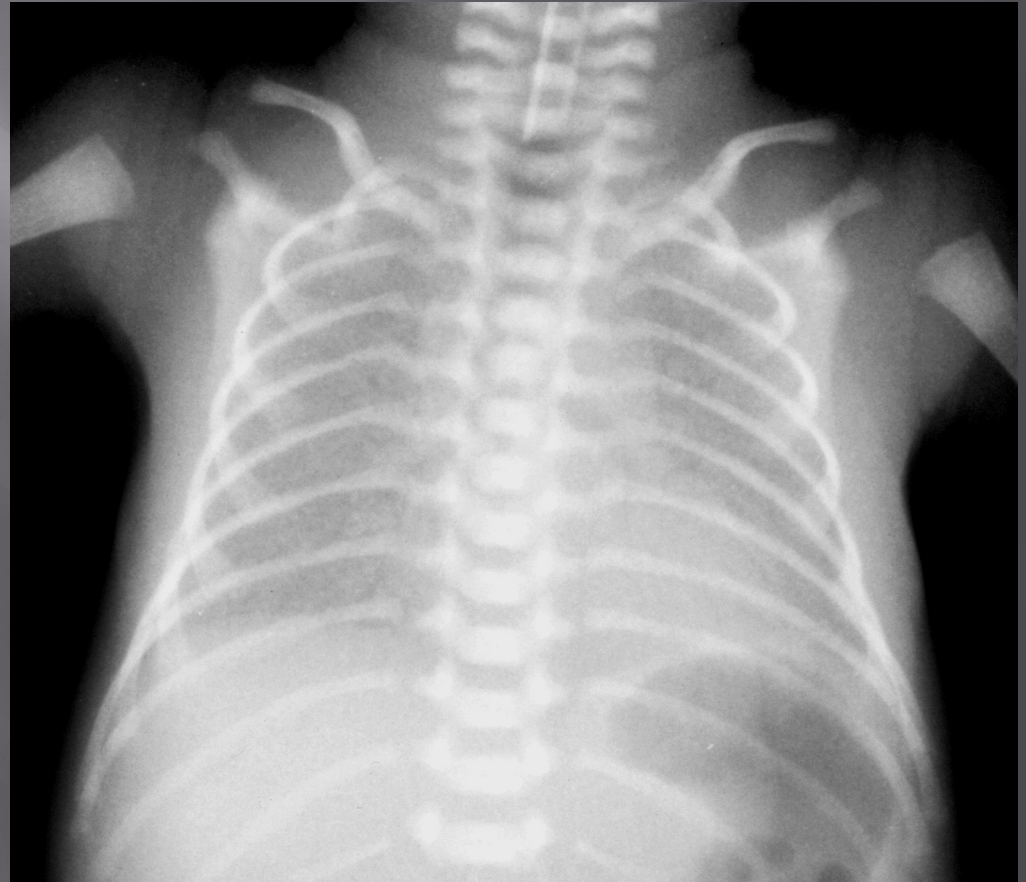
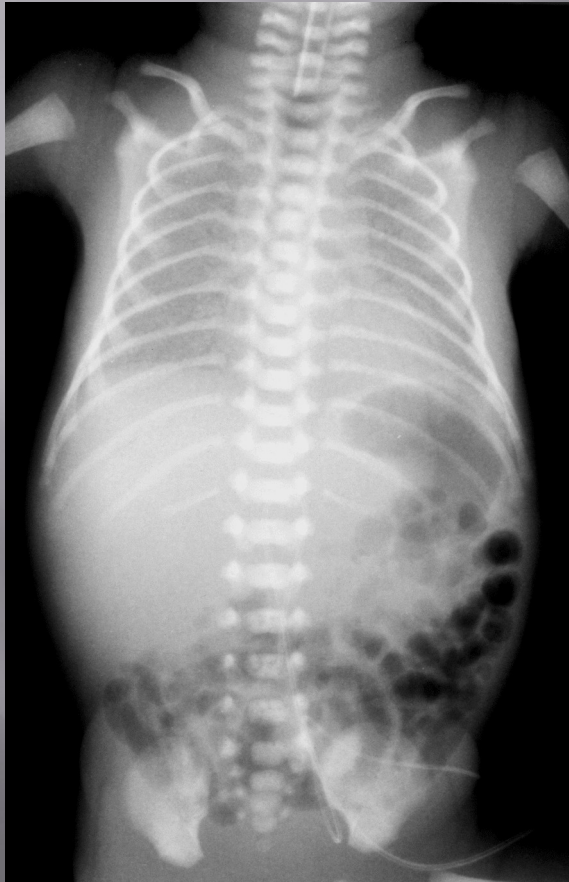
RDS: I degree - fine reticulogranular densities



RDS: II degree - fine densities, leak bronchogram

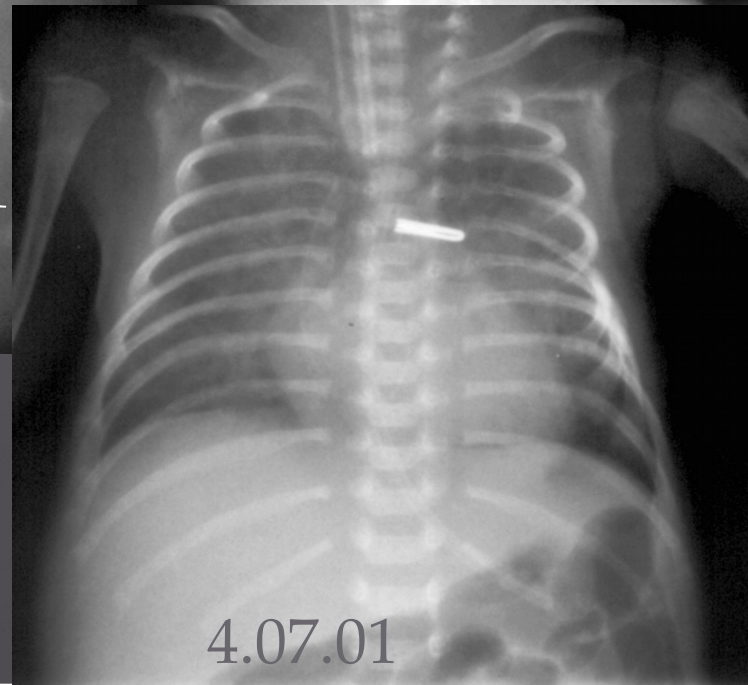
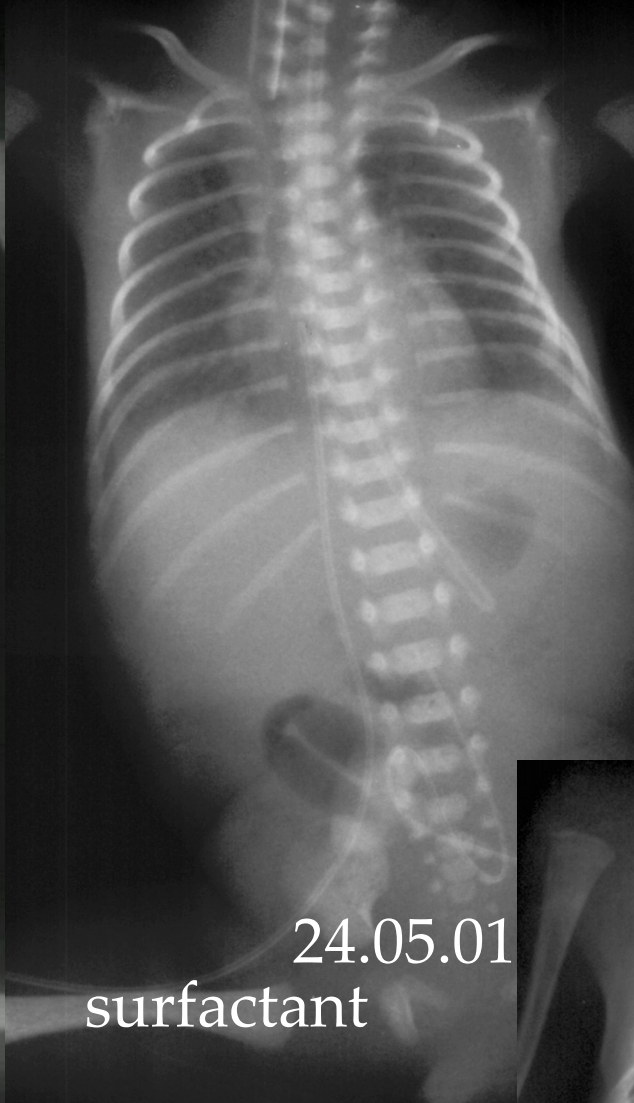


RDS: III degree - diffuse opacities; marked underaeration of both lung, bronchogram, borders of the heart and diaphragm are obliterated



RDS: IV degree - no aerated lung  
(„ground glass appearance”)





RDS IV + PDA

# ACUTE RESPIRATORY INSUFFICIENCY - COMPLICATIONS AFTER MECHANICAL VENTILATION

## early

- pneumothorax
- pneumomediastinum
- pneumopericardium
- pneumoperitoneum

interstitial emphysema  
atelectasis

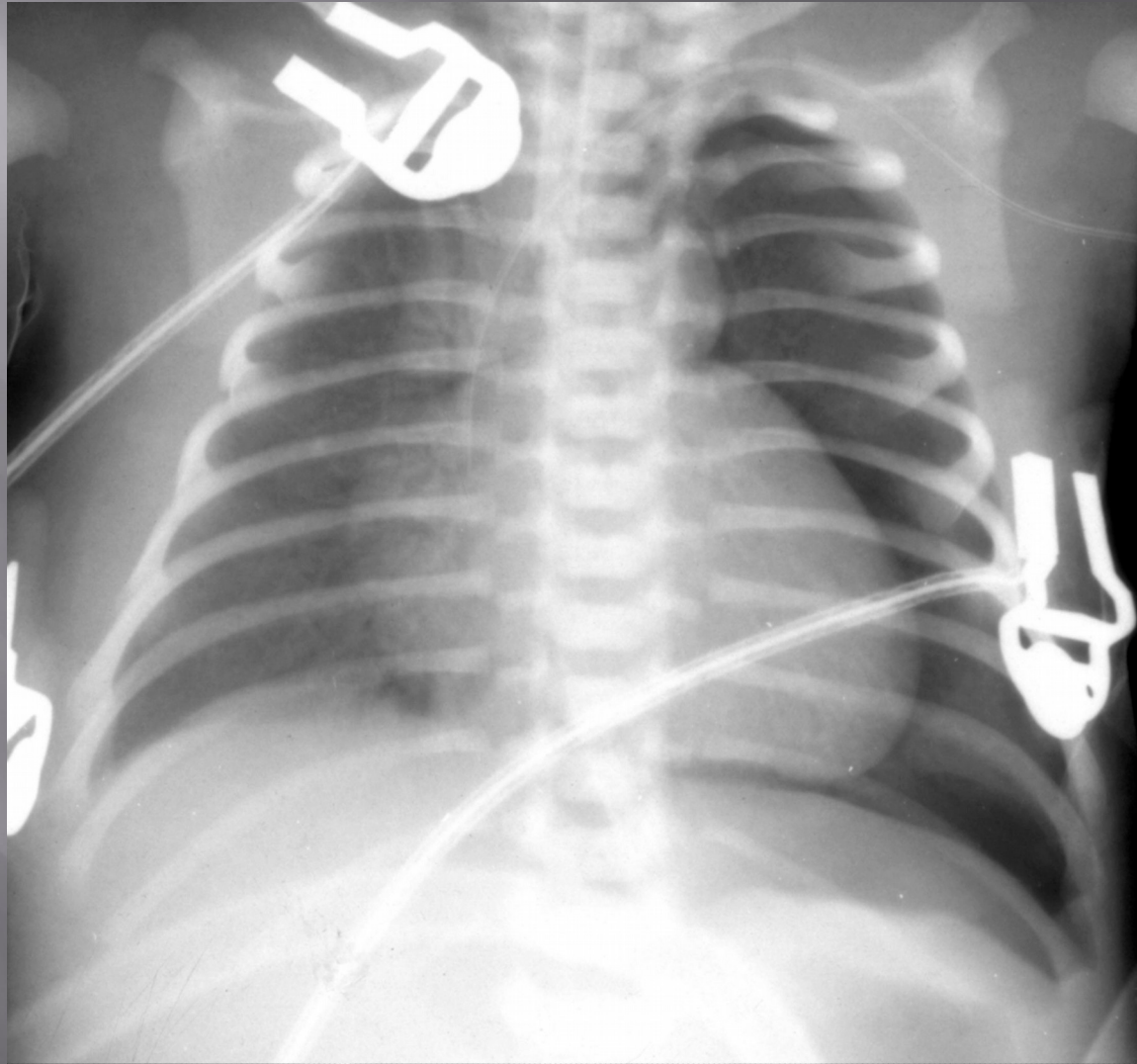
PDA

pulmonary hypertension

## late

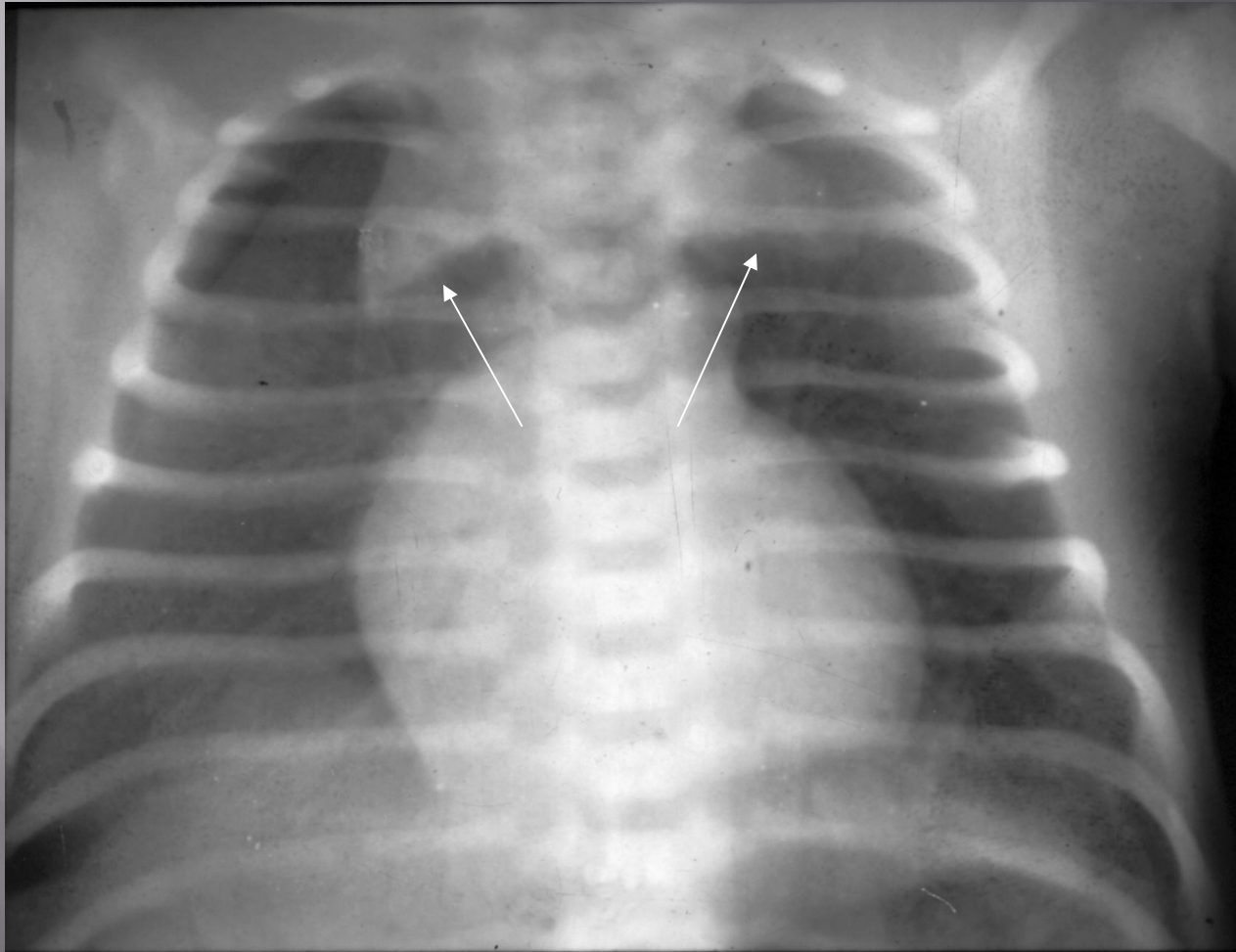
BPD

# RDS, pneumomediastinum





# PNEUMOMEDIASTINUM & PNEUMOTHORAX

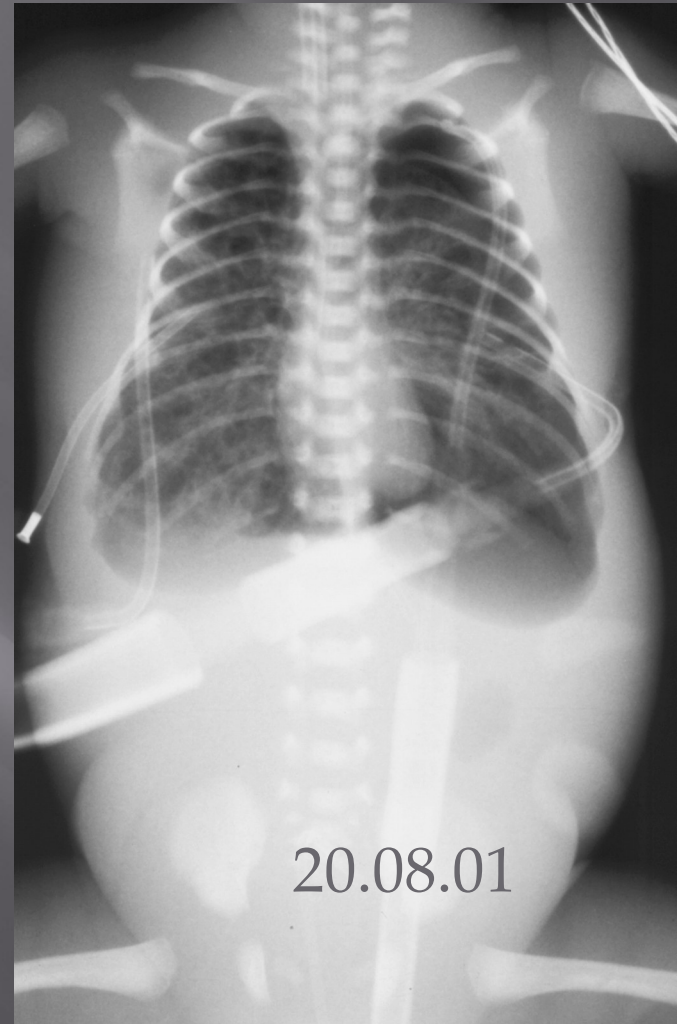


THYMUS - „sail sign”



RDS

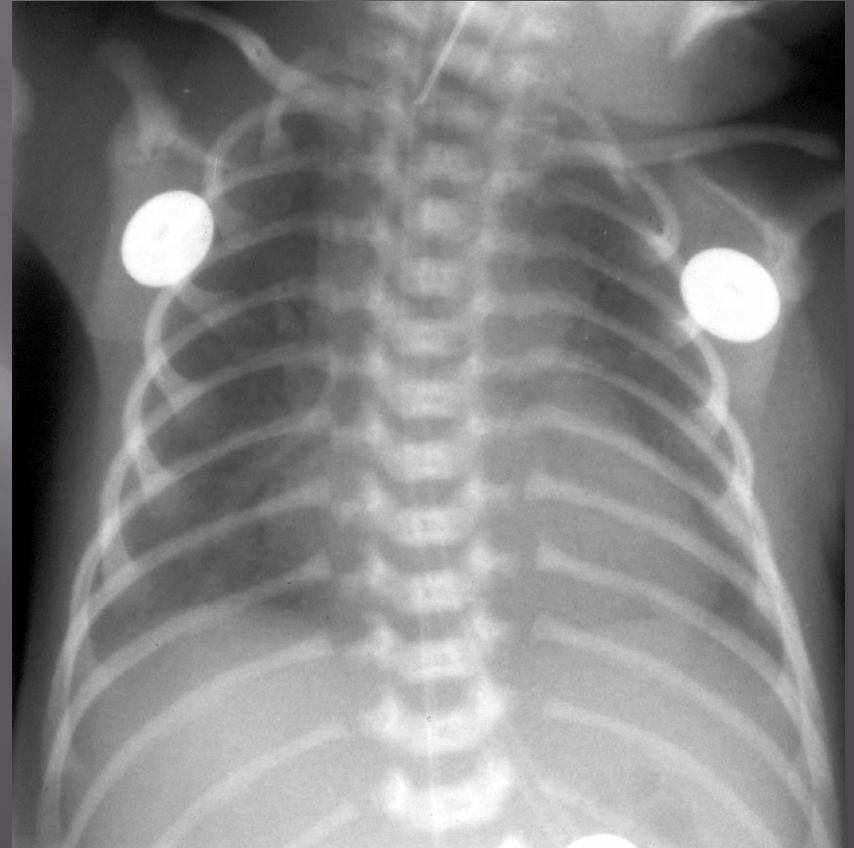
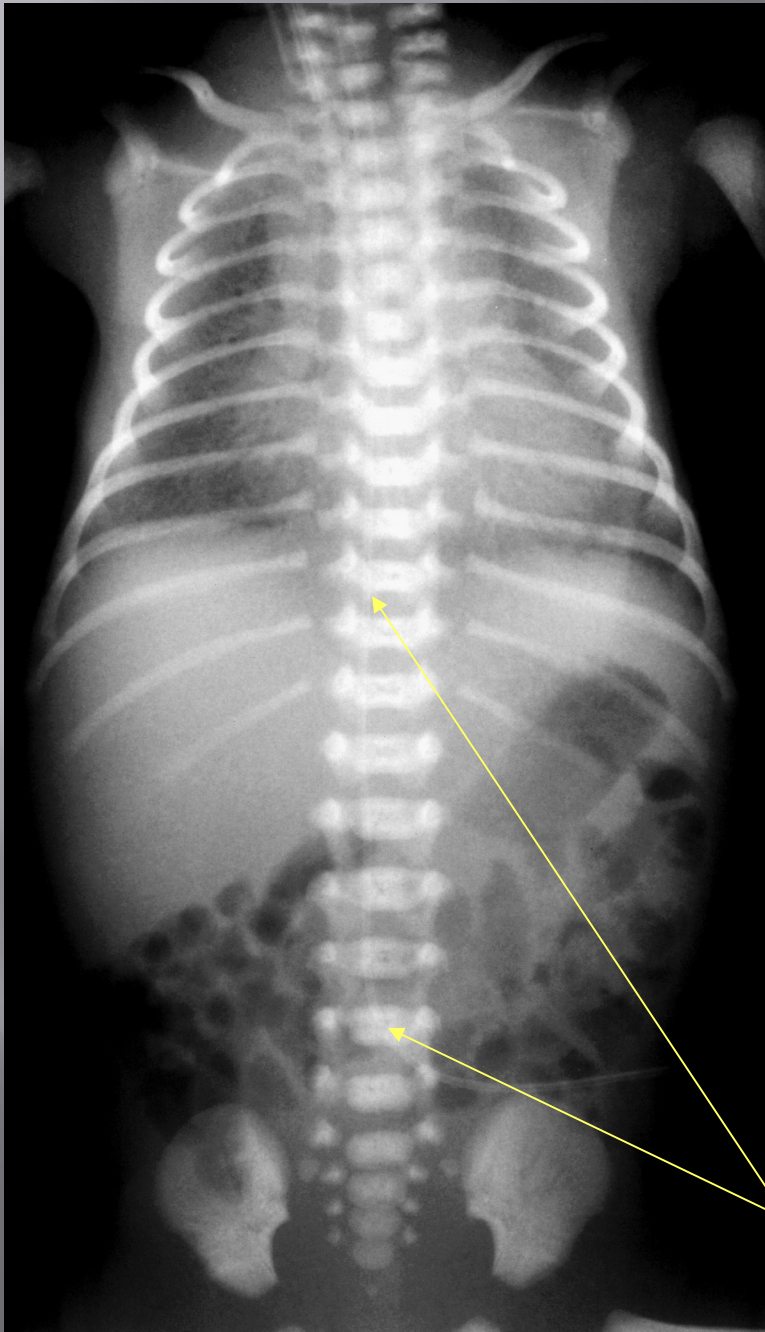
pneumothorax  
pulmonary interstitial  
emphysema



# DIFFERENTIAL DIAGNOSIS

	TTN	RDS	Pneumonia
Etiology	Cesarean section	Surfactant deficiency	Intrauterine infection, aspiration
Fetal age	Premature, full-term	Premature	Full-term, premature
Lung volume	Normal	↓	↑ ↓
Complication	—	pneumothorax BPD	Pleural effusion
Regression	quickly (2-3 days)	↓ ↑	After antibiotic therapy

**TTN**

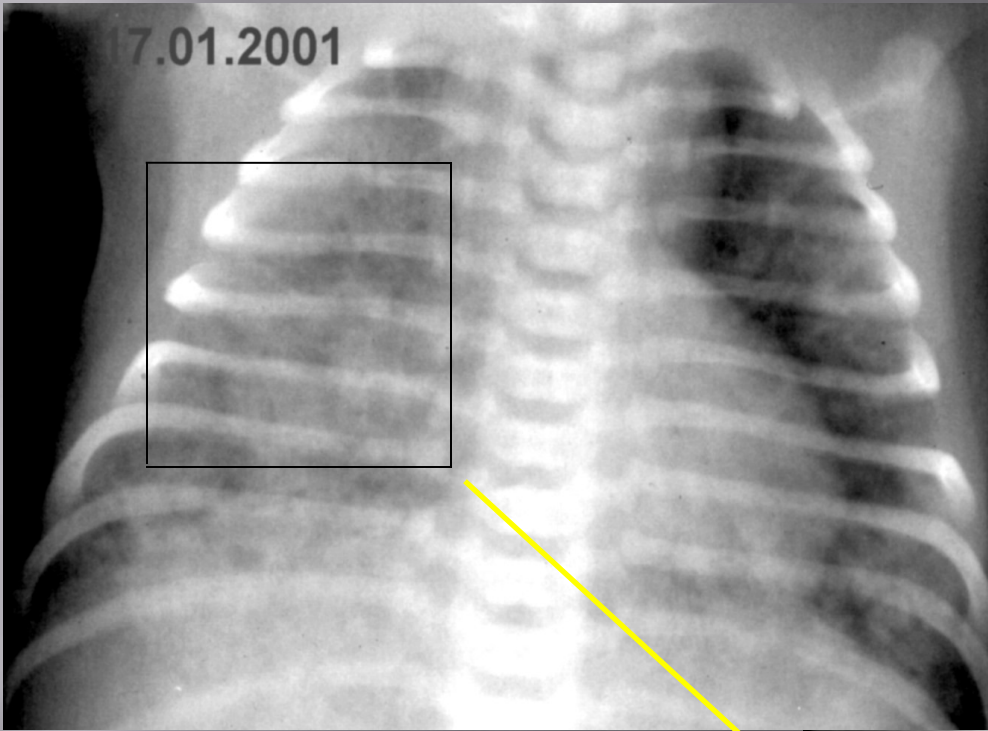


**Venous catheter**

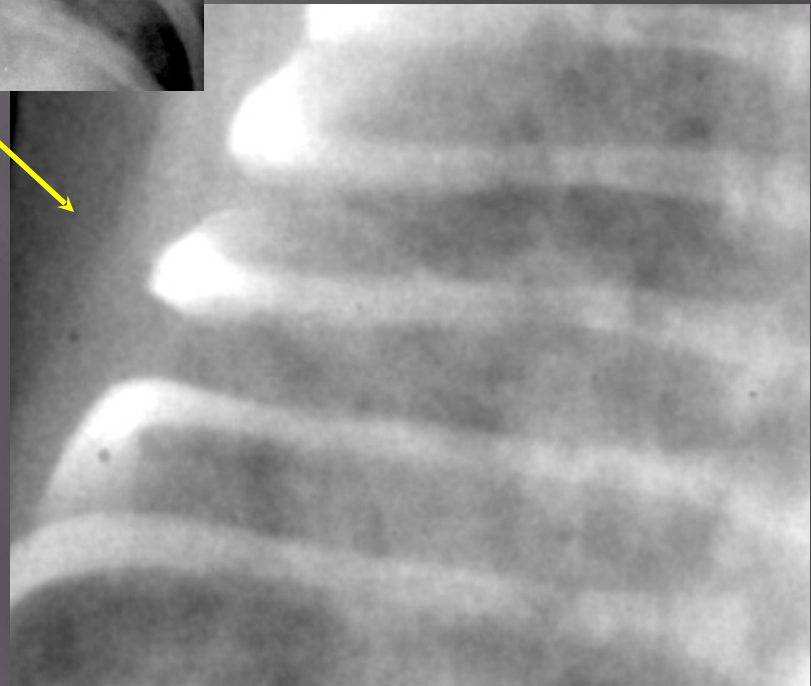
# ETIOLOGY OF ACUTE RESPIRATORY INSUFFICIENCY IN NEWBORNS

## MAS - meconium aspiration syndrome

- fetus aspirate meconium *in utero* because of some perinatal or parturitional stress
- meconium may be inhaled at the first breath
- the radiograph shows:
  - increased lung volume
  - „patchy“ opacities throughout both lungs



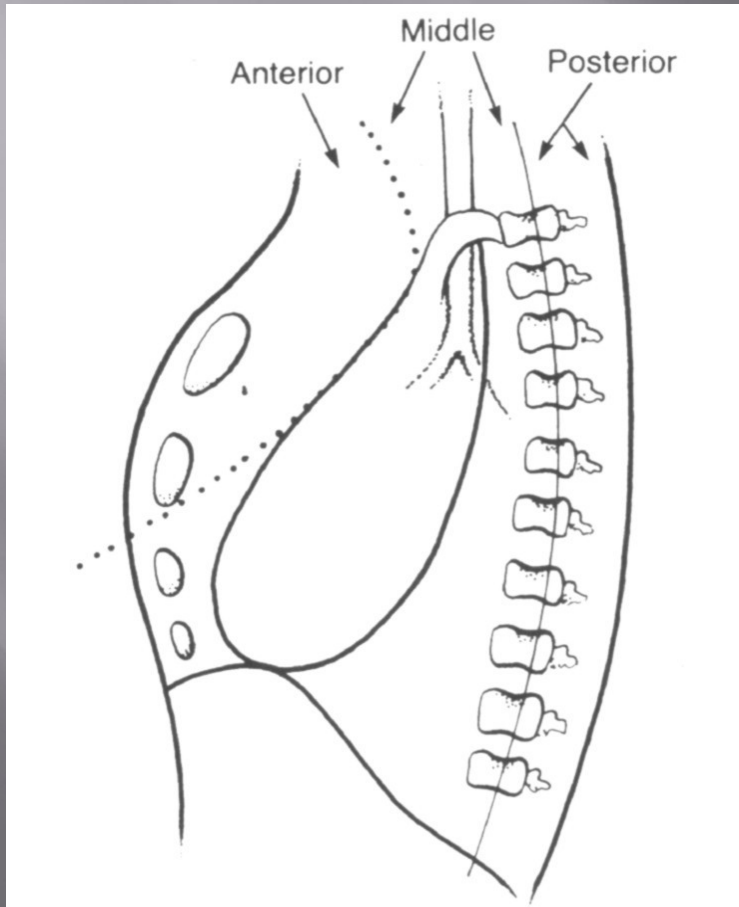
MAS -  
coarse, globular,  
rounded densities  
dispersed  
throughout the  
lungs;



# IV. MEDIASTINAL MASSES

## C = CHEST

The mediastinum graphically is separated into: the anterior, middle and posterior compartments



**MEDIASTINUM IS COMPOSED OF:**

**THE THYMUS,  
TRACHEA,  
HEART,  
GREAT VESSELS,  
ESOPHAGUS,  
LYMPH NODES,  
NEURAL ELEMENTS**



## ANTERIOR MEDIASTINUM ( the four T's and a C )

- TERATOMA
- THYMOMA
- THYROID ( often mentioned, never seen ! )
- “TERRIBLE” LYMPH NODE ENLARGEMENT  
( by either infection or malignancy )
- CYSTIC HYGROMA

## MIDDLE MEDIASTINUM (for each organ abnormality)

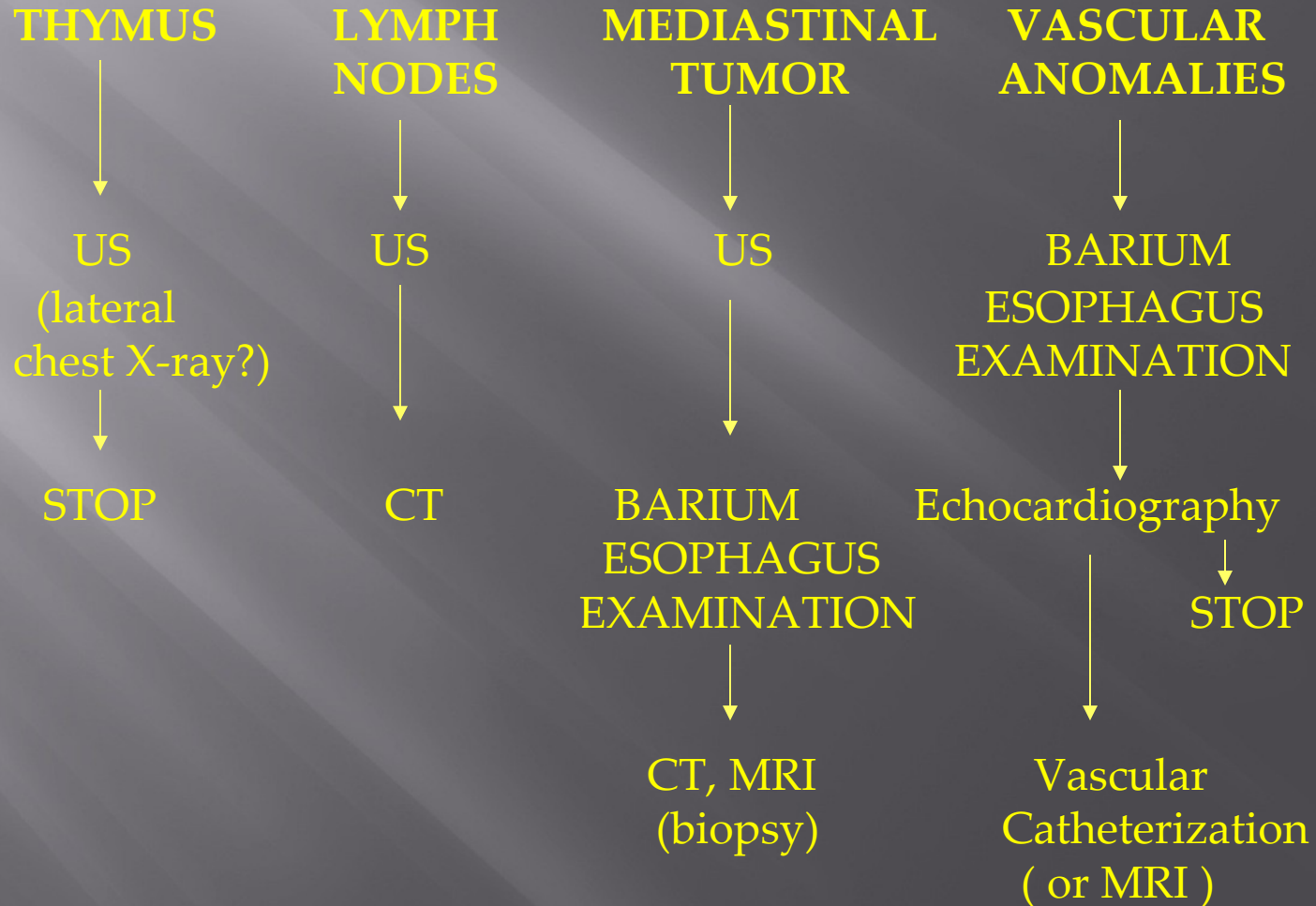
- **ESOPHAGUS : DUPLICATION CYSTS**
- **GREAT VESSELS : ANEURYSMAL DILATATION**
- **HILA : ENLARGED LYMPH NODES**  
(leukemia, lymphoma, tuberculosis, etc.)
- **TRACHEA : BRONCHOGENIC CYSTS**
- **PERICARDIUM : CYST**

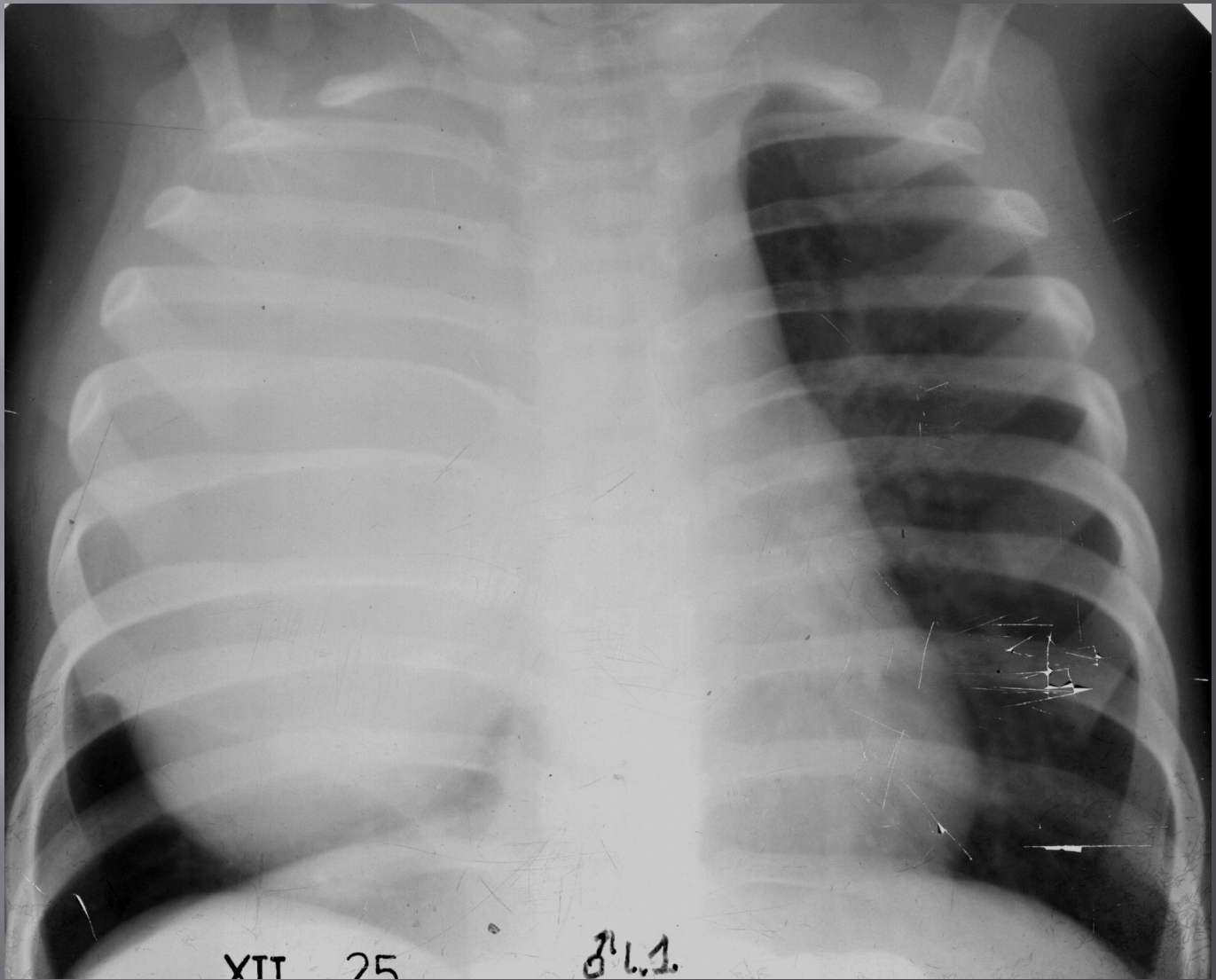
## POSTERIOR MEDIASTINUM ( T, E, N )

- TUBERCULOSIS OR ANY SPINAL INFECTION
- EXTRAMEDULLARY HEMATOPOIESIS (ADULTS)
- NEURAL TUMORS : NEUROBLASTOMA,  
GANGLIONEUROMA, NEURENTERIC CYST

# MEDIASTINAL MASSES DIAGNOSTIC ALGORITHM

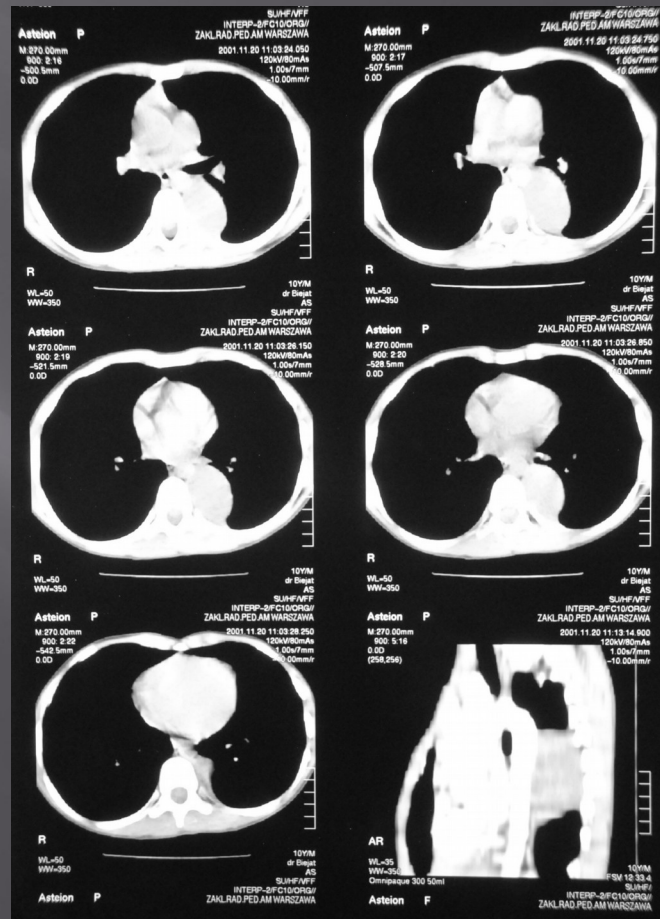
## CHEST X-RAY





**Neuroblastoma**

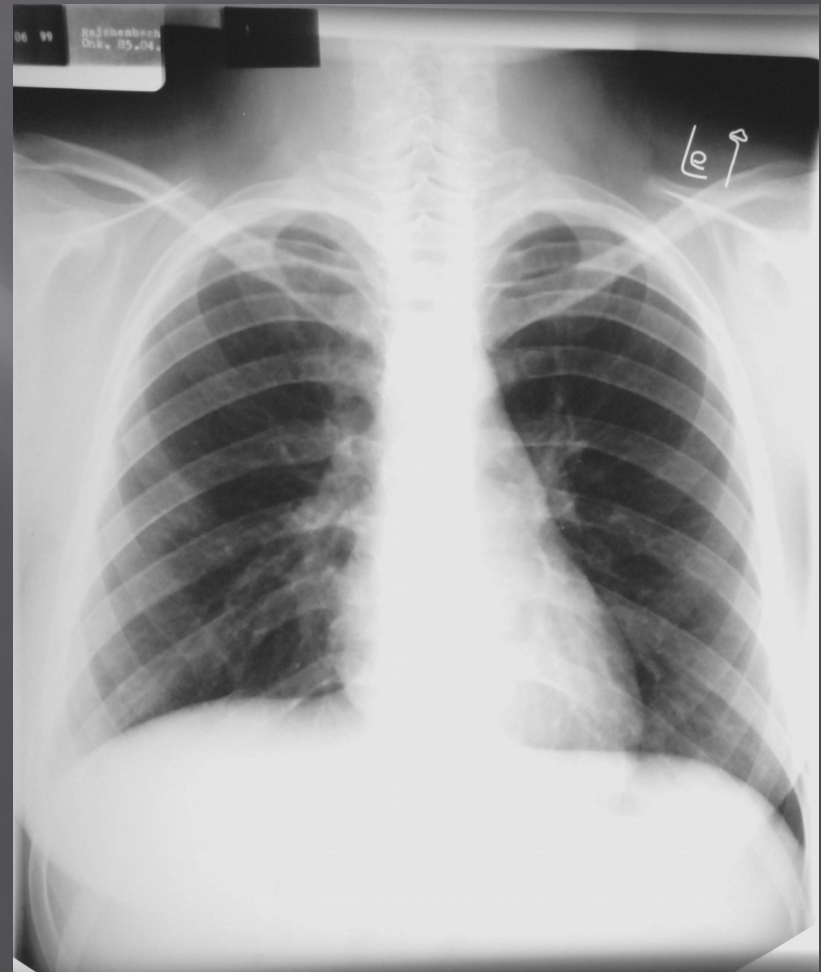
# NEUROBLASTOMA



NHL



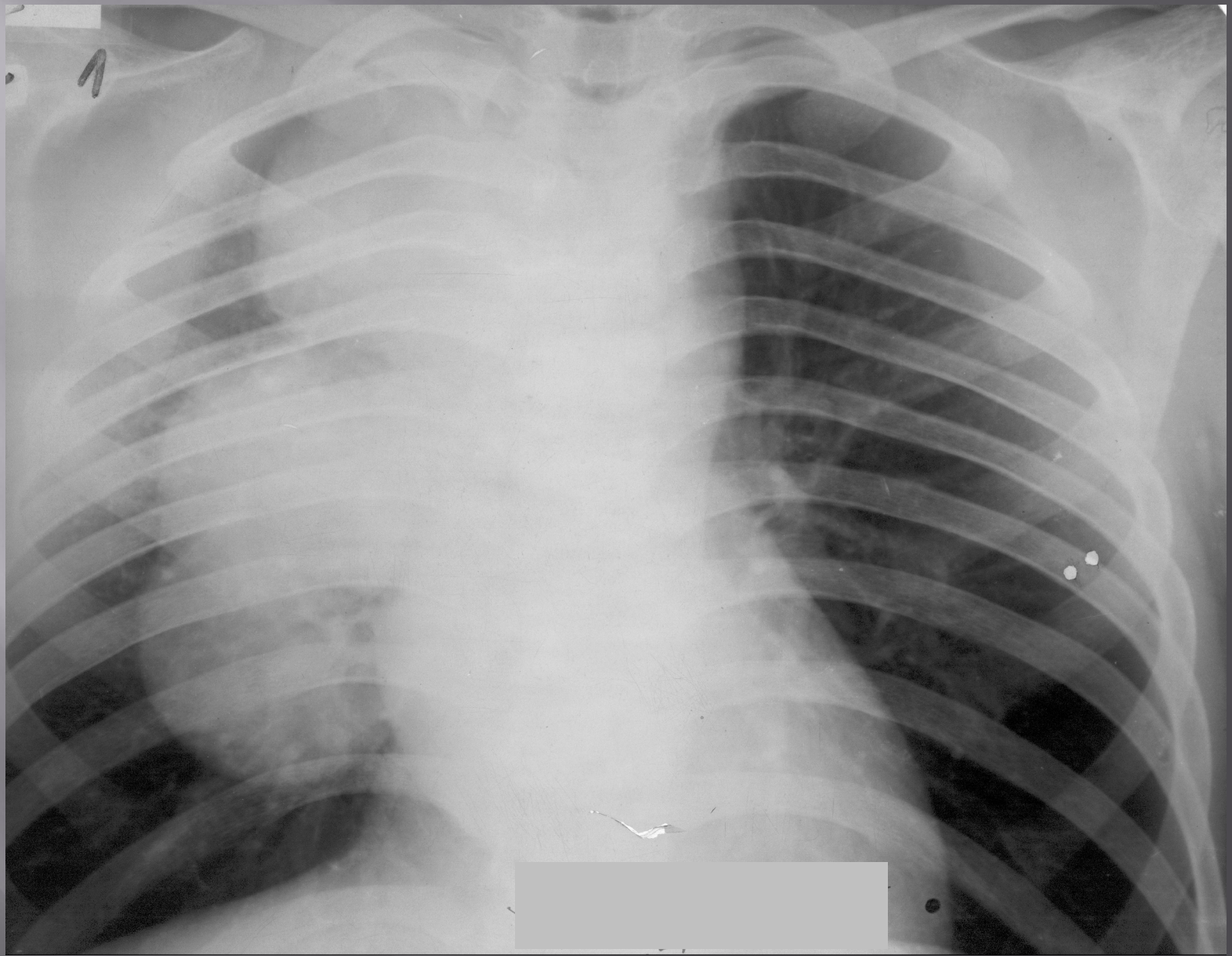
After 3 weeks of treatment



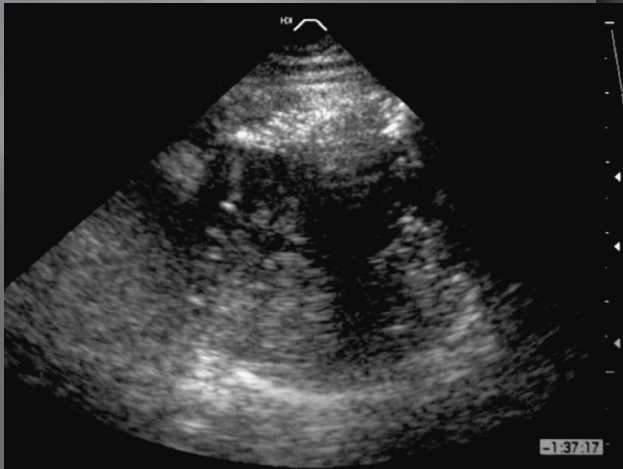
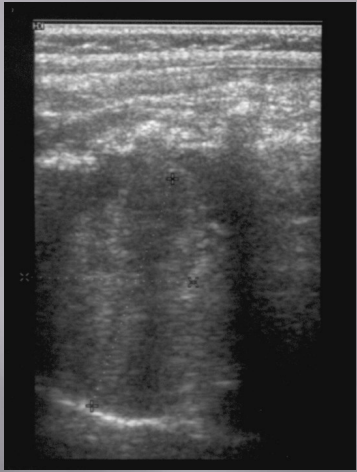
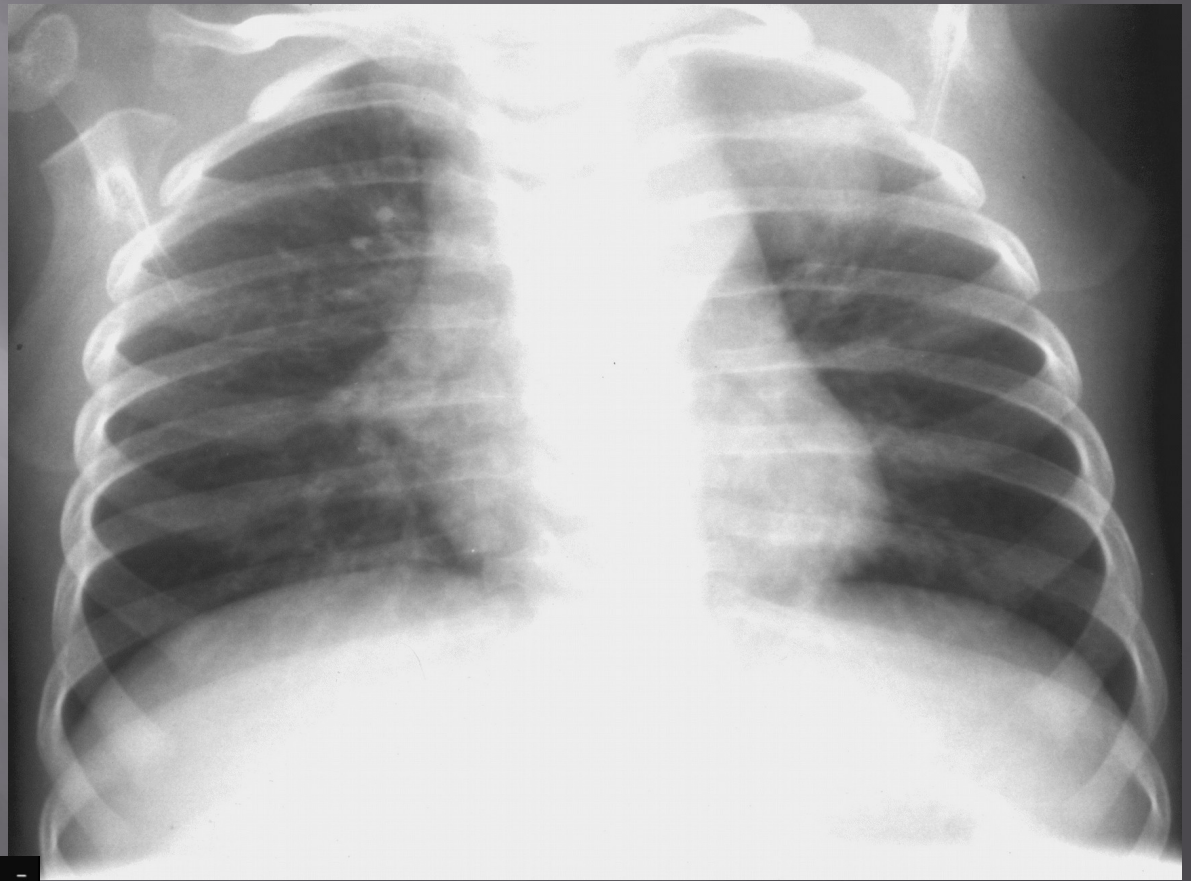
HL







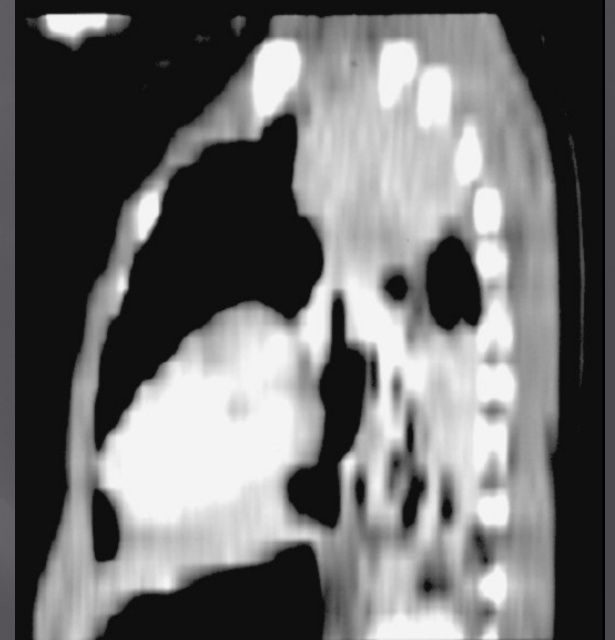
**NHL**



Primary clinical diagnosis  
- Pneumonia ?

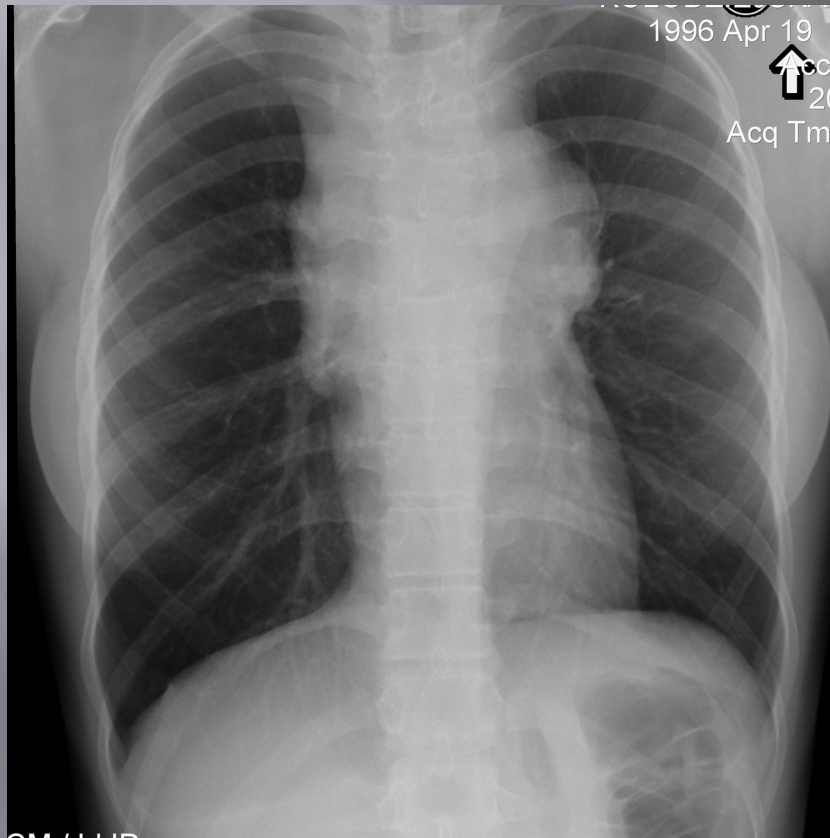


**Pre-contrast  
scan**

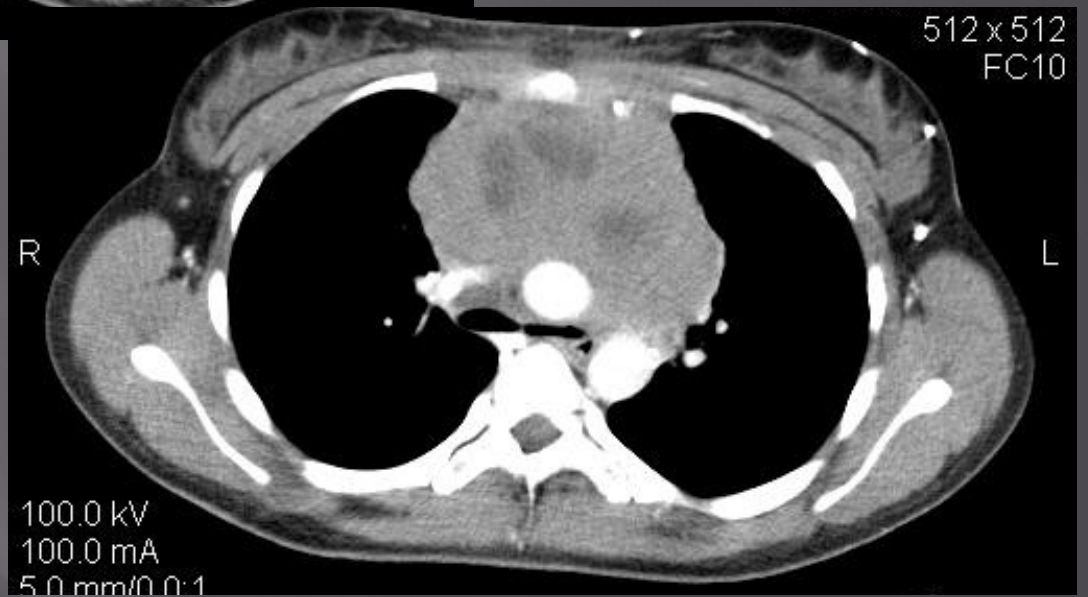


**Post - contrast  
enhancement**

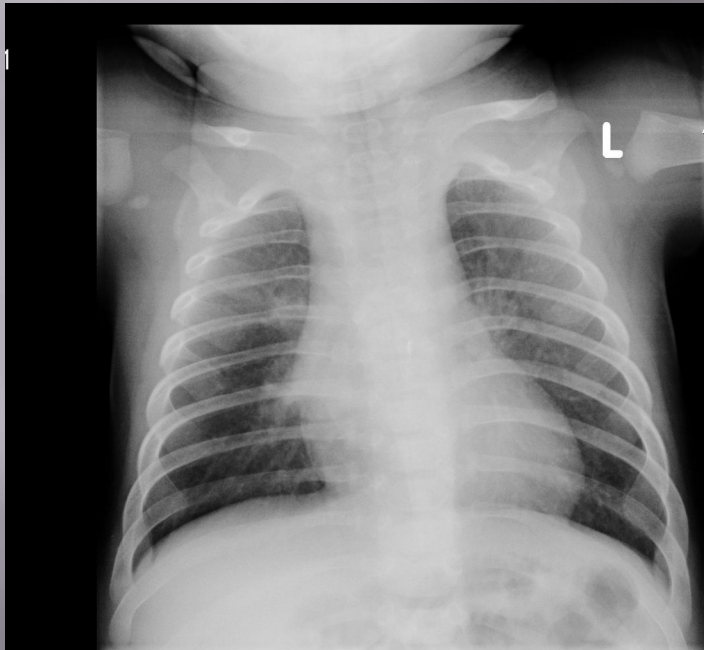
# 13 y.o. girl



# NHL

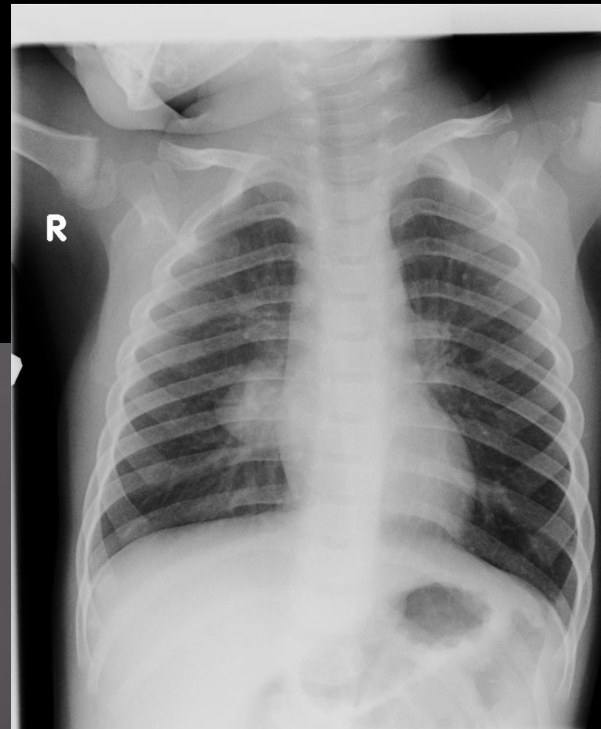


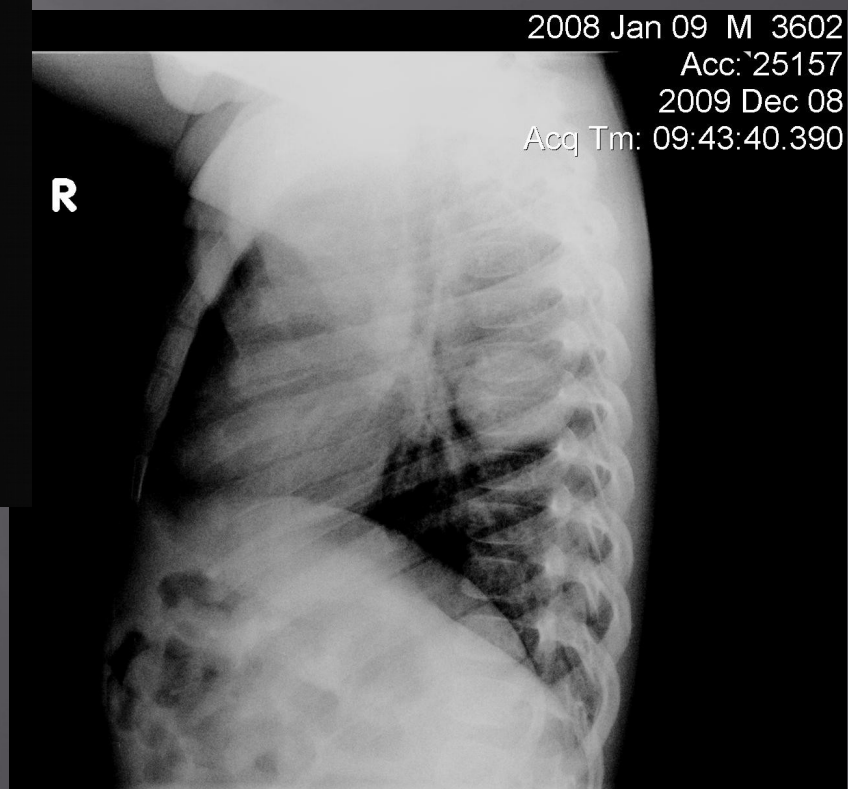
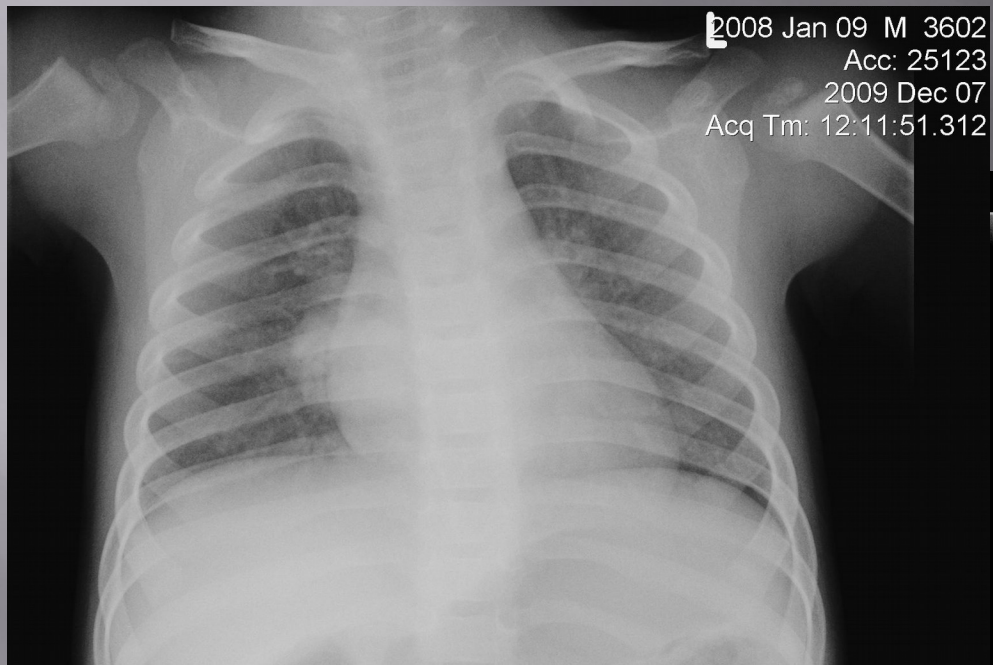
# 1 y.o. boy –respiratory tract infection

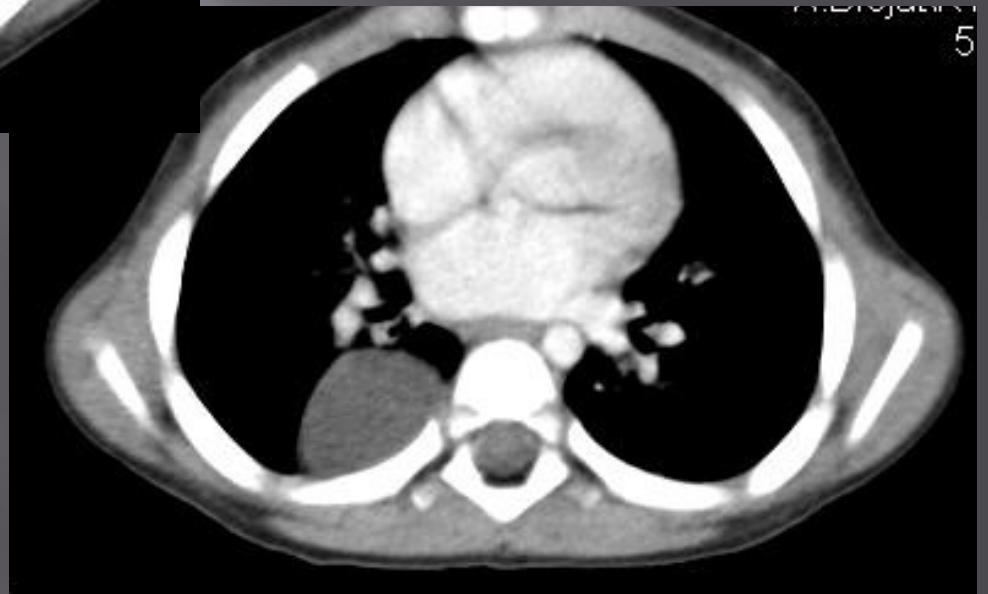


2008 Jan 09 M 3602  
Acc: 4563  
2008 May 18  
Acq Tm: 19:08:08

2008 Jan 09 M 3602  
Acc: 24844  
2009 Nov 28  
Acq Tm: 12:39:01.812

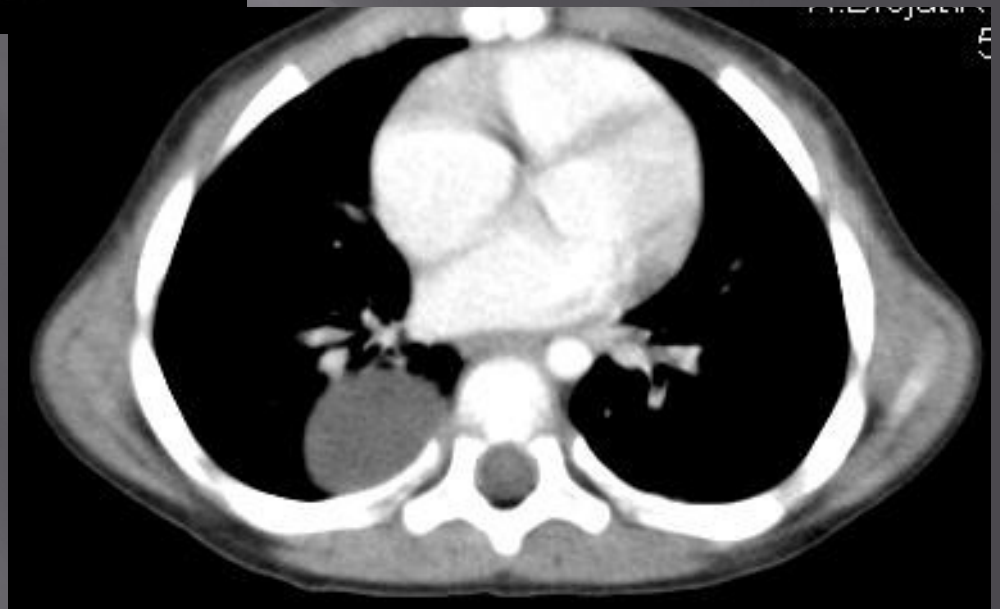
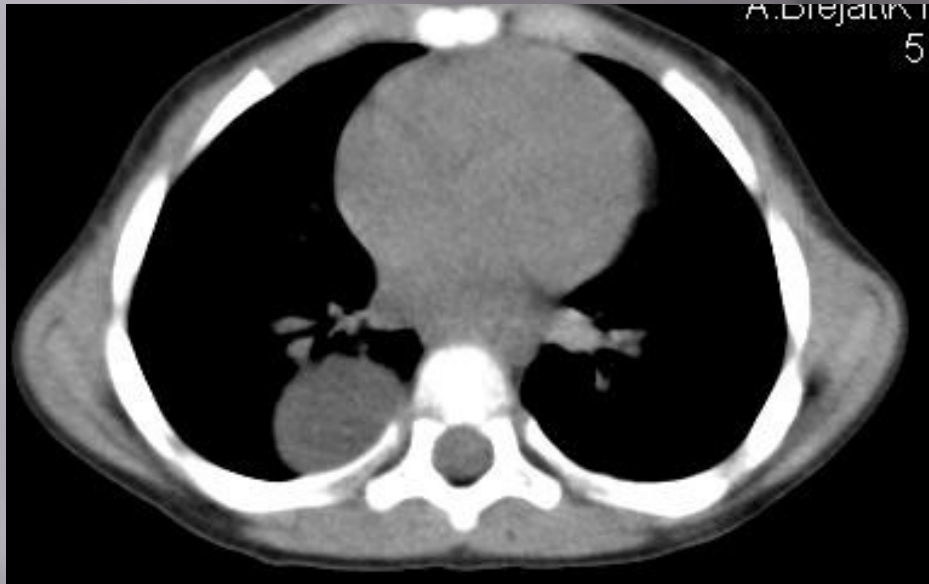




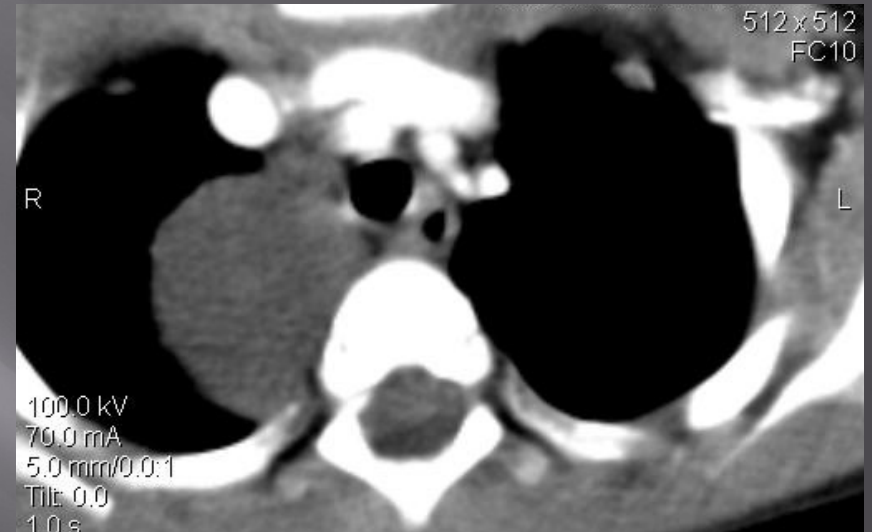
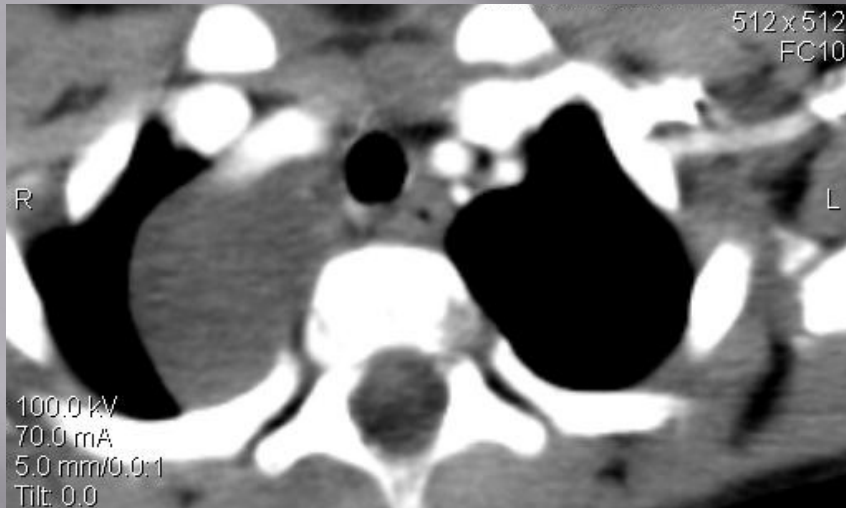


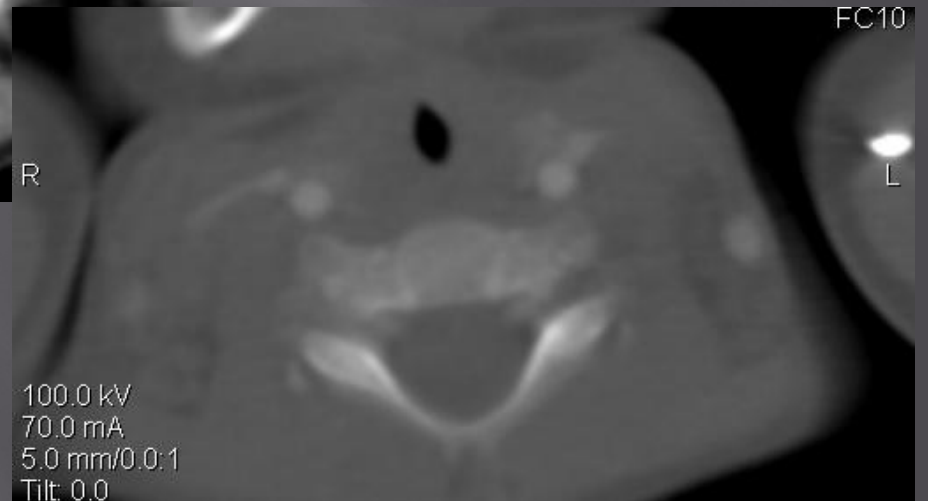
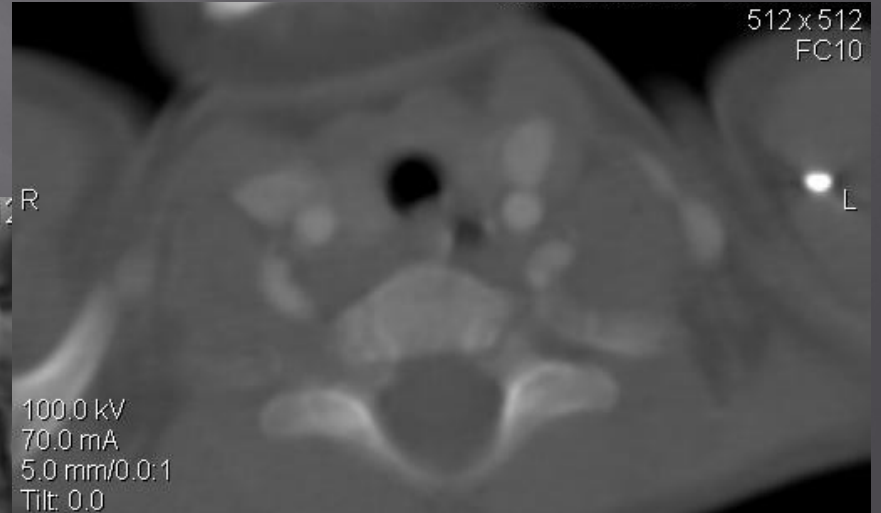
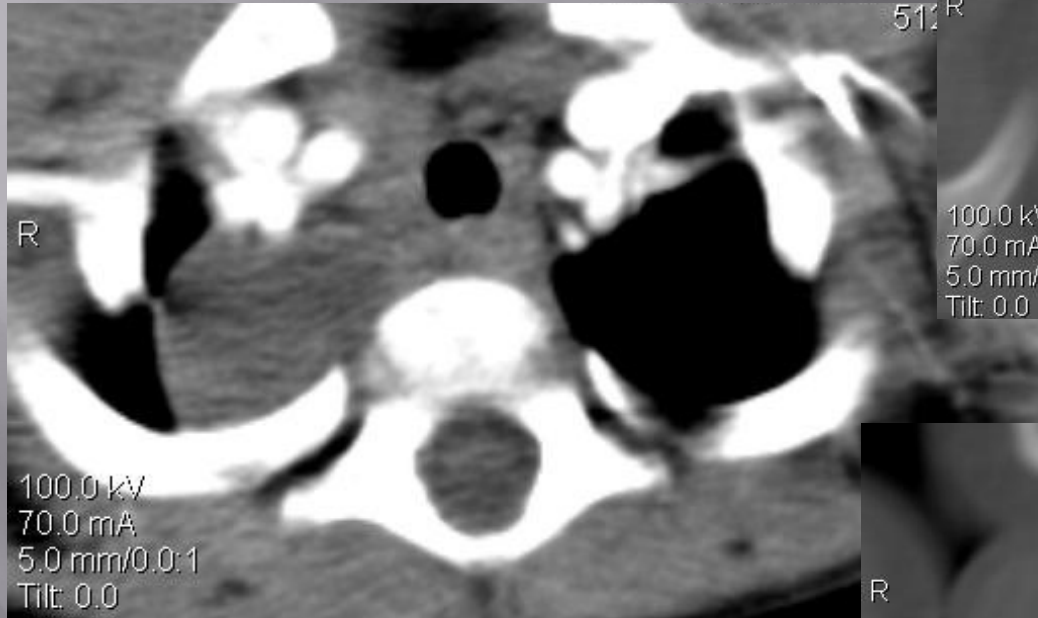


# Bronchogenic cyst



# SCHWANNNOMA – 4 y.o boy





# V. CONGENITAL HEART DISEASE

**Physical examination**



**ECG, Chest X-Ray**



**Echo cardiography + Doppler Study**



**„Surgical“**

**„Non- Surgical“**



**Invasive Diagnostic Procedures**



**Open Surgery**

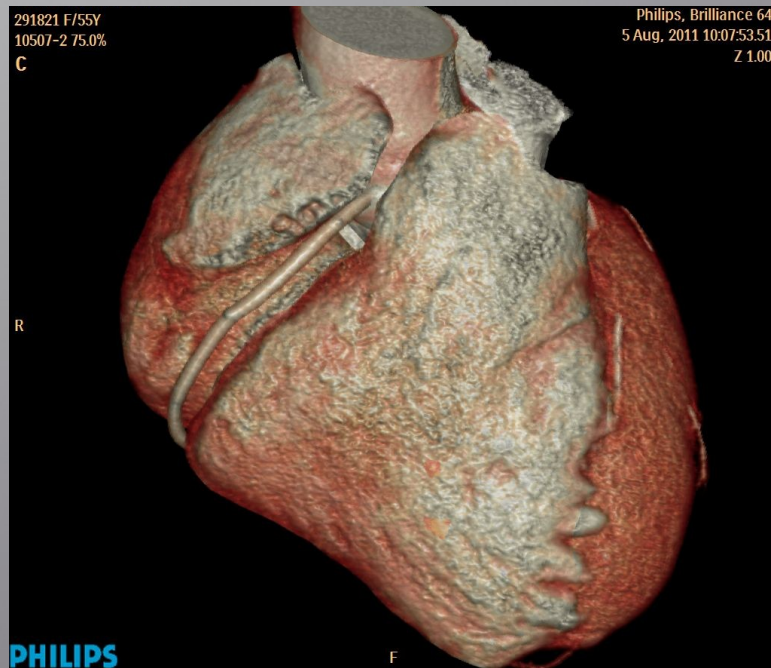
**Transvascular Treatment**

**Conservative Treatment**

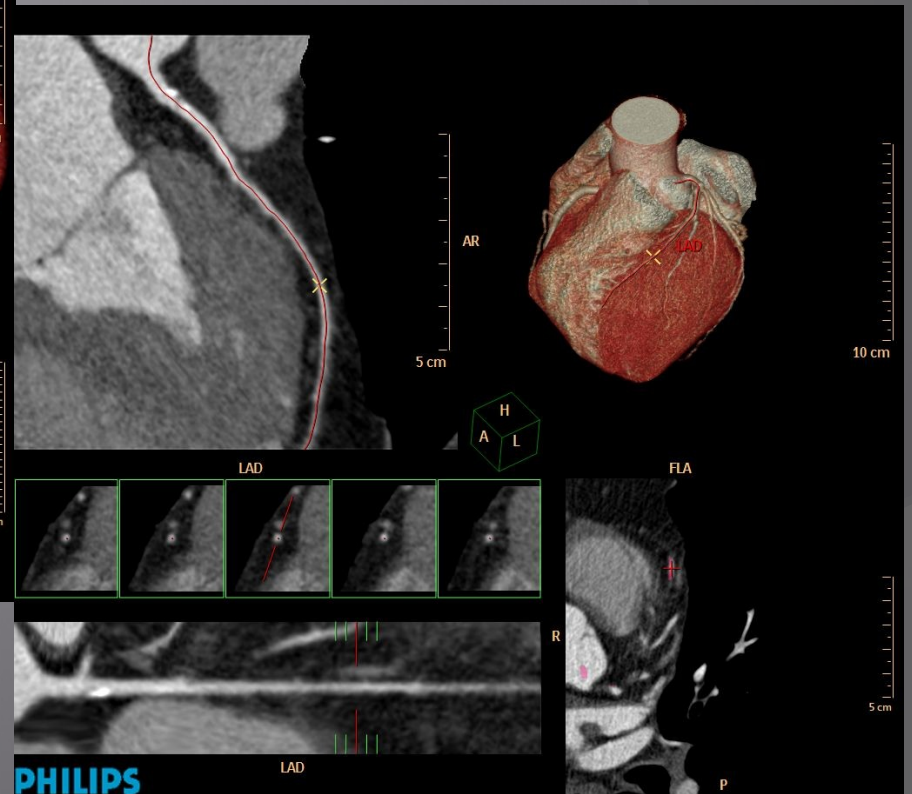
# Algorithm for diagnosis of congenital heart disease in children

- **Chest X-Ray/Echocardiography**
- **Non-invasive diagnostic techniques:**
  - MR, CT, NS
- **Invasive diagnostic techniques:**
  - cardiac catheterisation, angiography
- **Treatment: conservative, surgery, interventional transvascular procedures**

# CT- noninvasive diagnostic procedure



# CACTA - coronary arteries CT angiography



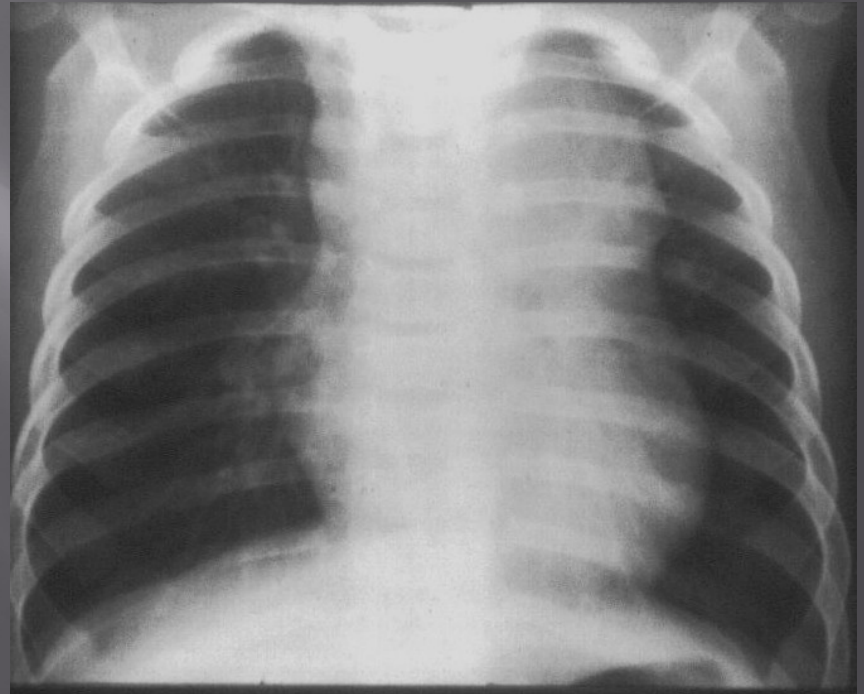


# Interventional Transvascular Percutaneous Procedures

- **Rashkind**
- balloon atrioseptostomy
  
- **Coil Embolisation**
- PDA, collaterals, fistulas
  
- **Amplatzer Occlusion**
  - ASD, VSD
  
- **Balloon Valvuloplasty**
  - Stenotic pulmonary valve. Stenotic aortic valve
  
- **Balloon Angioplasty**
  - Stenosis of peripheral pulmonary arteries. Recoarctation of the aorta

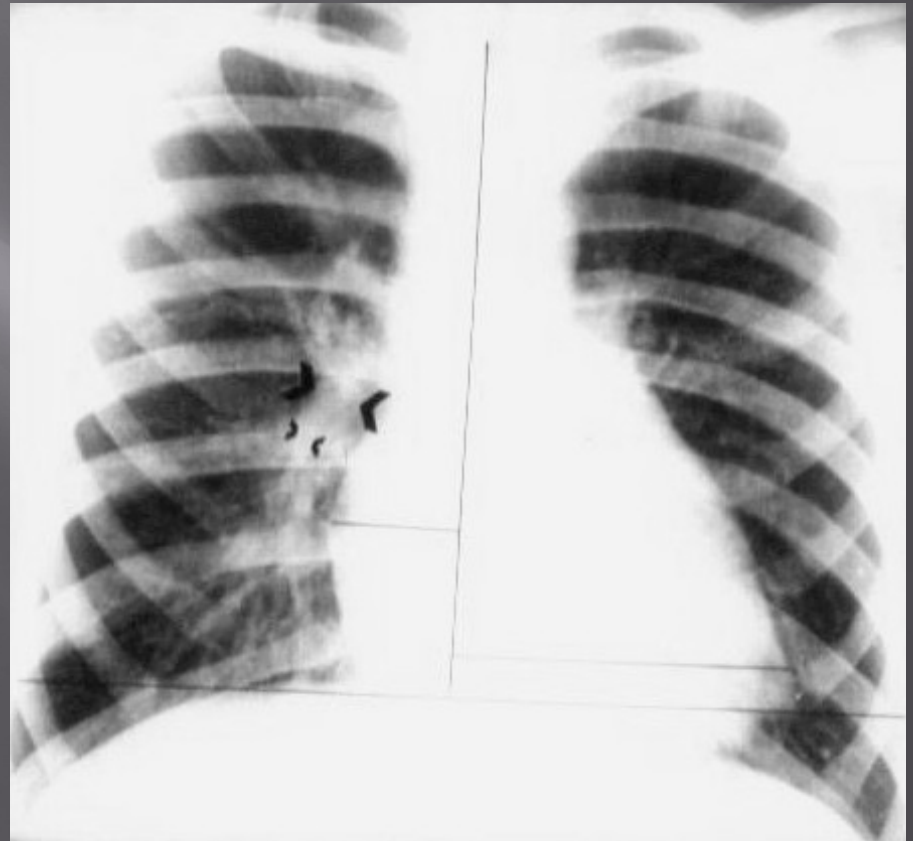
# Chest X-ray in newborn & infants

- **Supine position**
- **Only frontal film  
(AP=anterior –  
posterior)**
- **Without contrast  
medium in  
esophagus**

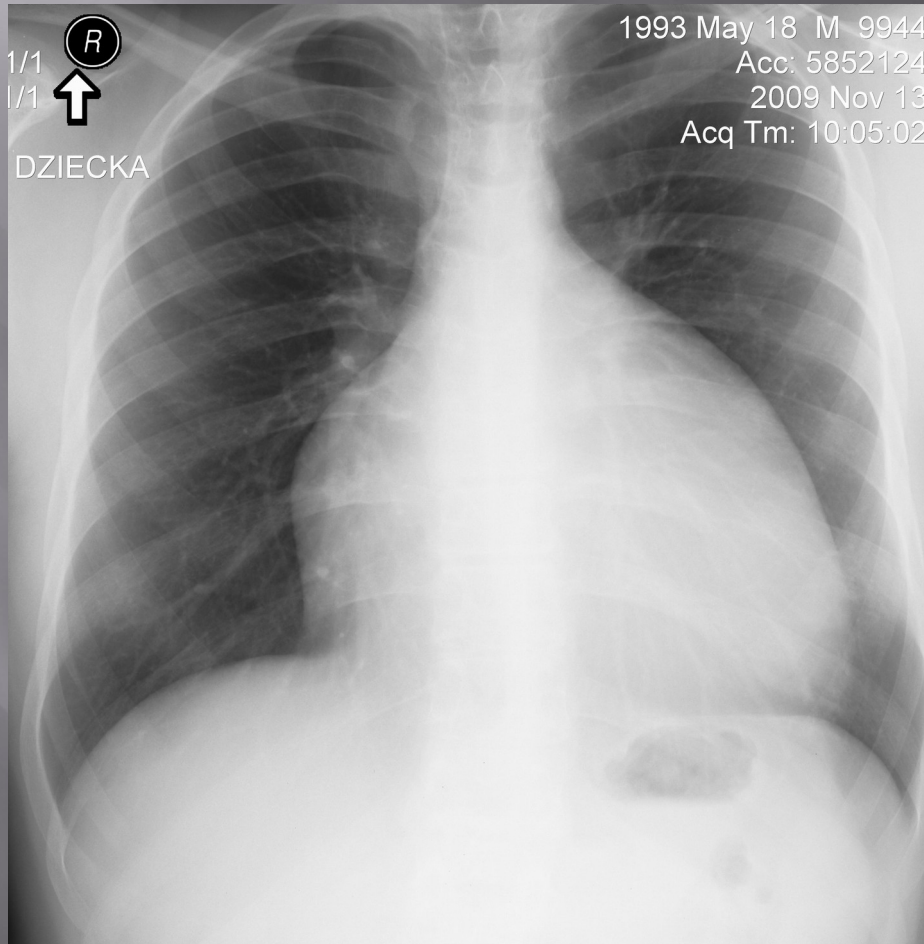


# Chest X-ray Film

- Size of the vessels and pulmonary circulation
- Size of the heart
- Deformations of the ribs



# EBSTEIN ANOMALY – heart size



# PULMONARY VASCULARITY

**NORMAL - VASCULAR ANOMALITIES**

**(RIGHT SIDED ARCH, RINGS)**

**- AORTIC STENOSIS**

**- CoA**

**INCREASED**

**- VSD**

**- ASD**

**- PDA**

**- TGA**

**DECREASED**

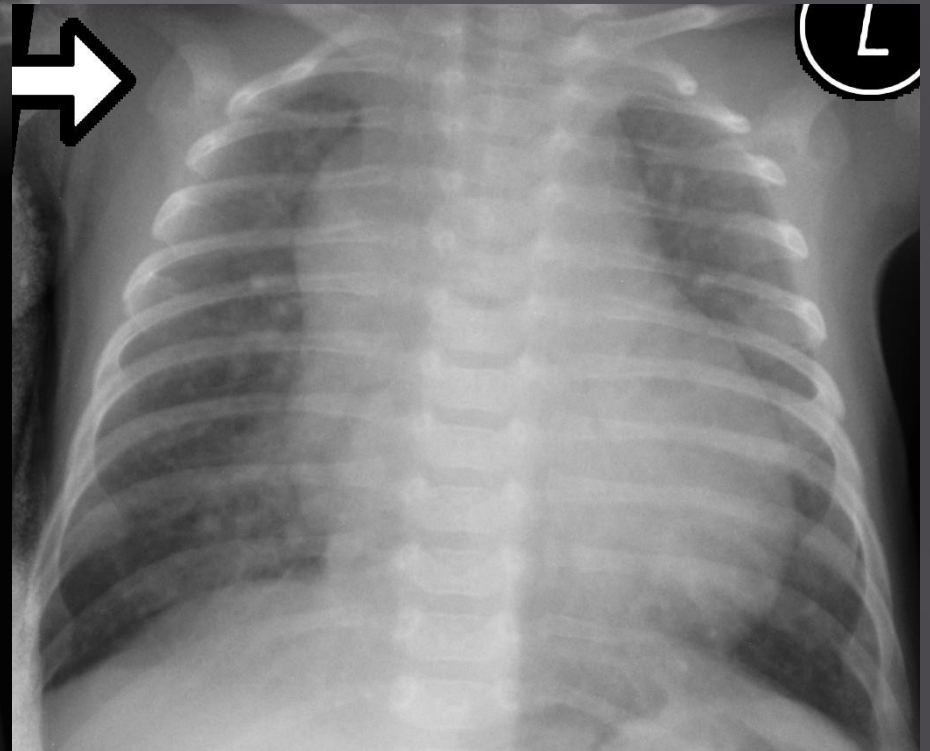
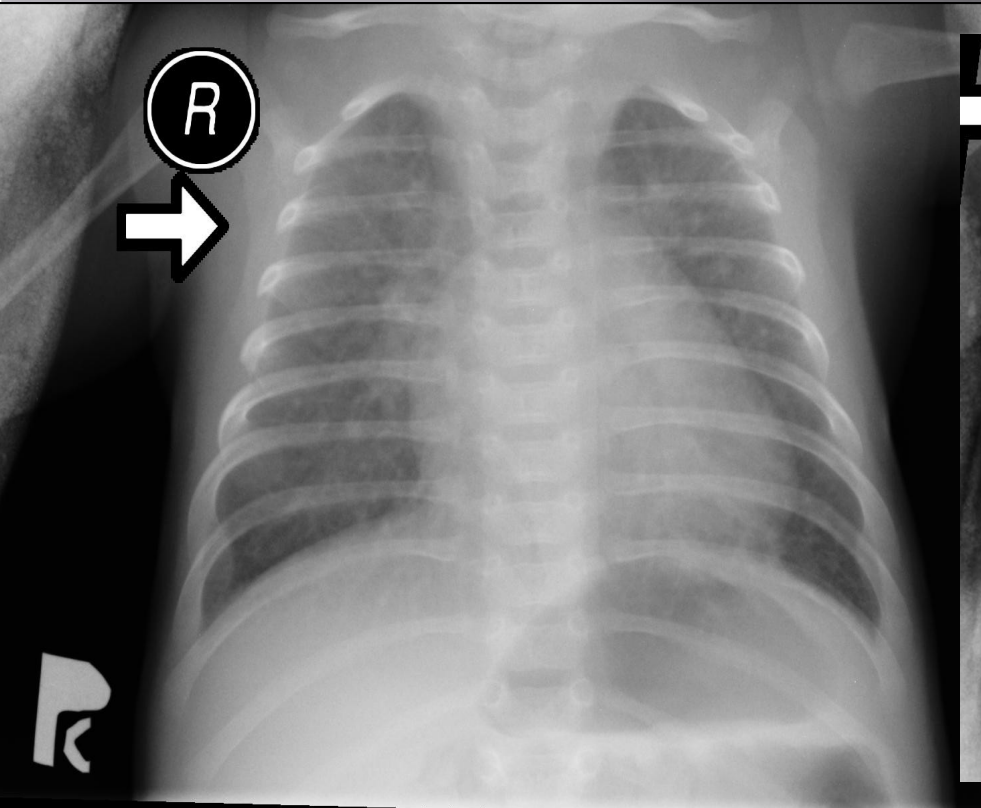
**- TETRALOGY OF FALLOT**

**- PS**

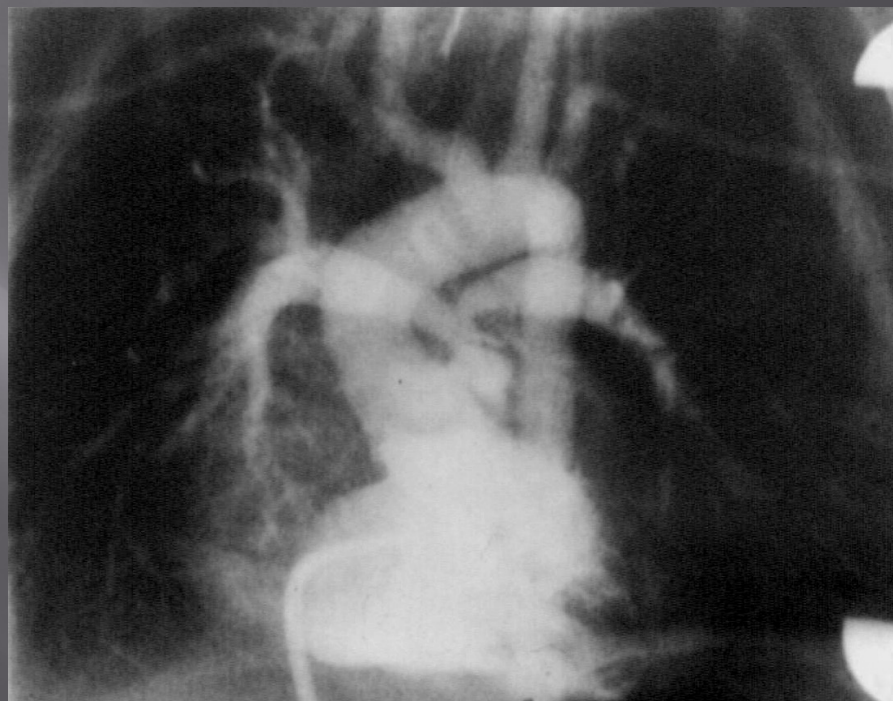
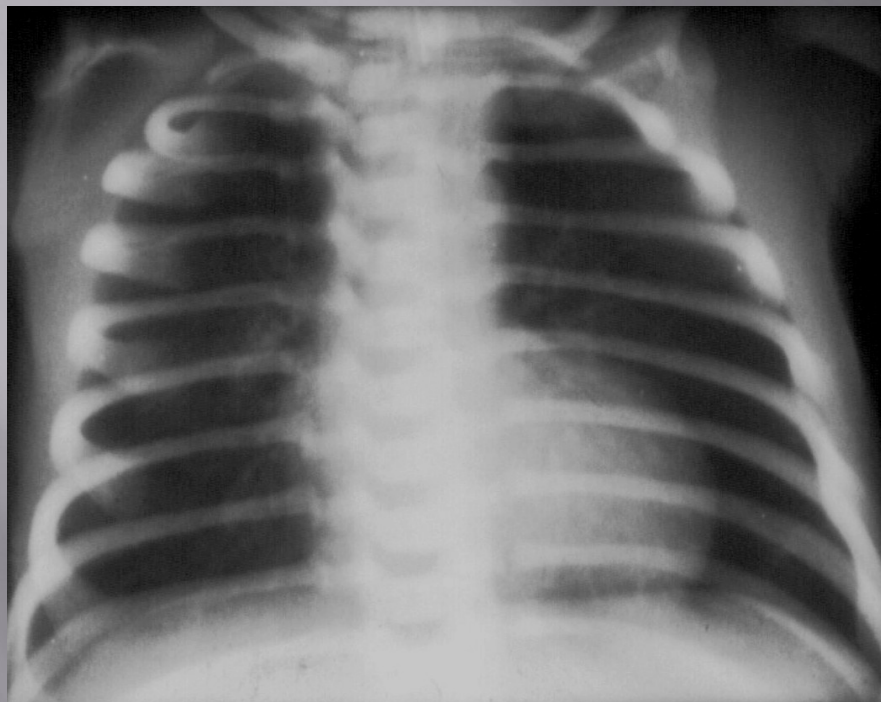
# INCREASED VASCULARITY

VSD+ASD

VSD

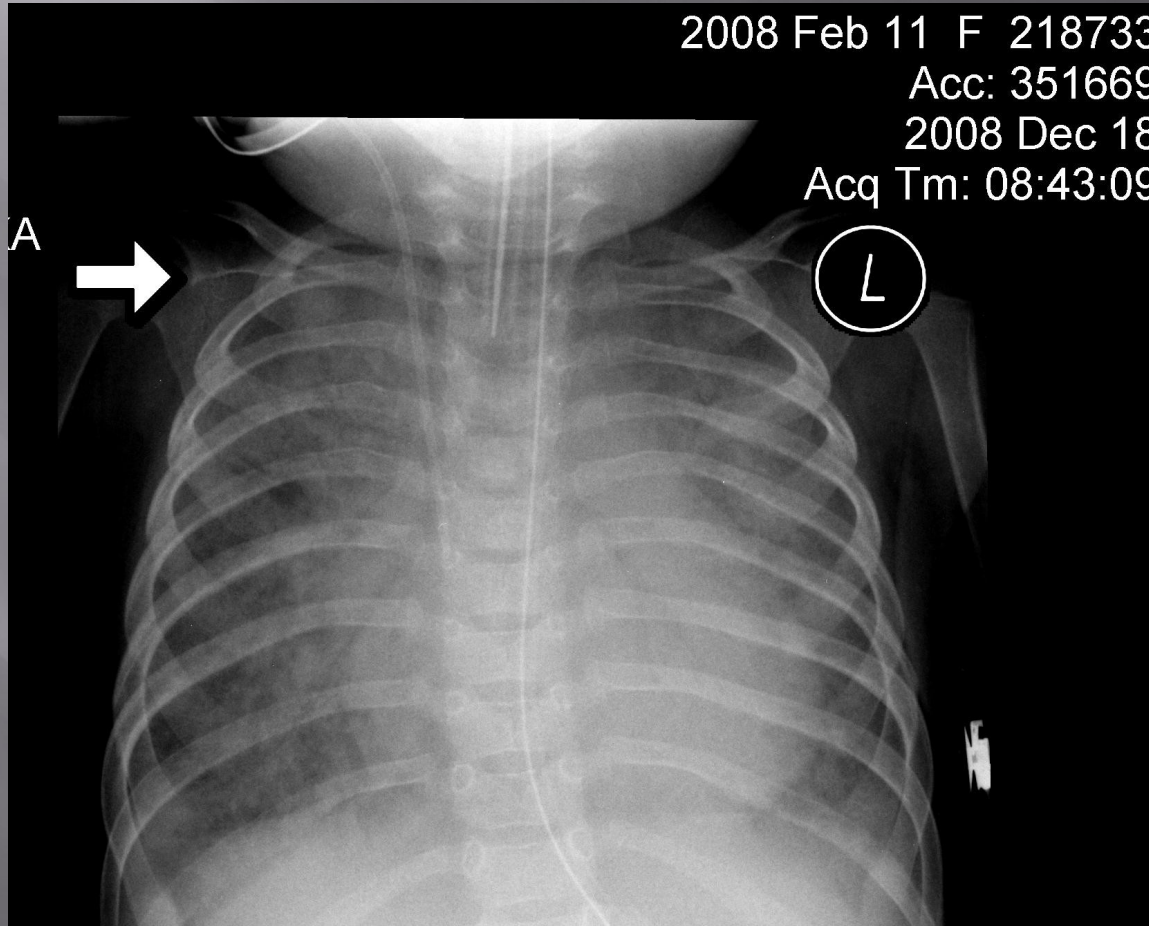


# DECREASED VASCULARITY



**Tetralogy of Fallot**

# CAVC – pulmonary edema

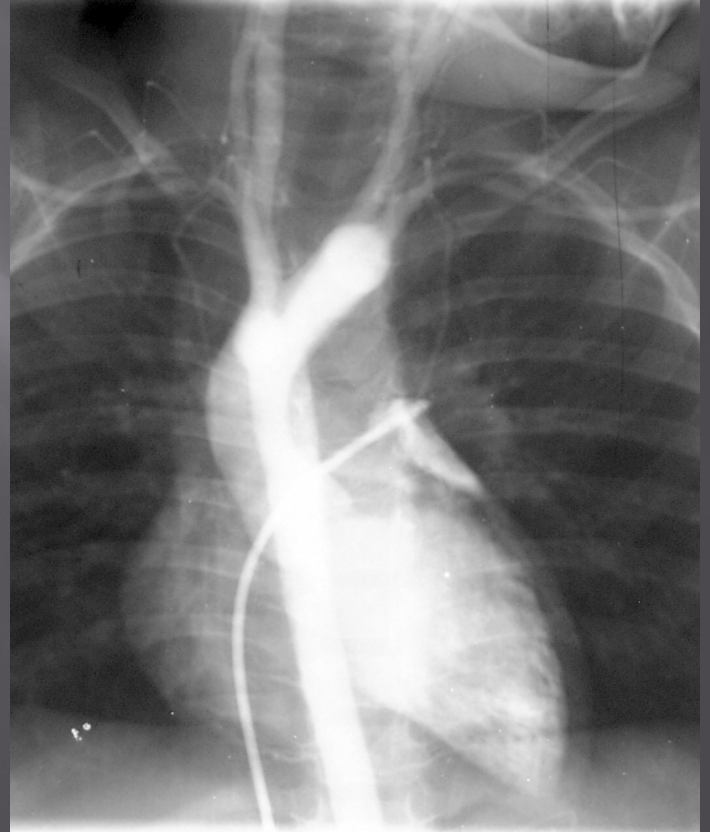




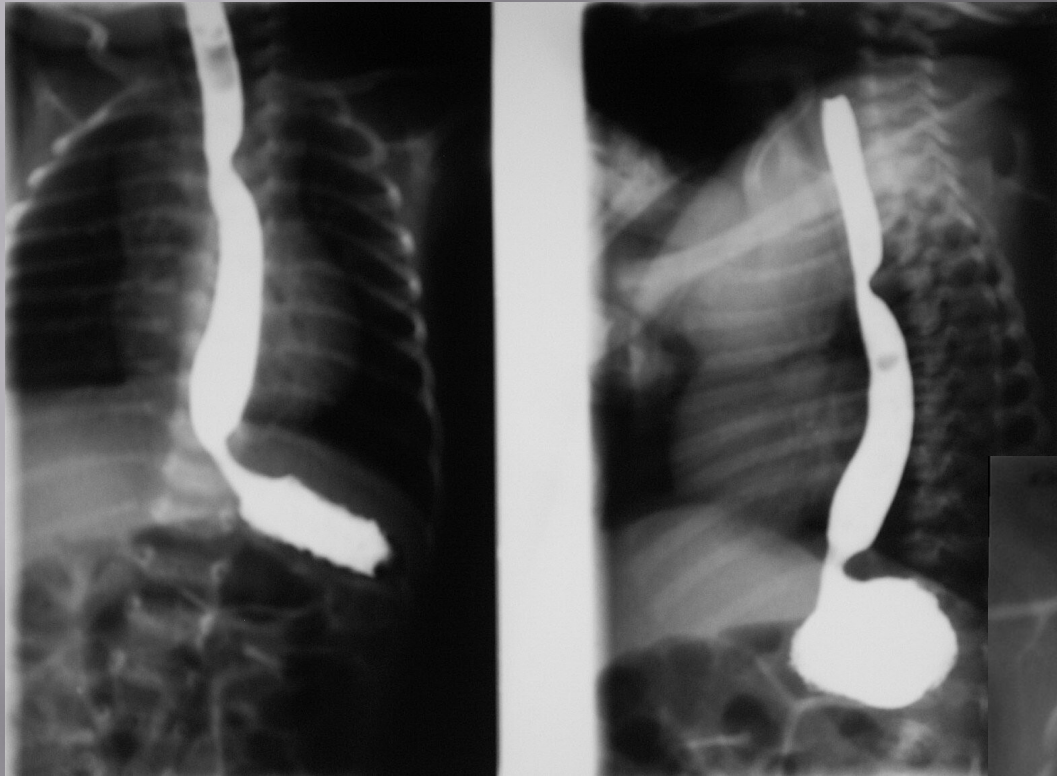
# VASCULAR ANOMALITIES - RINGS

- DYSPNOE, STRIDOR
- ECHO
- BARIUM SWALLOW
  
- CT, MR
- AORTOGRAFY

## DOUBLE AORTIC ARCH



# DOUBLE AORTIC ARCH



030313/3038  
2003-07-11

Acq:2  
Img:1

FSV.1



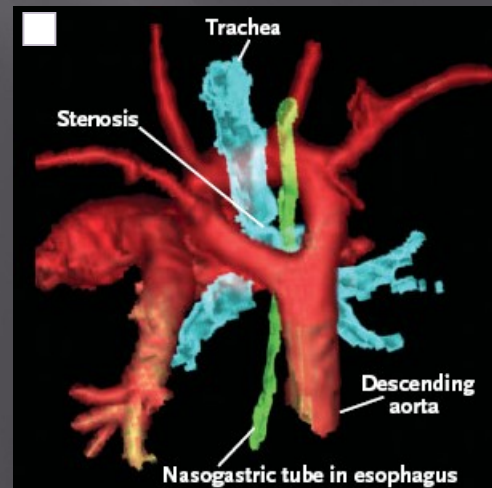
030313/3038  
2003-07-11

Acq:2  
Img:5

FSV.1



CT



# RIGHT SIDED AORTA

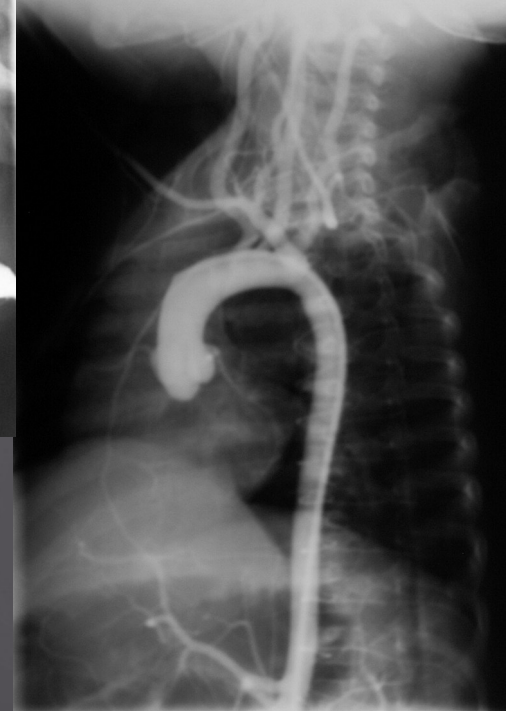
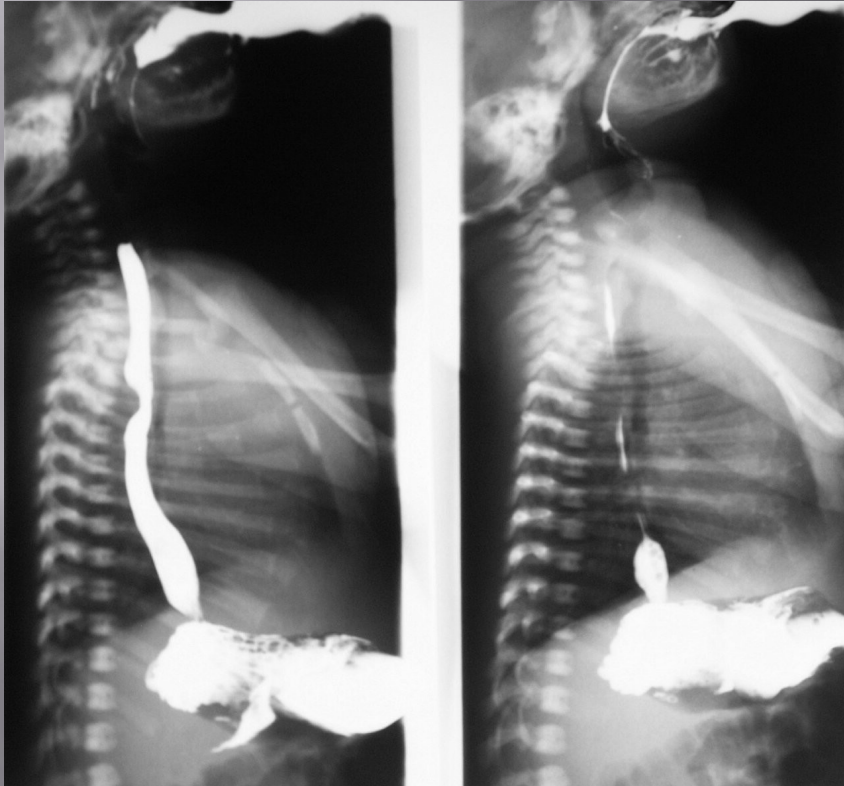
283709 F/7M  
4 SRODPIERSIE  
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Philips, Brilliance 64  
16 Mar, 2011 9:24:26.00  
Z 1.00

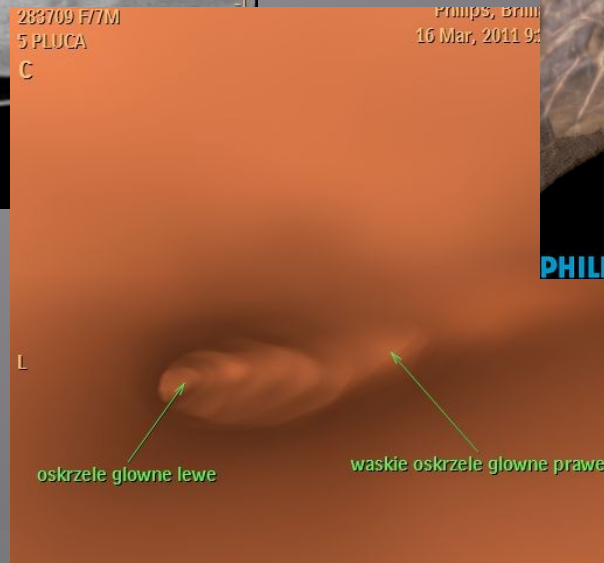
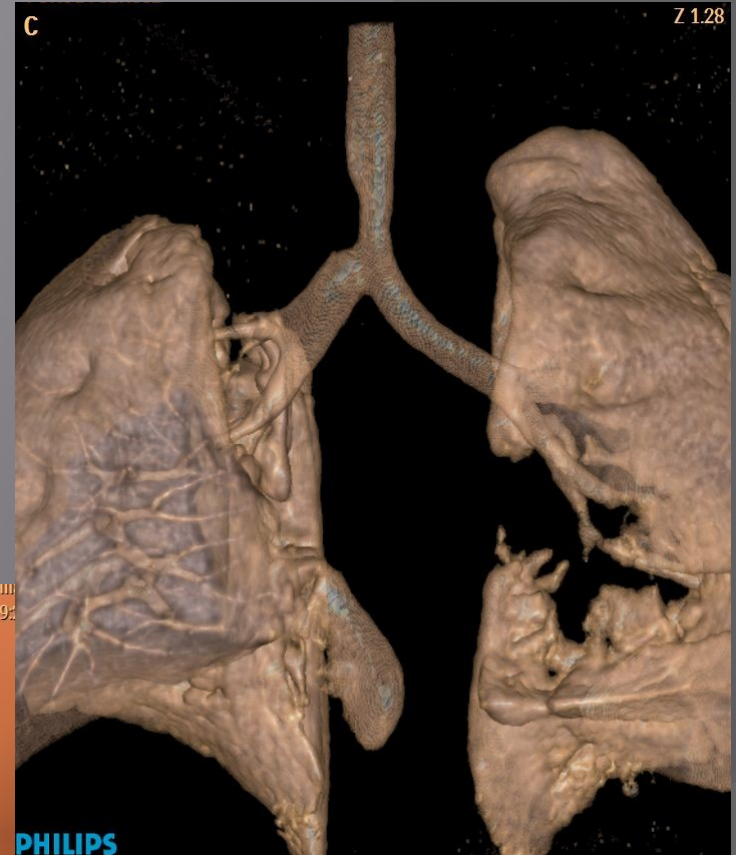


PHILIPS

# ABERRANT RIGHT SUBCLAVIAN ATERY

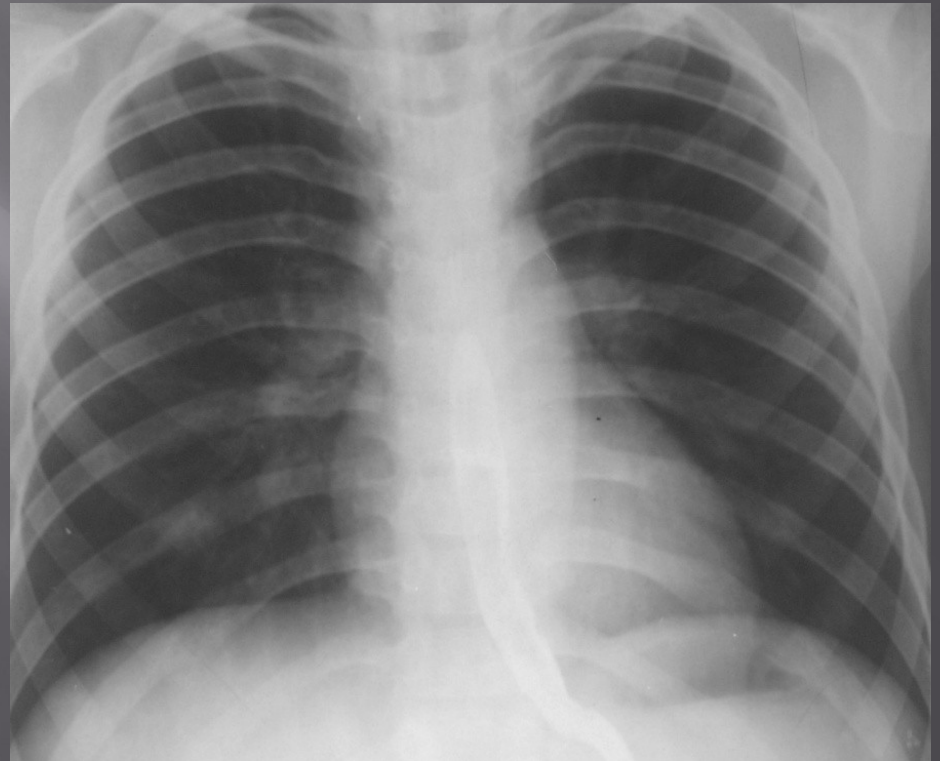


# Right sided aorta & a. lusoria



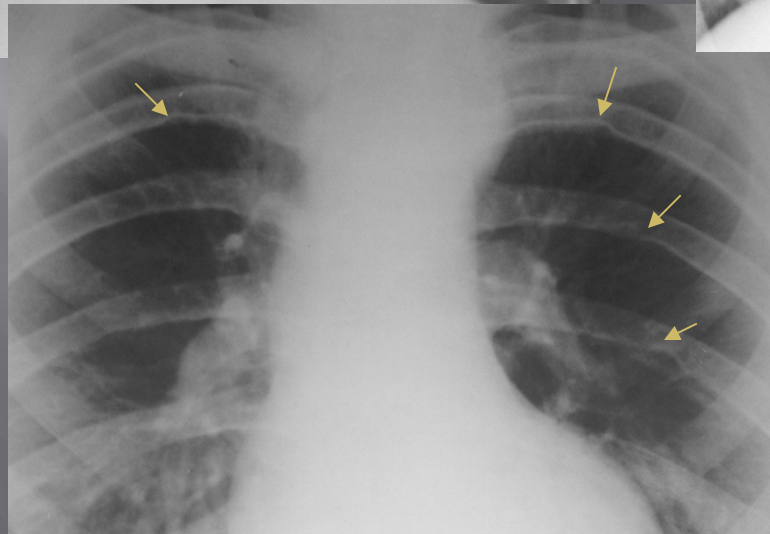
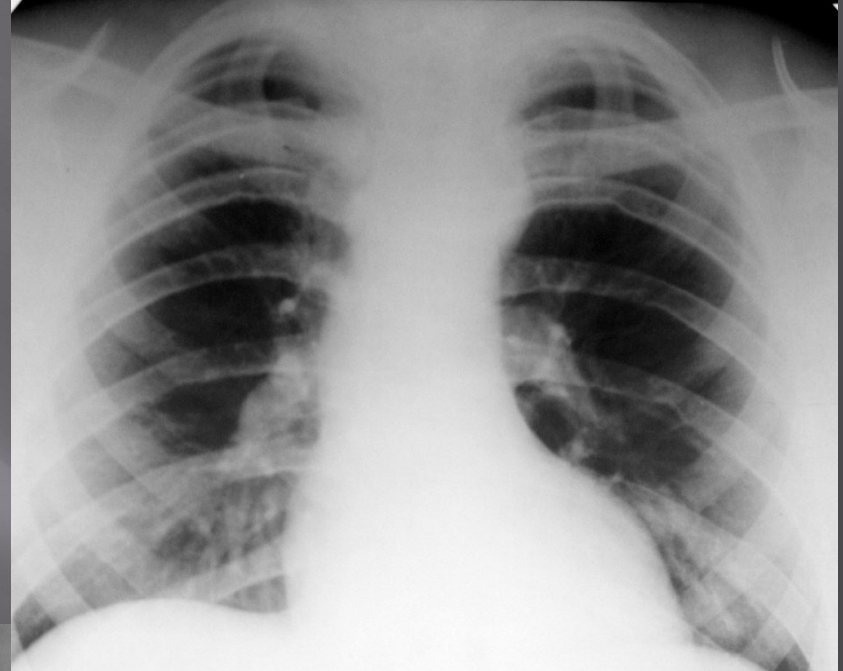
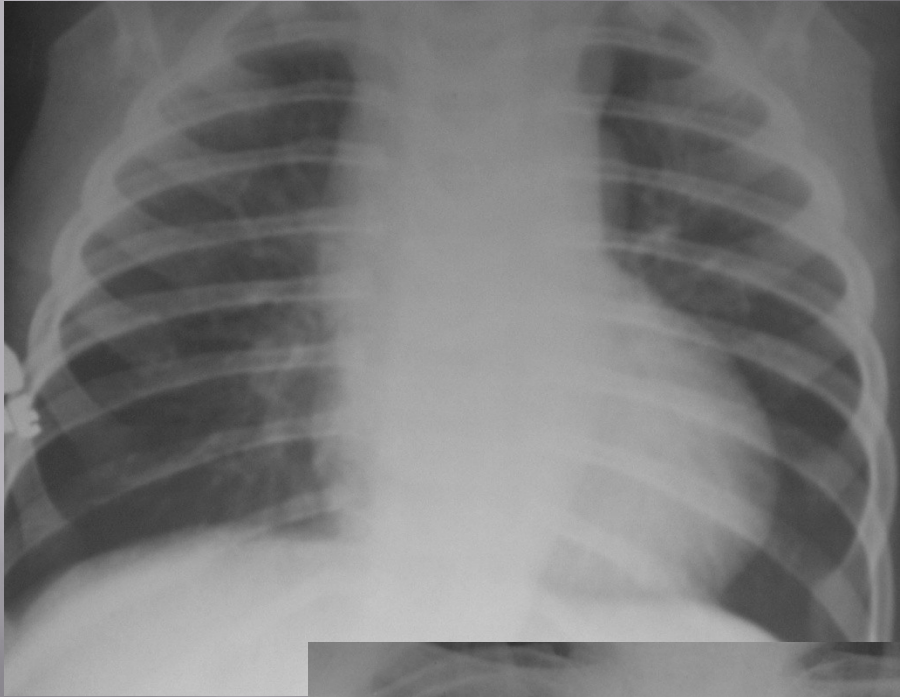
# CoA and ReCoA

- **CoA**
  - echo + doppler + MR/CT
  - aortography – newborn
- **ReCoA**
  - aortography + **balloon angioplasty**
  - aortography + **stent** in older patients

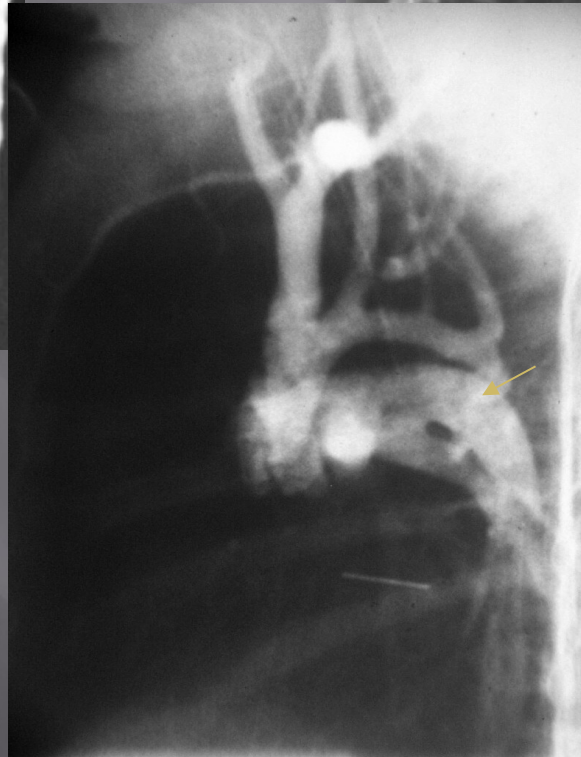
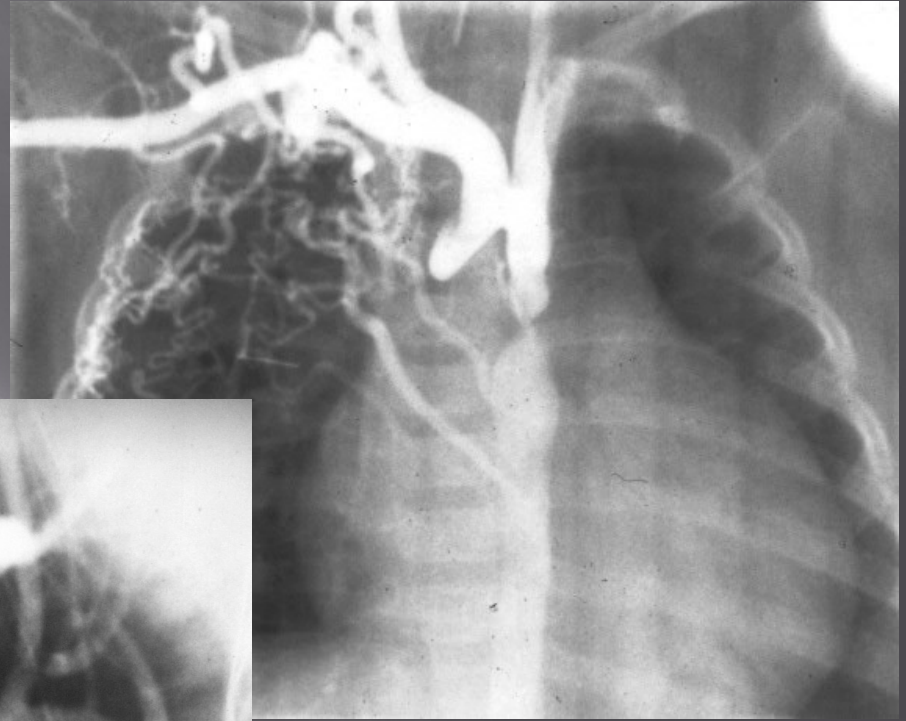




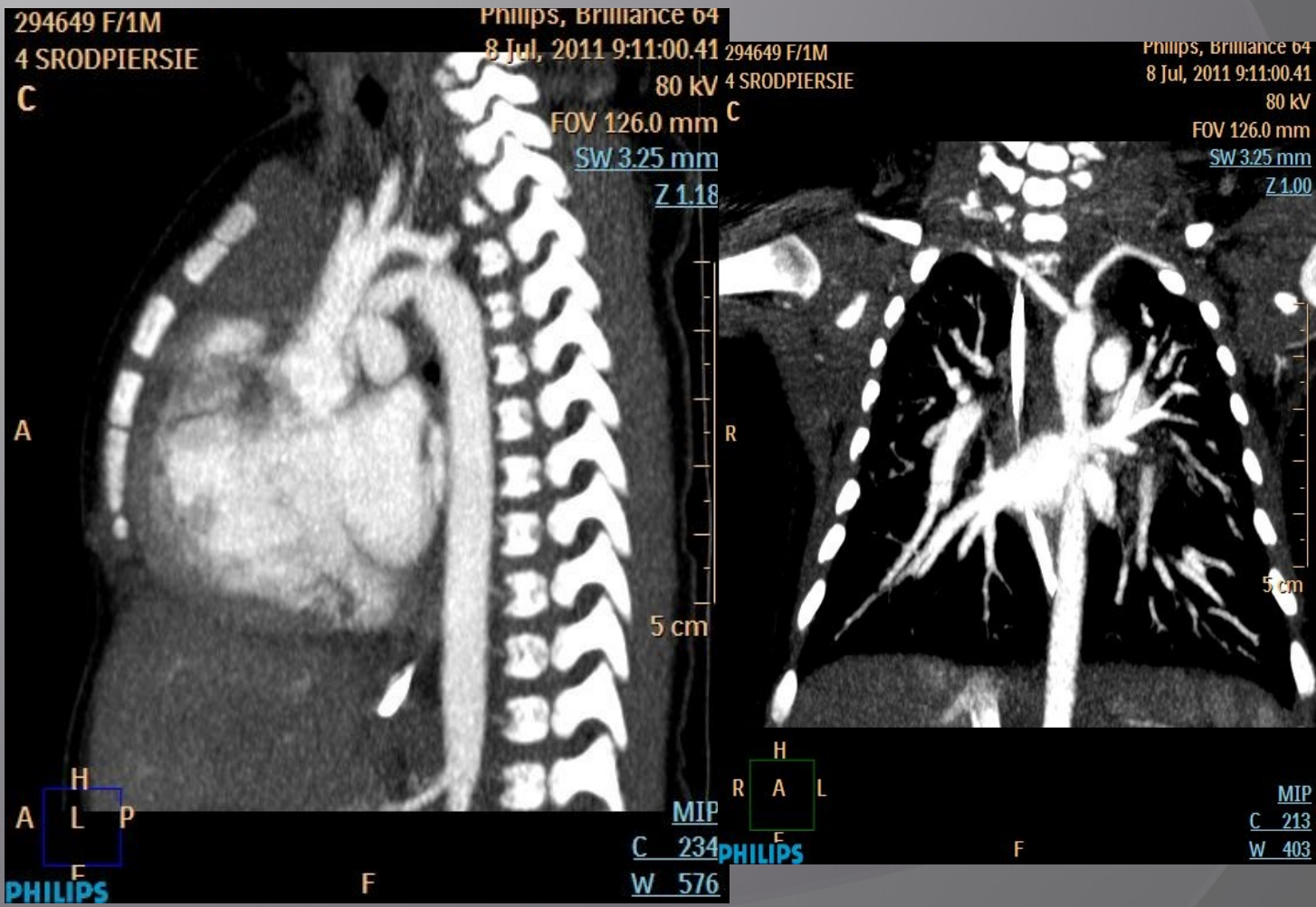
# CoA

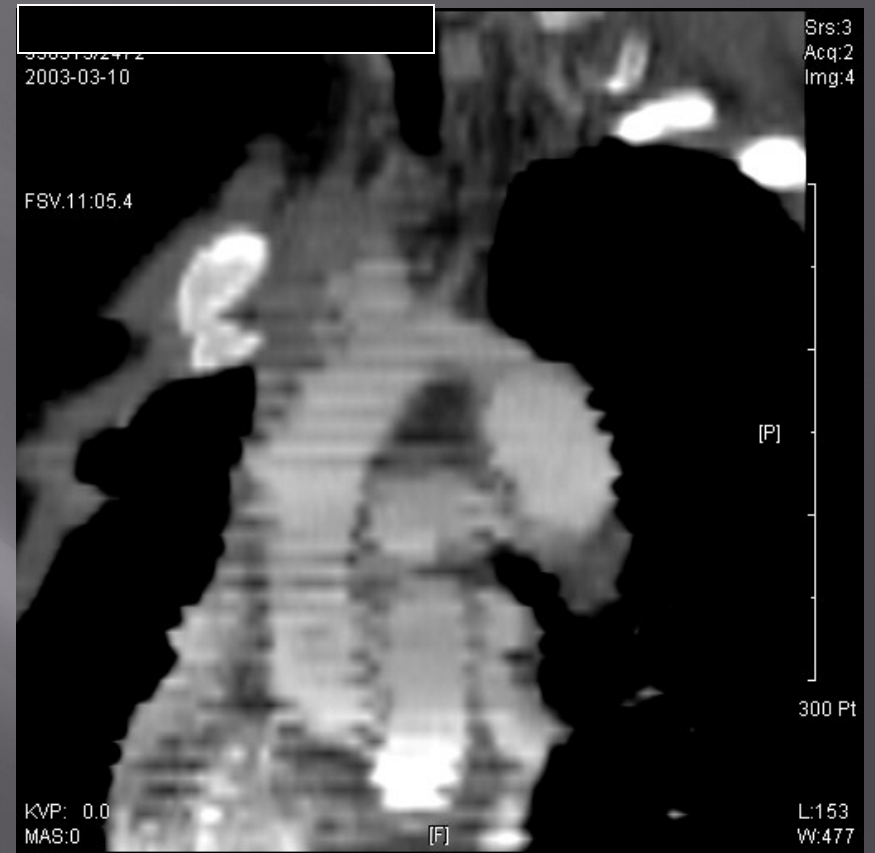
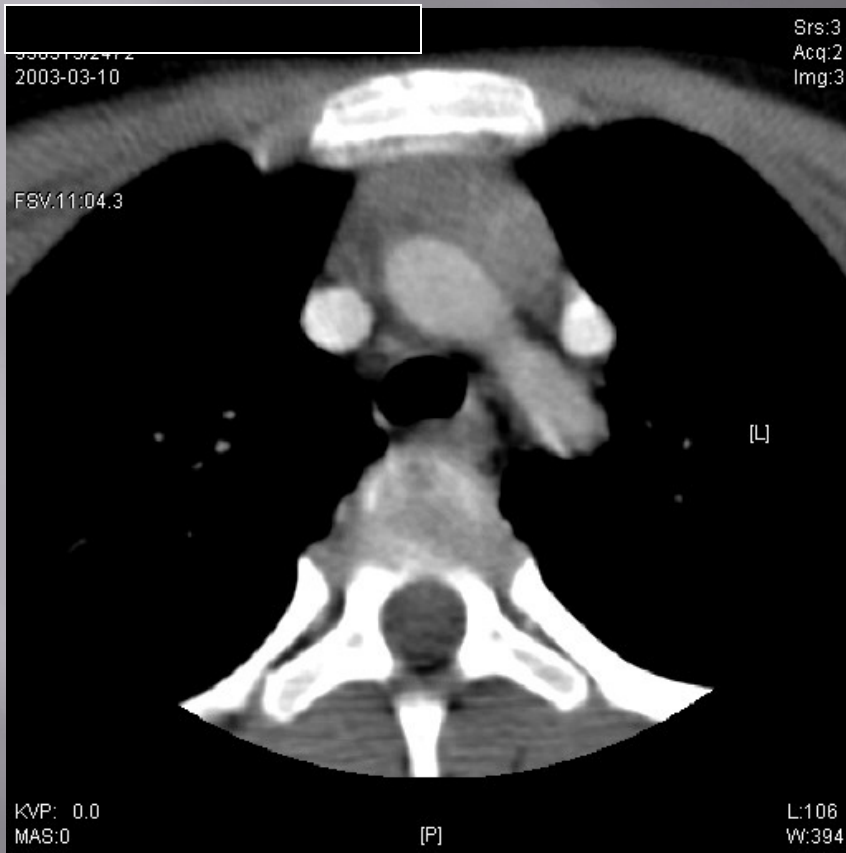


# CoA



# CoA & a. lusoria

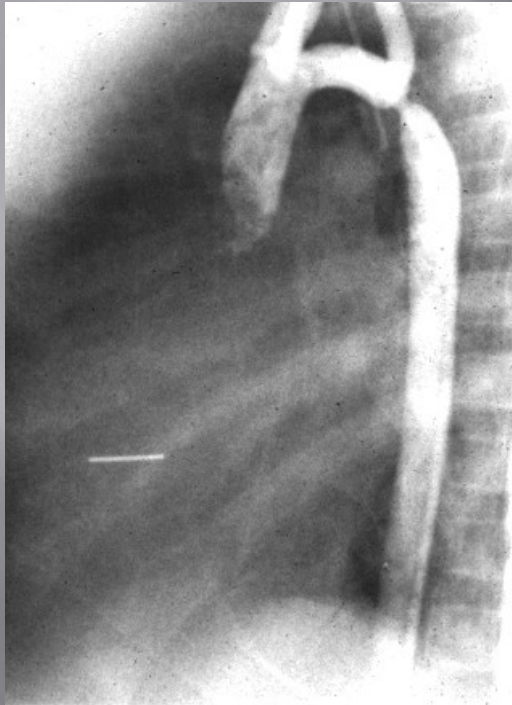




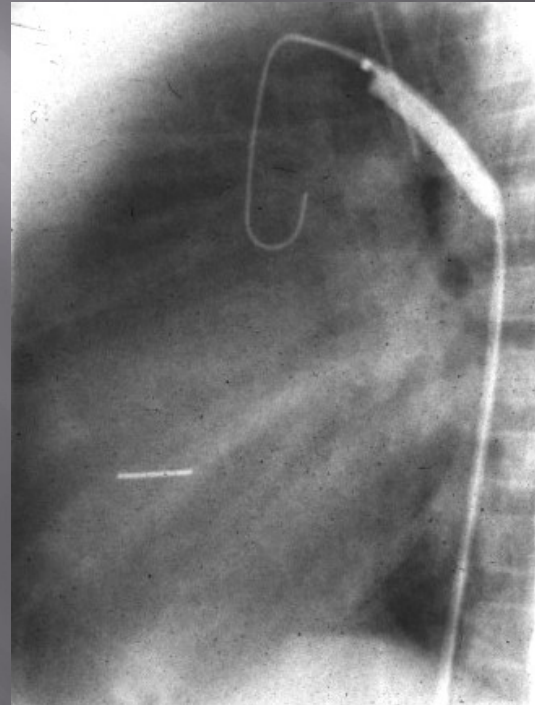
## CT angio- ReCoA

# ReCoA

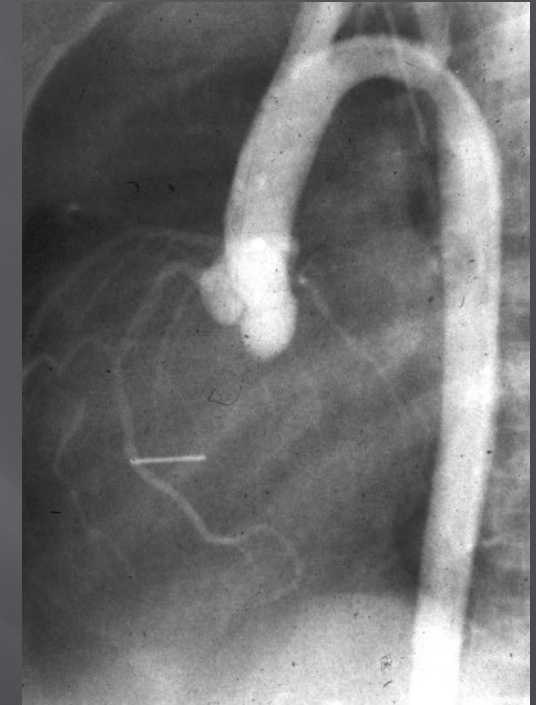
balonoplasty



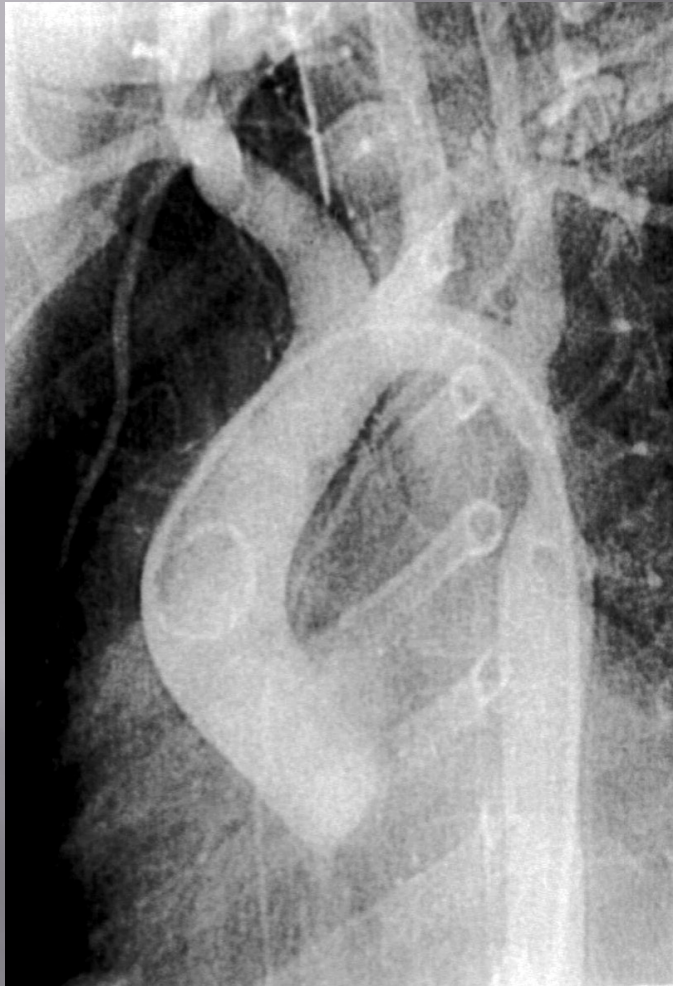
**before**



**balonoplasty**



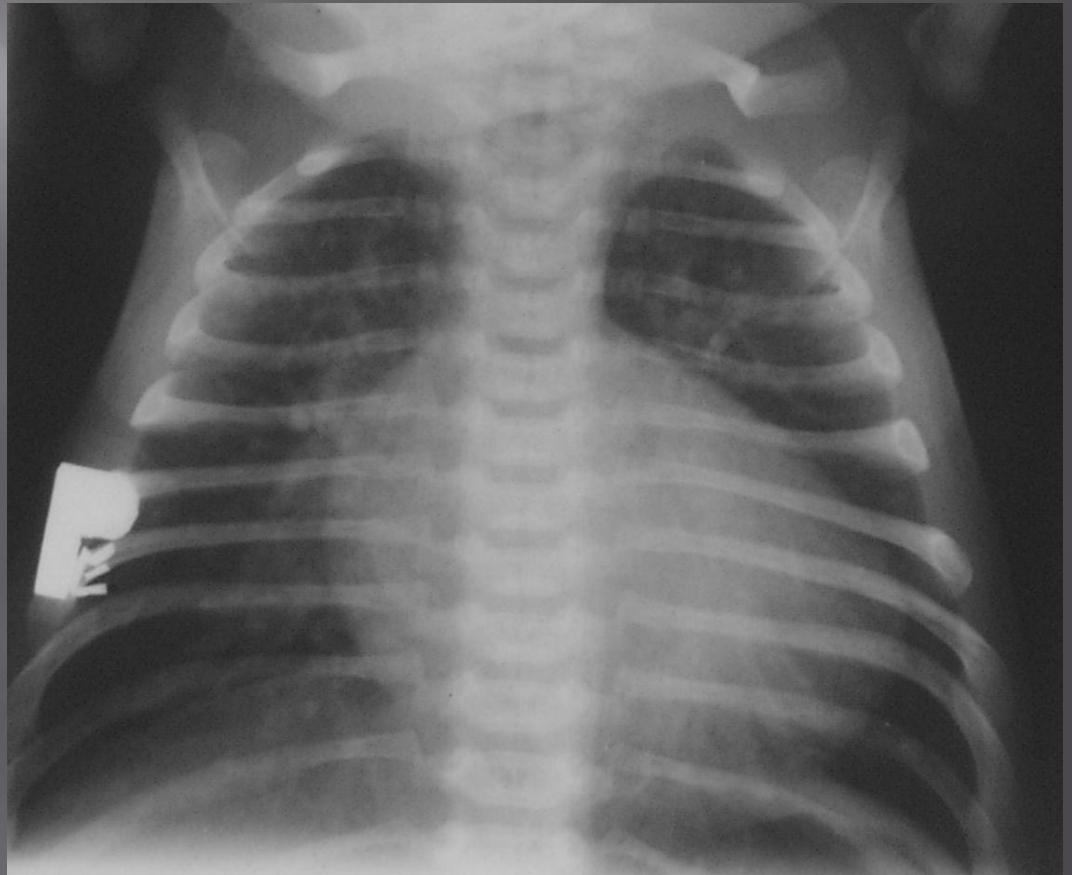
**after**



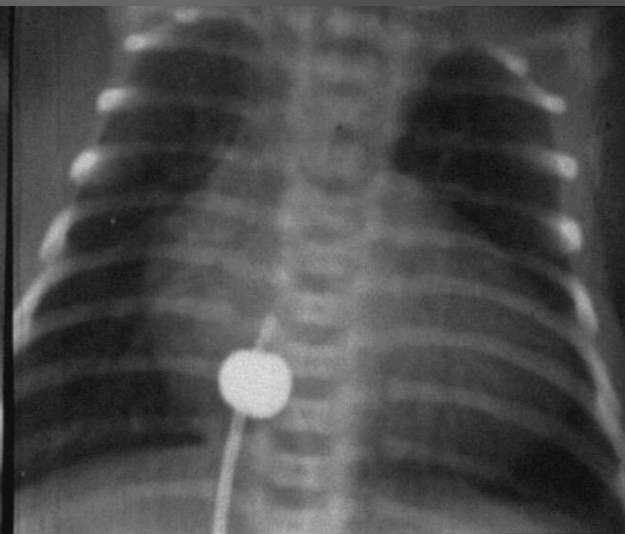
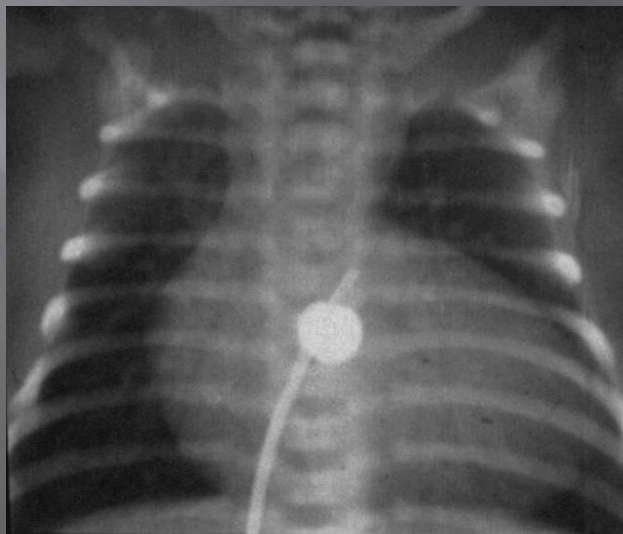
**Aortography- ReCoAstent**

# TGA

- echo-cardiography
- Rashkind procedure



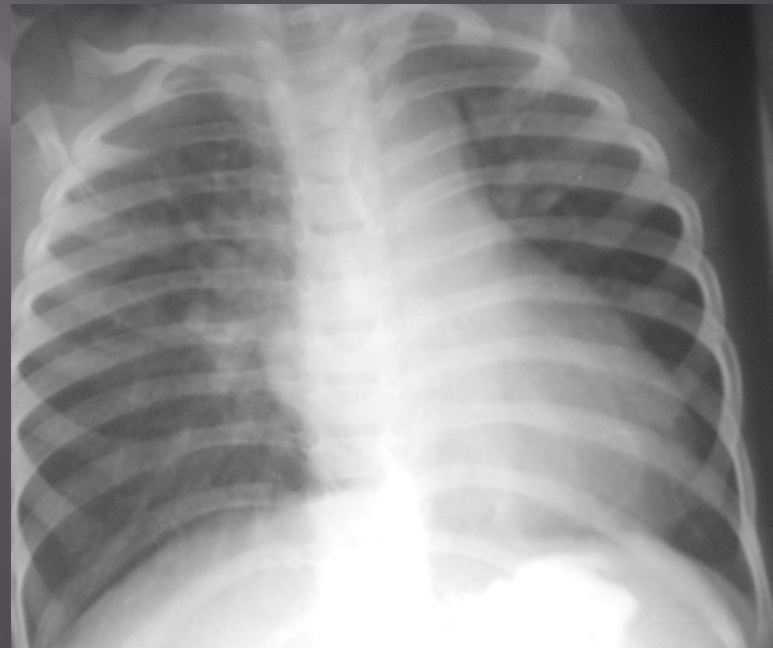
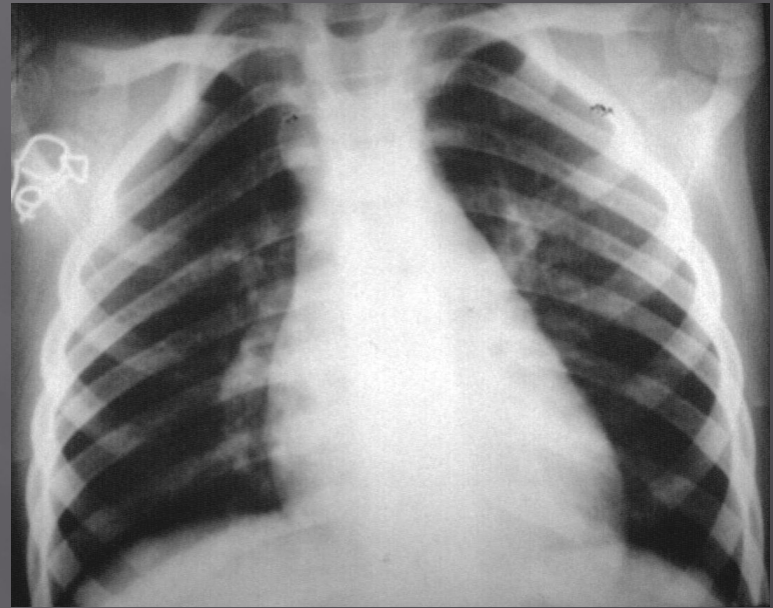
# Rashkind procedure

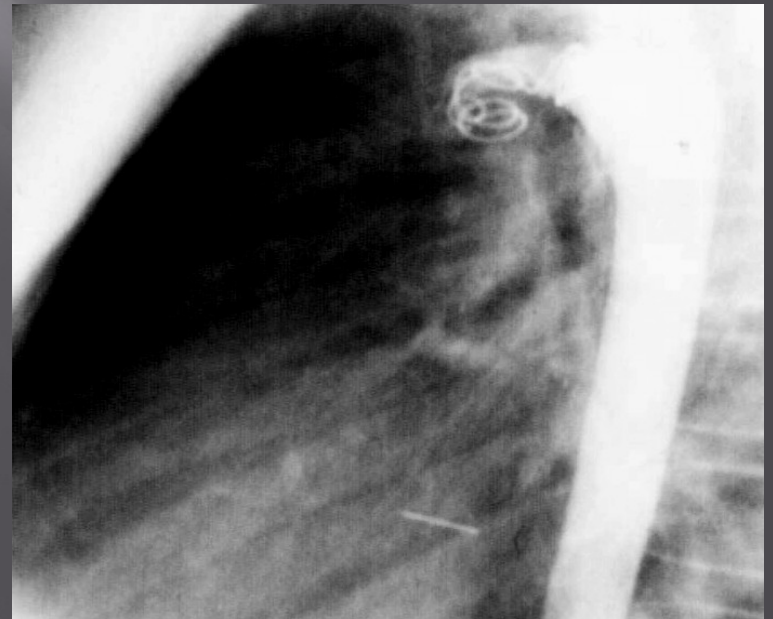
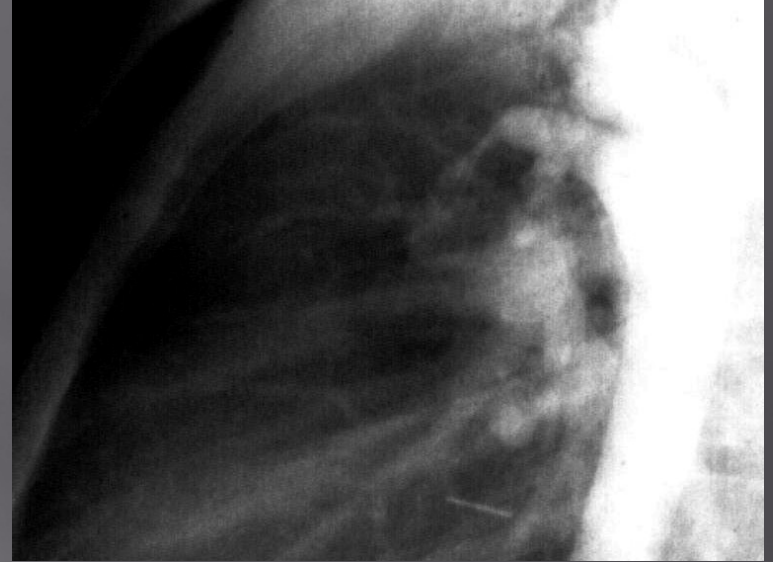




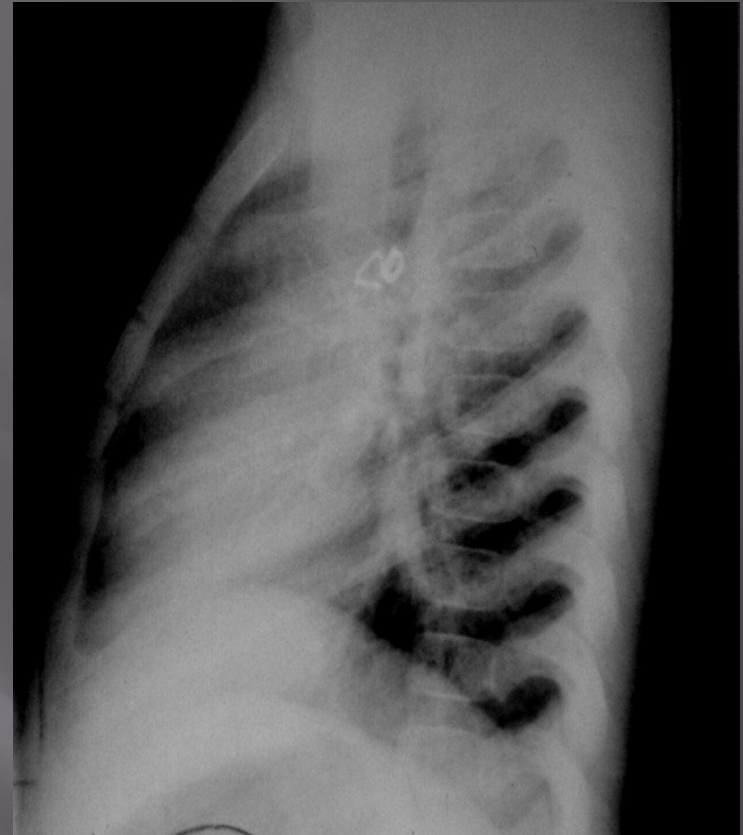
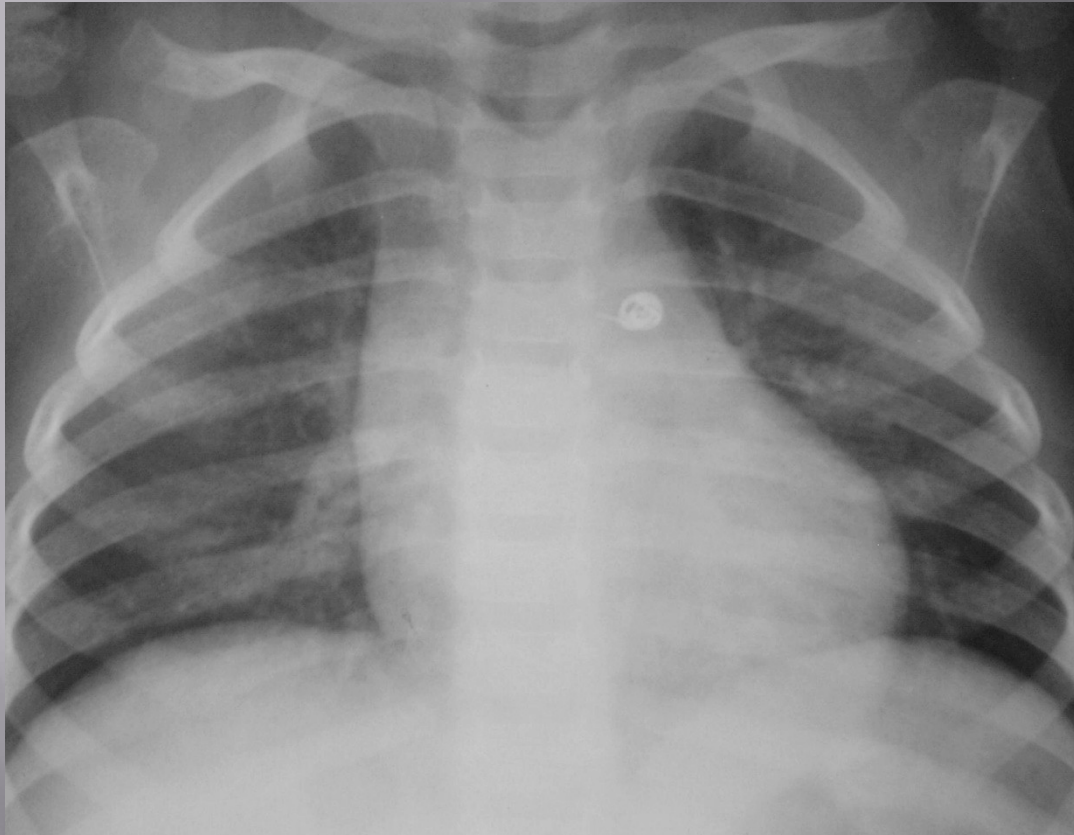
# PDA

- echo
- aortography
- babies > 6 month age  
COIL embolisation





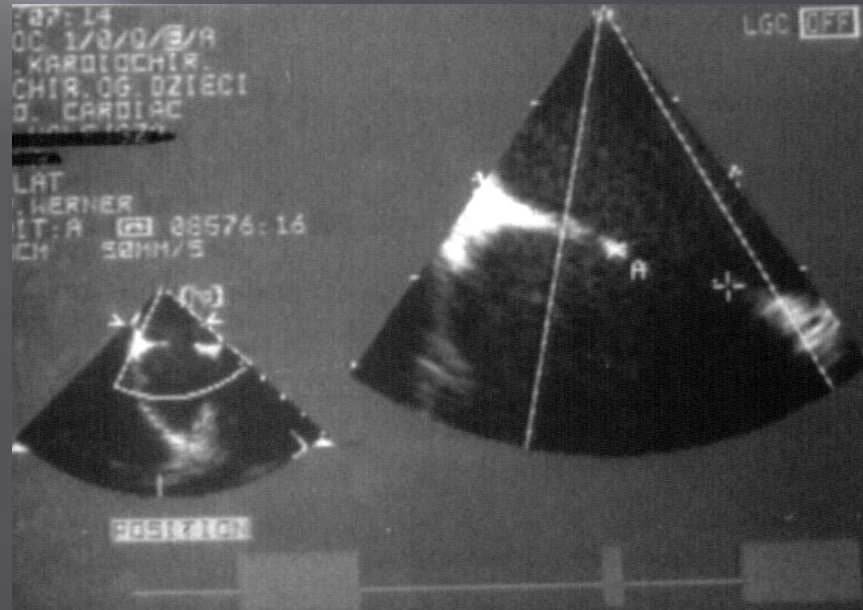
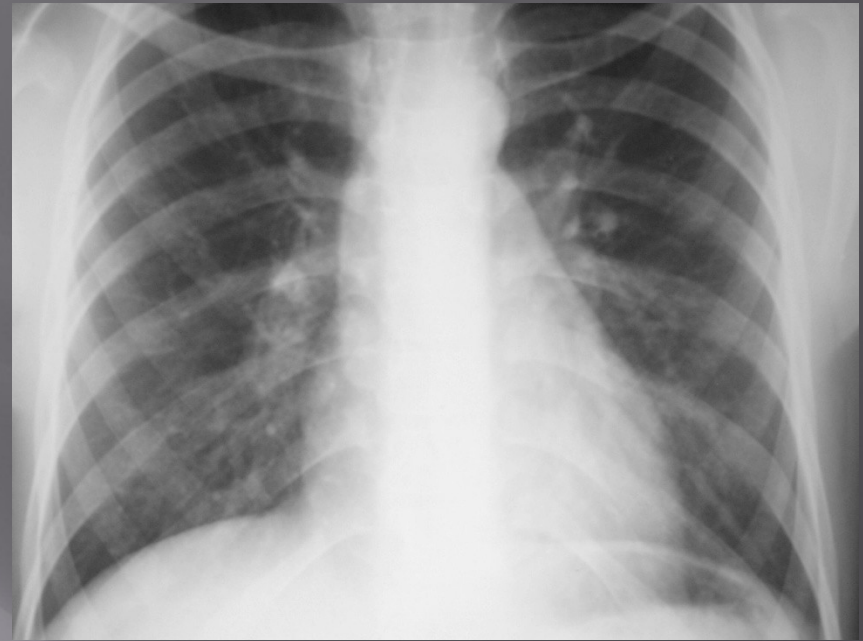
**PDA coil embolisation**

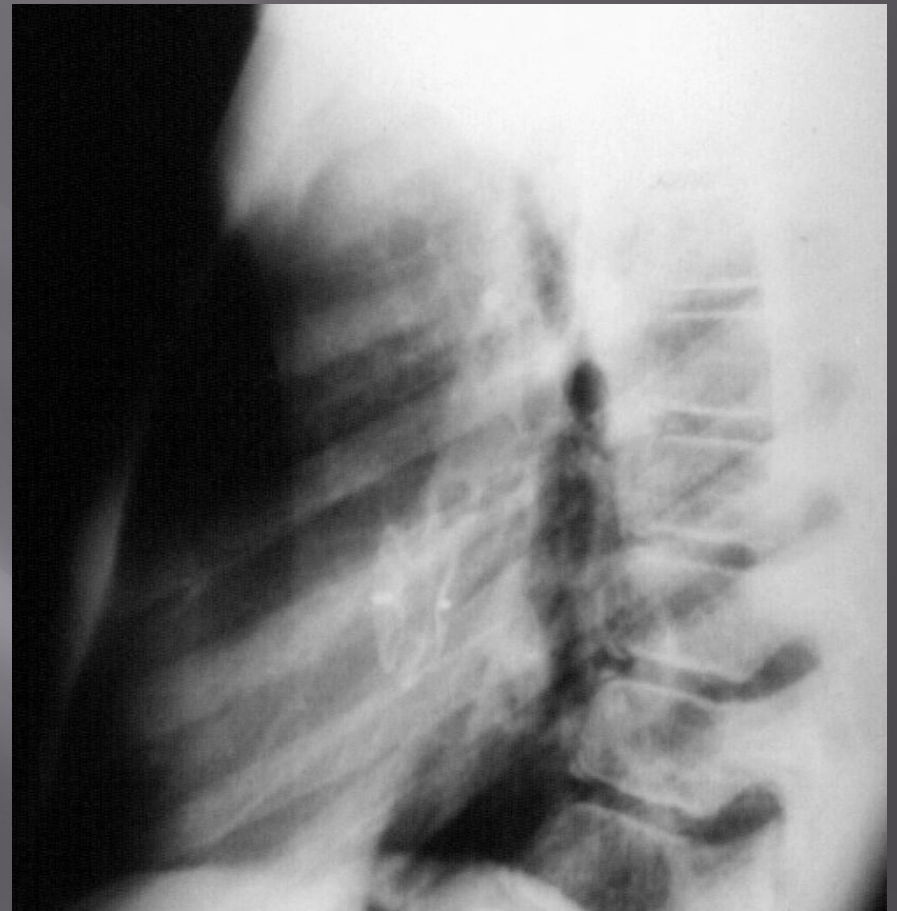
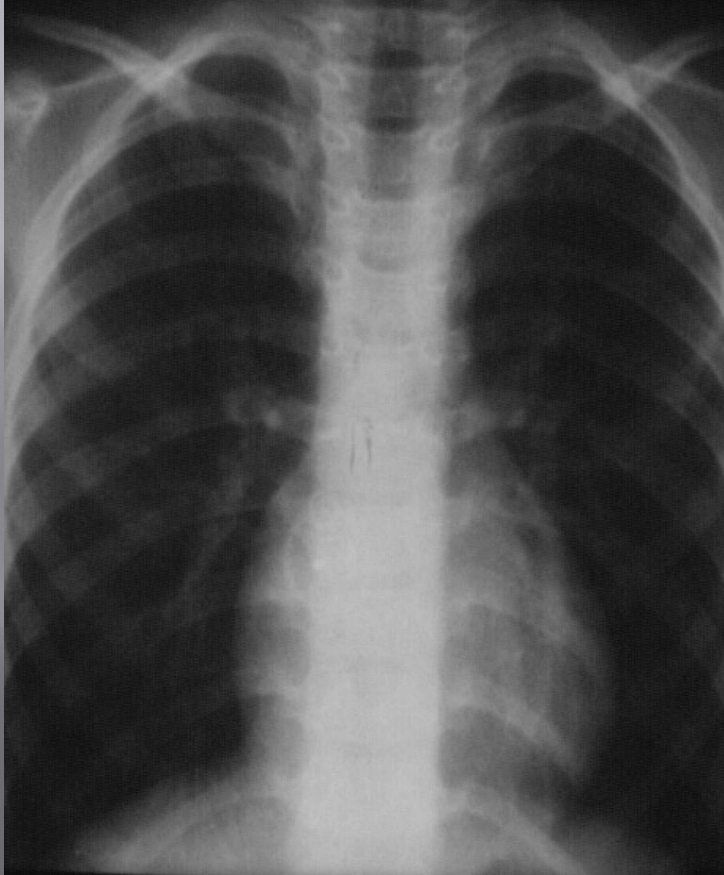
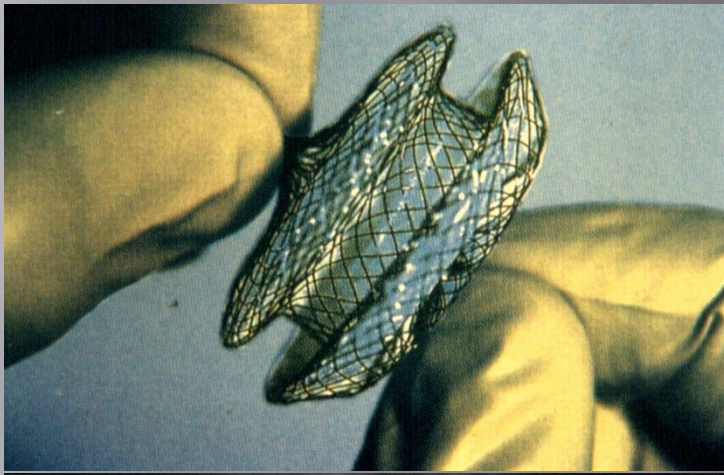


**PDA after coil embolisation**

# ASD

- transesophageal echocardiography + cardiac catheterization
- Amplatzer occlusion device

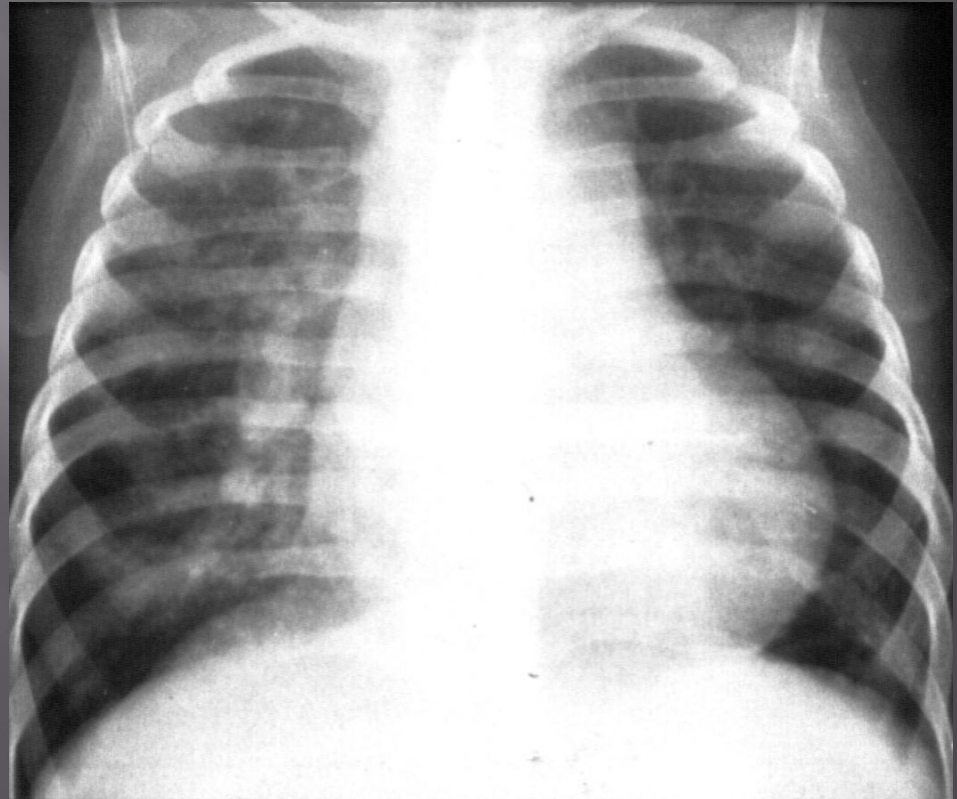




**ASD Amplatzer**

# VSD

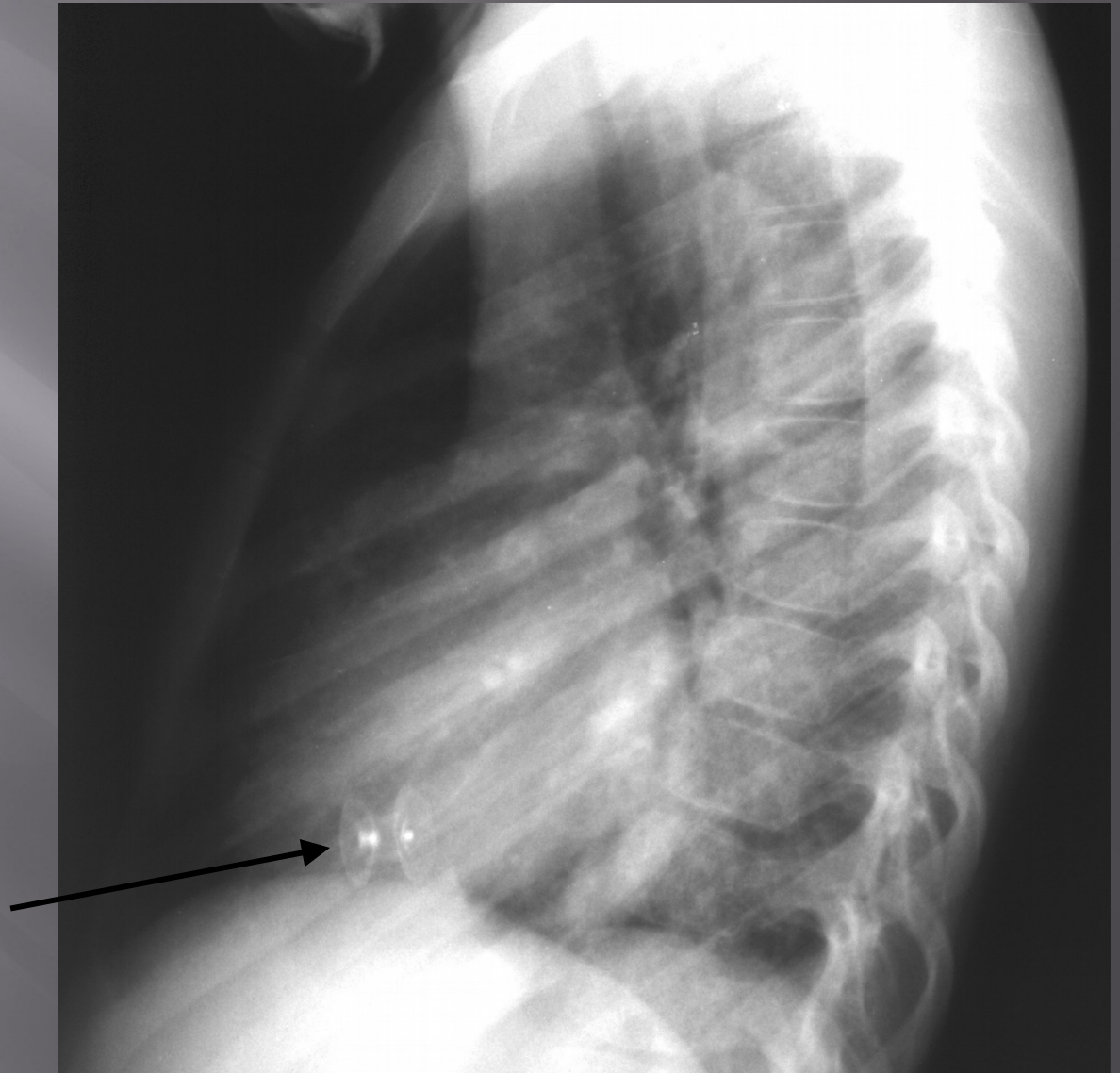
- transesophageal echocardiography + cardiac catheterisation (Amplatzer)
- hemodynamic examination – pulmonary hypertension?



# VSD

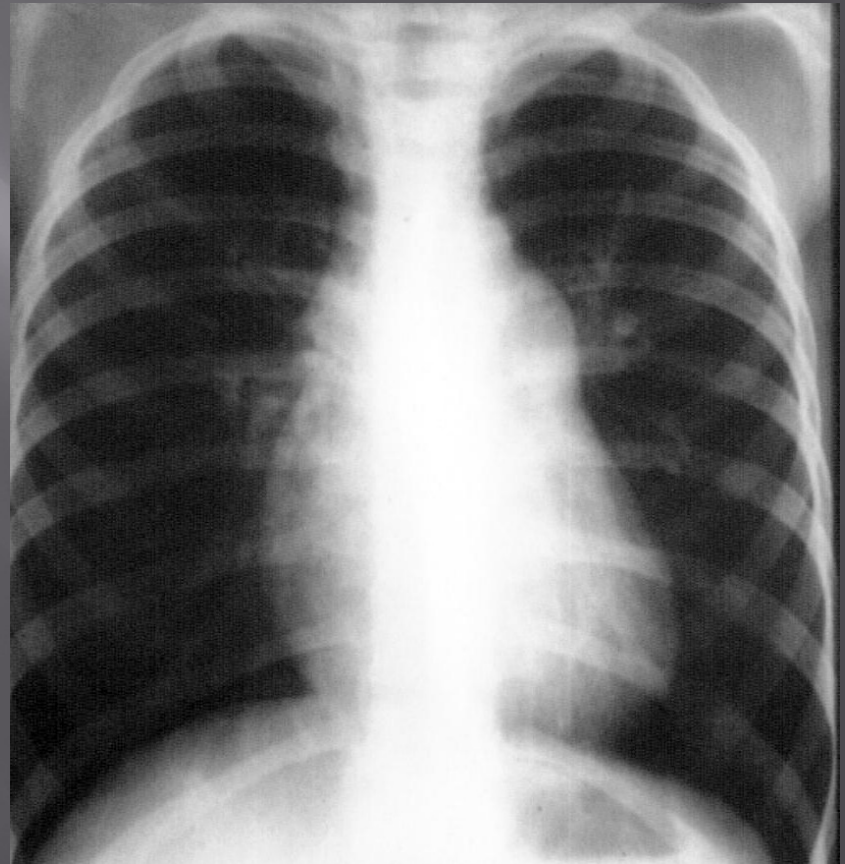
Chest X-ray lateral view

*Amplatzer occluder*



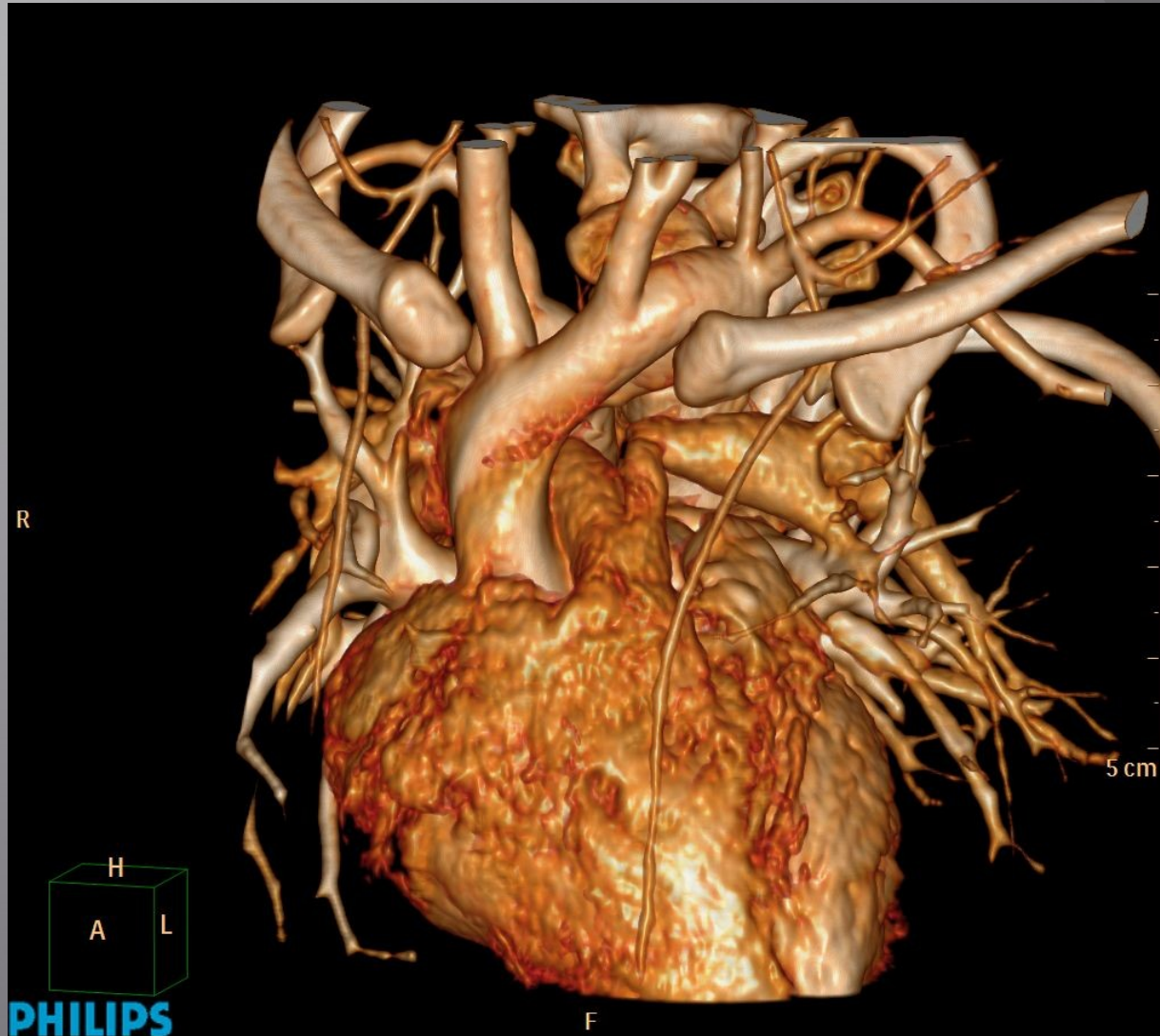
# PS

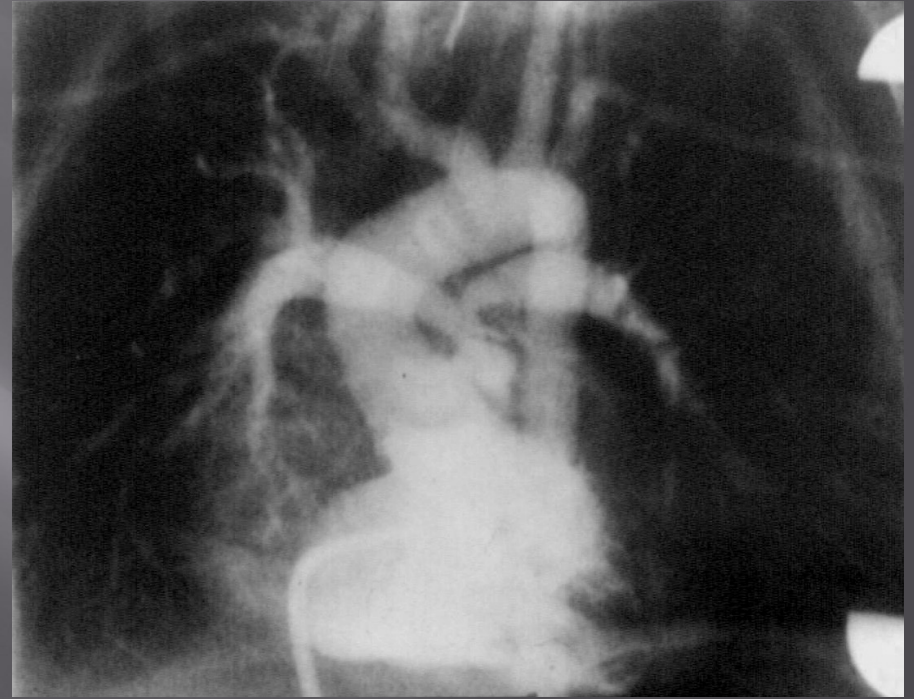
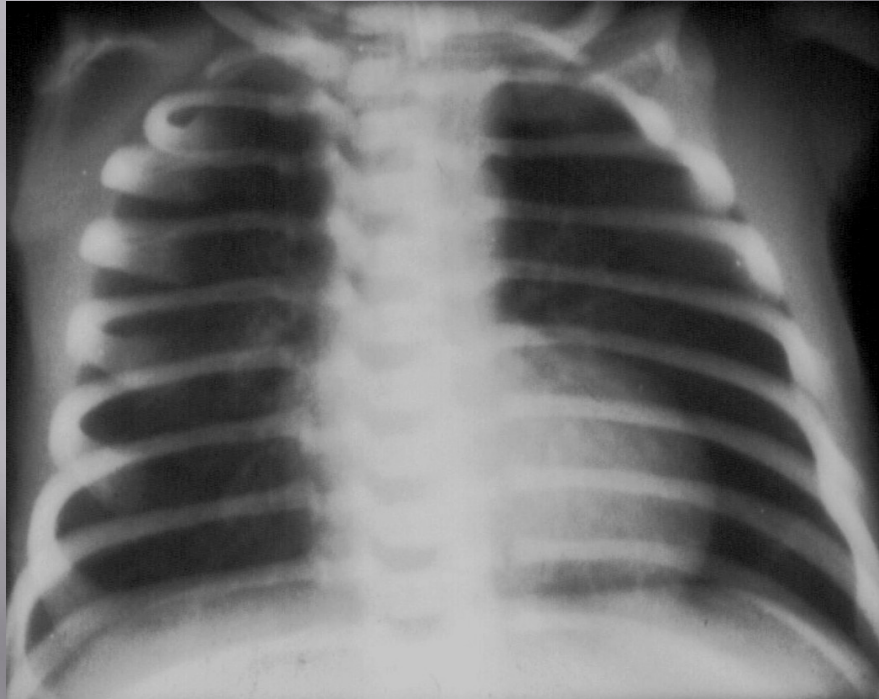
- **echo+ doppler  
angiocardiography**
- **hemodynamic  
examination –  
gradient RV/PA**
- **balonoplasty**





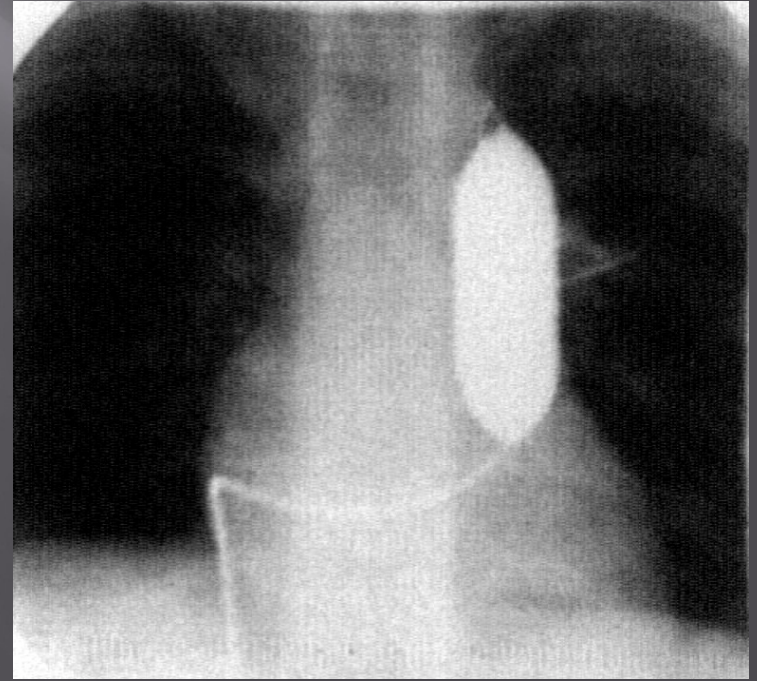
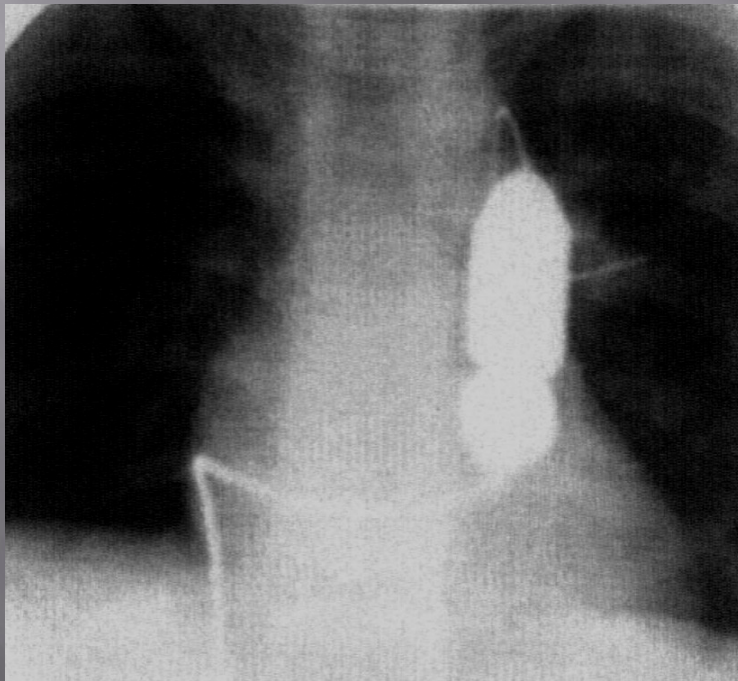
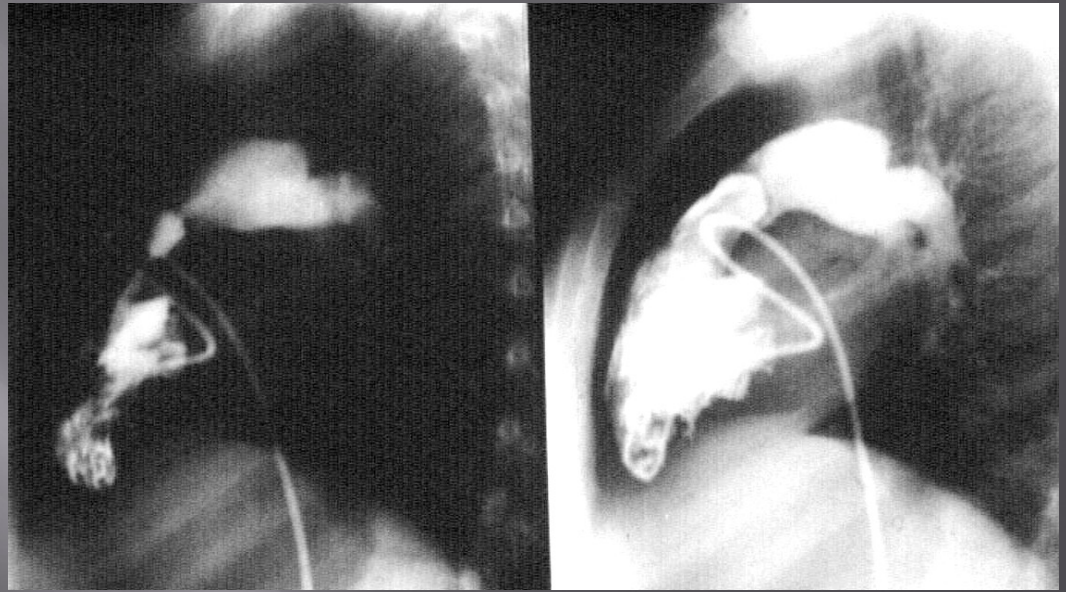
# LPA STENOSIS





**Tetralogy of Fallot**

**PS  
balonoplasty**



# Risks of complications related to interventional procedures

- **Local** (transient without long term effects)
  - bleeding
  - vessel spasm
  - hematoma
- **General**
  - transient hypotension
  - arrhythmia
- **Major complications**
  - cardiac wall rupture and cardiac tamponade, vessel rupture

# COMPLICATION

