CXR reading for IMPAACT

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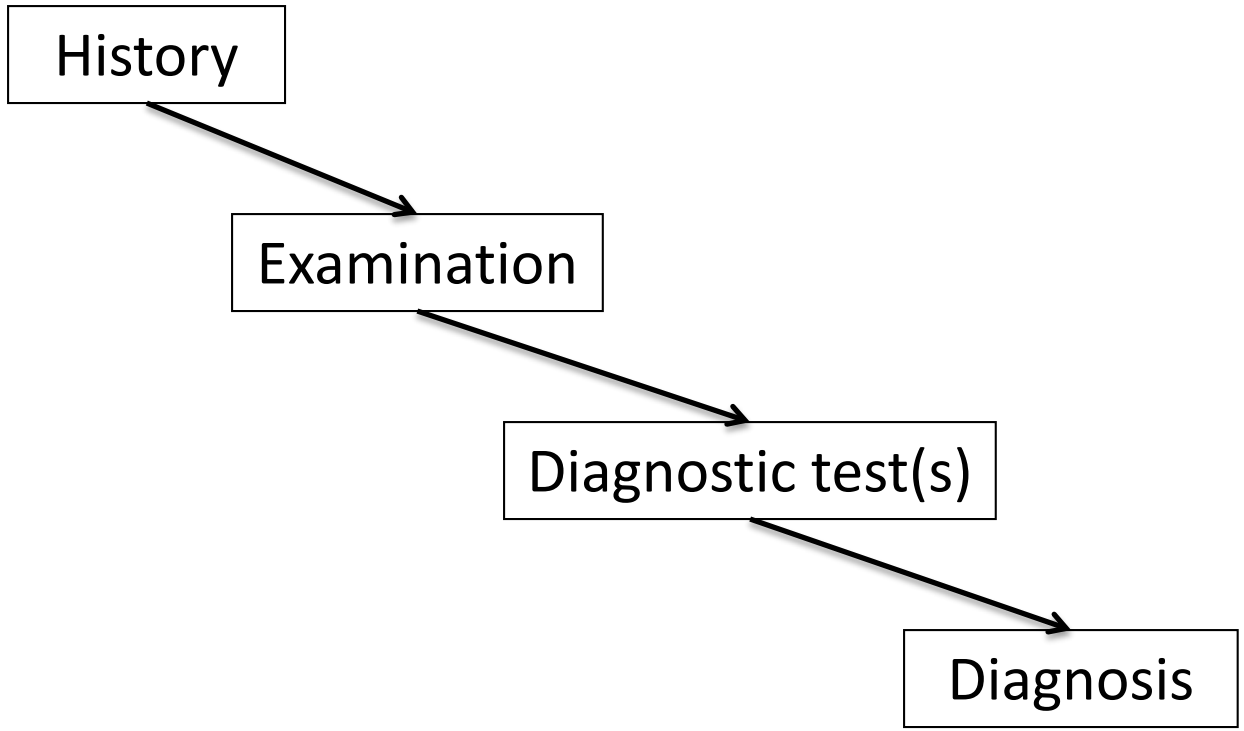
IMPAACT International Maternal Pediatric Adolescent AIDS Clinical Trials Group

DESMOND TUTU tb CENTRE · SENTRUM · IKIKI Every breath counts

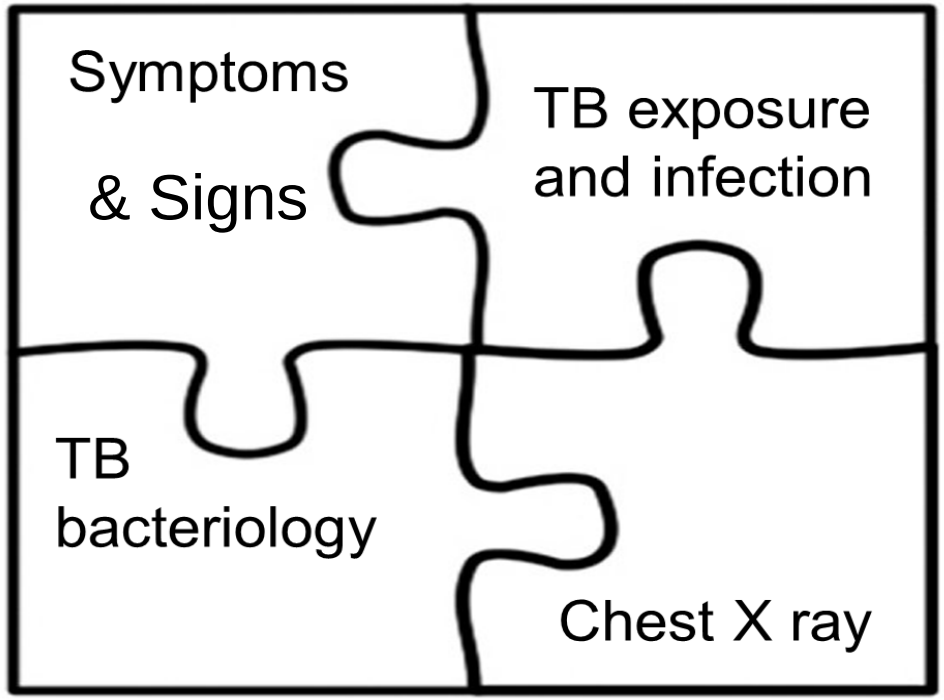
Why do we need the CXR?

- Contributes to the diagnosis of TB in children
- Exclude children with uncertain TB or other disease (concerning CXR)
- Contributes to understanding treatment failure (wrong diagnosis, non-adherence, DR-TB?)
- Can be used to evaluate response to treatment

Making a diagnosis



TB diagnosis in children



Liz Walters

Table 1. Clinical and radiological/laboratory criteria required to make a diagnosis of confirmed, probable or possible TB in child TB contacts < 5 years of age

Clinical (A)	Radiological/laboratory (B)
Cough or cervical neck mass (≥2x2cm) for >2 weeks despite a course of antibiotics	AFBs or caseating granulomas on microscopy (not confirmed by culture or Xpert to be TB)
Fever or lethargy for >1 week despite a course of antibiotics	Chest radiograph suggestive of TB (concurrence between two blinded CXR reviewers) despite a course of antibiotics.
Documented failure to thrive i.e. flattening of weight curve crossing centiles, documented weight loss e.g. >5%, moderate or severe malnutrition [Weight-for-height Z score <-2] in relation to previous measures	CSF suggestive of TB (white cell count <1000 cells, protein >1g/dl, glucose <2.2mmol/l)
Classic gibbus suggestive of spinal TB	Pleural aspirate or ascitic tap with WBC counts, protein, and glucose levels suggestive of TB, consider ADA
Depressed level of consciousness, new onset seizures or focal neurological signs suggestive of TB meningitis	CT brain suggestive of CNS TB

Confirmed = Positive *M. tuberculosis* + at least one of either A or B
Probable = At least one of A and at least one of B
Possible = At least one of A or B (but not both) and a decision to treat

Factors to understand in childhood CXR contact investigation studies:

- What have we learnt regarding the CXR from other contact tracing studies ?
- Most of the CXR are normal
- About 1 in 10 children less than 5 years old might have TB

Table 2 Characteristics of children enrolled in a community-based diagnostic study at enrolment ($n = 1093$) and at the time of diagnosis of a potential disease episode ($n = 109$)

Characteristics	Total cohort ($n = 1093$) n (%)	Children with potential TB ($n = 109$) n (%)
Age at enrolment, months, median (range)	61 (3–190)	39 (5–184)
Age at TB episode, years	NA	41 (5–188)
Age <2 years	197 (18)	26 (23)
Age <5 years	534 (49)	74 (67)
HIV-infected	169 (15)	23 (21)
Median CD4 count at enrolment, cells/mm^3: absolute (range), % (range)	1400 (35–4200), 28.5 (3–47)	1450 (35–3700), 27 (3–44)
Median CD4 count at TB episode, cells/mm^3: absolute (range), % (range)	NA	1232 (35–2601), 27 (3–47)
Follow-up of HIV-infected children, months, median (range)	15 (0–29)	15 (3–28)
Follow-up of non-HIV-infected children, months, median (range)	15 (0–21)	15 (0–21)
Ethnicity		
Mixed race	717 (66)	73 (67)
Xhosa	365 (33)	35 (32)
Other	11 (1)	1 (1)
Community		
A	355 (32)	28 (26)
B	359 (33)	45 (41)
C	379 (35)	36 (33)
Recruited from TB household	671 (61)	76 (70)
Recruited from neighbouring household	242 (22)	13 (12)
Recruited from community HIV clinic	180 (16)	20 (18)

TB = tuberculosis; NA = not available; HIV = human immunodeficiency virus.

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http://dx.doi.org/10.5588/ijtld.14.0585

Table 4 TB disease spectrum observed in children with confirmed, probable and possible tuberculosis based on the protocol case definition ($n = 86$)*

	n (% of 86)
Intrathoracic tuberculosis	
Isolated uncomplicated intrathoracic lymph node disease	28 (32)
Controlled, uncomplicated intrathoracic (parenchymal) disease ($n = 29$) and 3 with additional uncomplicated intrathoracic lymph node disease	32 (37)
Pleural effusion with uncomplicated intrathoracic lymph node disease	1 (1)
Complicated intrathoracic lymph node disease (8 in isolation); 2 had additional controlled uncomplicated intrathoracic (parenchymal) disease	10 (12)
Uncontrolled uncomplicated intrathoracic (parenchymal) disease, of which 2 had additional uncomplicated intrathoracic lymph node disease	7 (8)
Disseminated disease (miliary TB) with bilateral small pleural effusions and uncomplicated intrathoracic lymph node disease	1 (1)
Uncontrolled complicated intrathoracic disease (complications were mostly lymph node related)	7 (8)
Extrathoracic TB	
Controlled uncomplicated cervical adenitis	1 (1)

*Entities listed show where there was overlap between more than one disease entity. Disease extent (controlled vs. uncontrolled) and the presence of complications are described using a standard approach used to describe disease spectrum and severity.[11]
TB = tuberculosis.

TABLE 1 Demographics of Children in Household Contact With an Adult Tuberculosis Source Case

Characteristic	*n* (%)
Adult tuberculosis source cases (*N* = 197)	
Sputum smear–positive	183 (93.8)
Sputum smear–negative, culture-positive	12 (6.2)
Household contacts <5 y of age (*N* = 271)	
Children with complete data set (symptoms, TST, and CXR)	252 (93.0)
Children included in the analysis (*N* = 252)	
Boys	141 (56.0)
Age categories	
Age ≤1 y	54 (21.4)
Age 1–2 y	106 (42.1)
Age 3–5 y	92 (36.5)
TST results (mean positive TST: 18 mm)	
TST positive (≥10 mm induration)	136 (54.0)
Tuberculosis treatment	
Isoniazid preventive chemotherapy	217 (86.1)
No preventive therapy (received isoniazid within the preceding year)	2 (0.8)
Treated for tuberculosis disease	33 (13.1)

www.pediatrics.org/cgi/doi/10.1542/peds.2007-3138

doi:10.1542/peds.2007-3138

TABLE 2 Radiographic Disease Manifestations Recorded in Child Tuberculosis Contacts

Tuberculosis Disease Manifestation	*n* (%)
Not tuberculosis	211 (83.7)
Uncertain tuberculosis	14 (6.0)
Treated as tuberculosis[a]	6 of 14 (42.9)
Certain tuberculosis	27 (10.7)
Uncomplicated lymph node disease	22 (81.5)
Complicated lymph node disease	
Parenchymal consolidation	2 (7.4)
Airway compression	1 (3.7)
Lung cavity	1 (3.7)
Pleural effusion	1 (3.7)

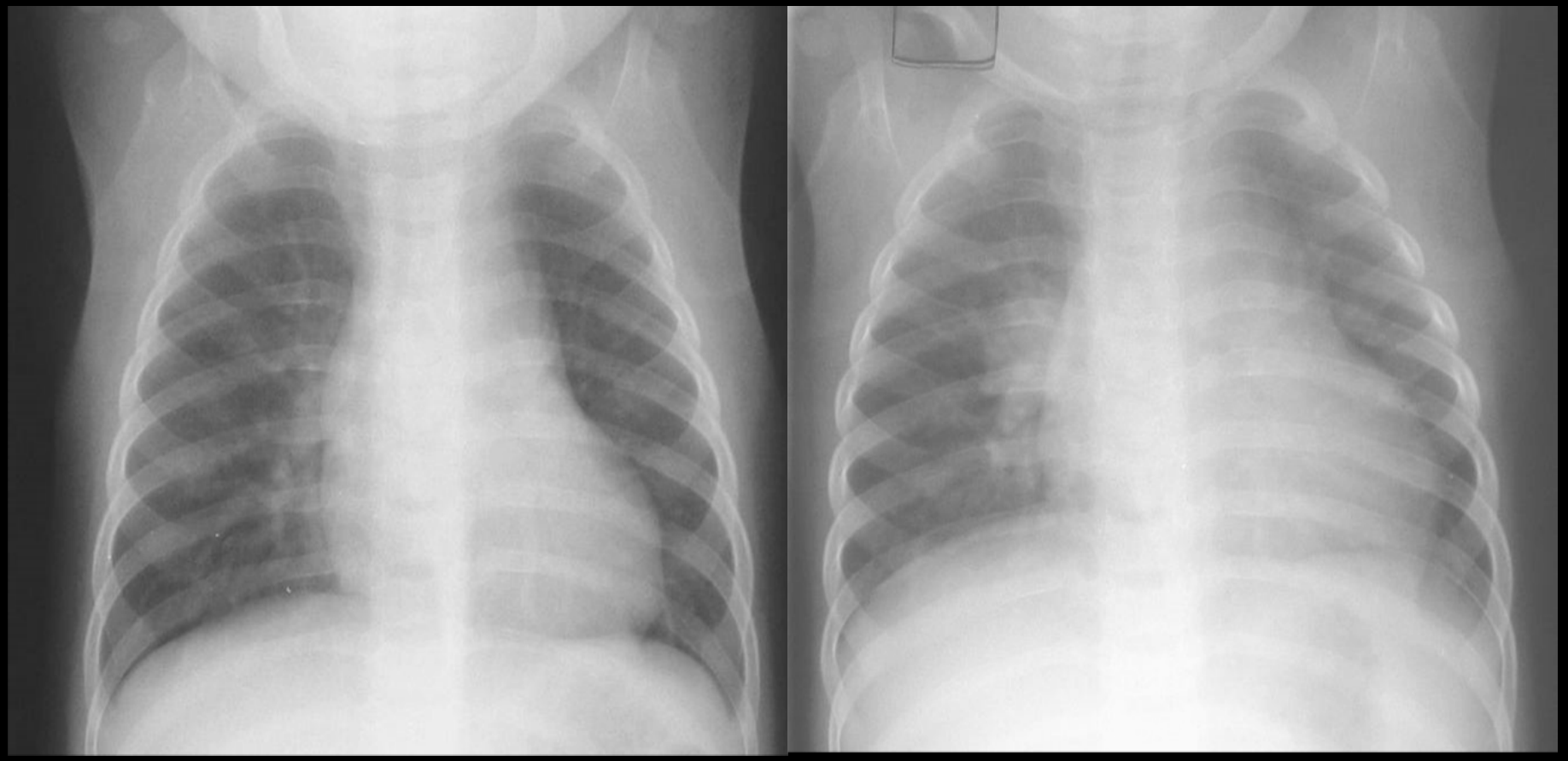
[a] The treating clinician initiated tuberculosis treatment in 6 children with uncertain tuberculosis; all had a positive TST result (mean: 19 mm) and had either suggestive symptoms or were <3 years of age.

Factors that complicate the reading of the childhood CXR

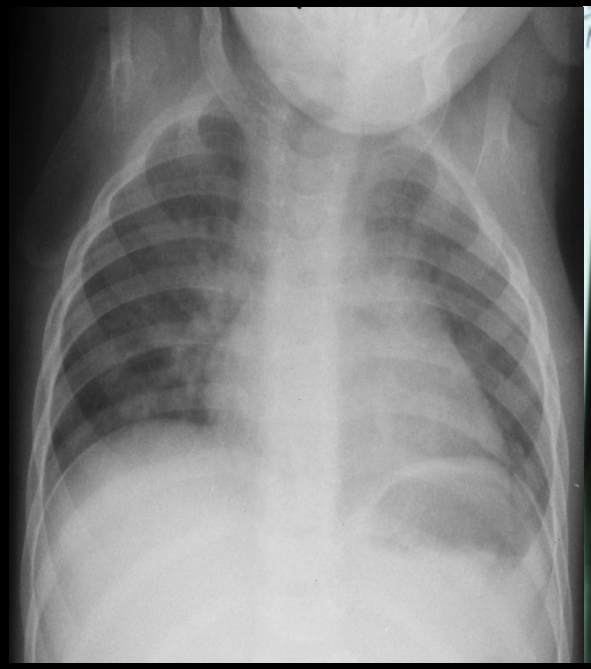
- Technical issues/Quality of the CXRs
- Understanding the anatomy of the CXR: pulmonary vessels
- Thymus
- Radiological images of enlarged mediastinal lymph nodes
- Radiological images confused with pulmonary TB

1. Technical issues

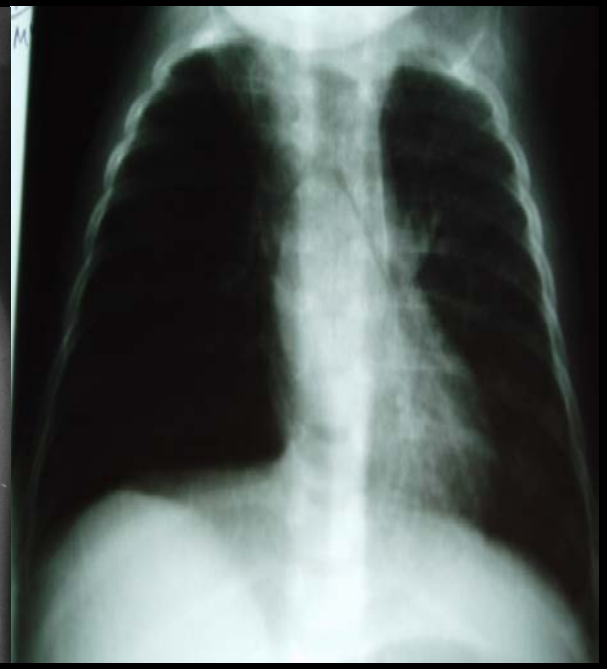
INSPIRATION



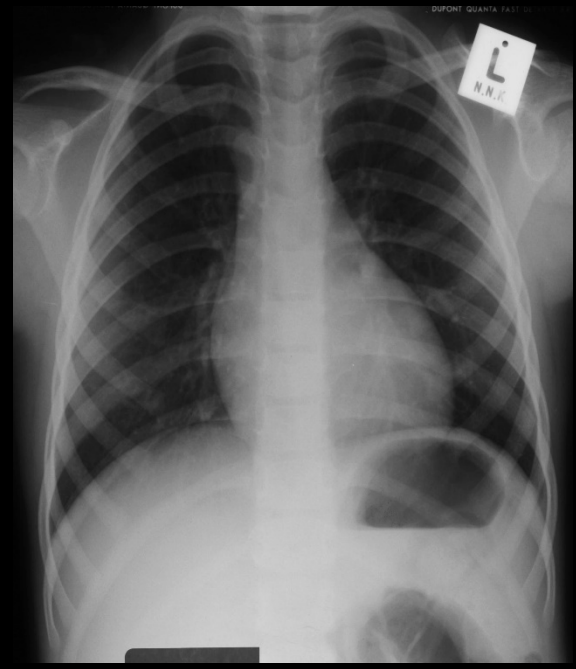
PENETRATION



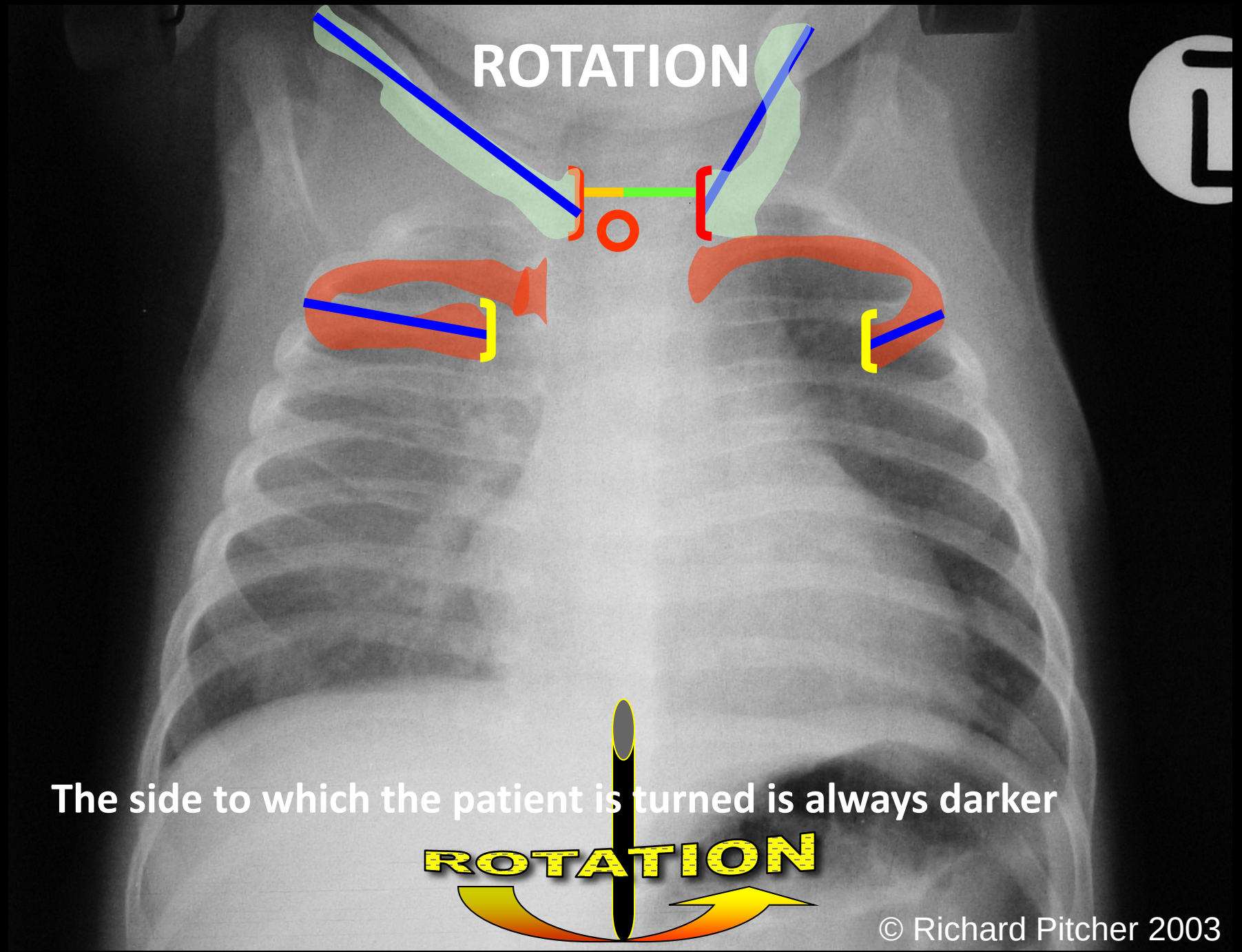
Under penetration



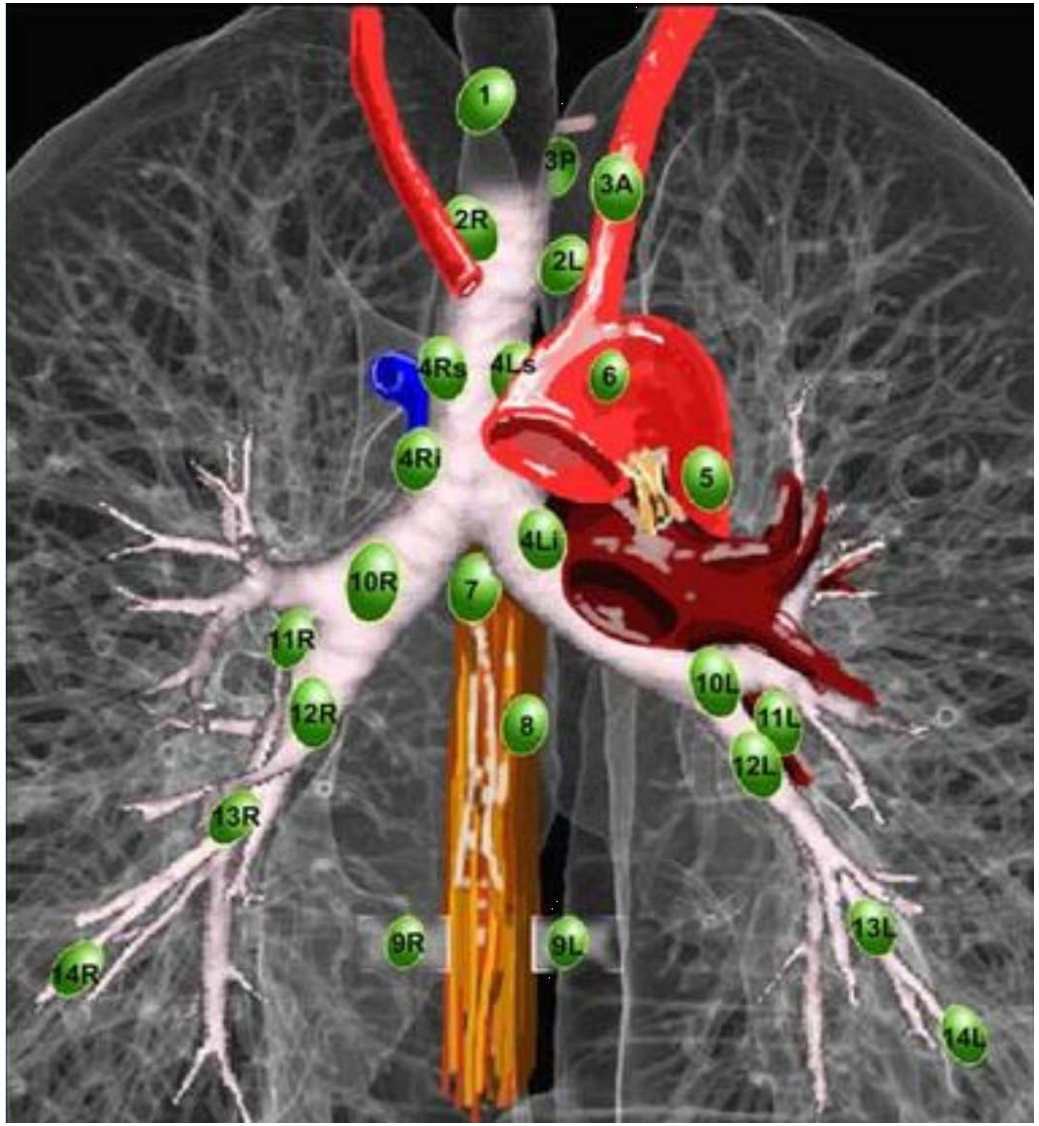
Over penetration



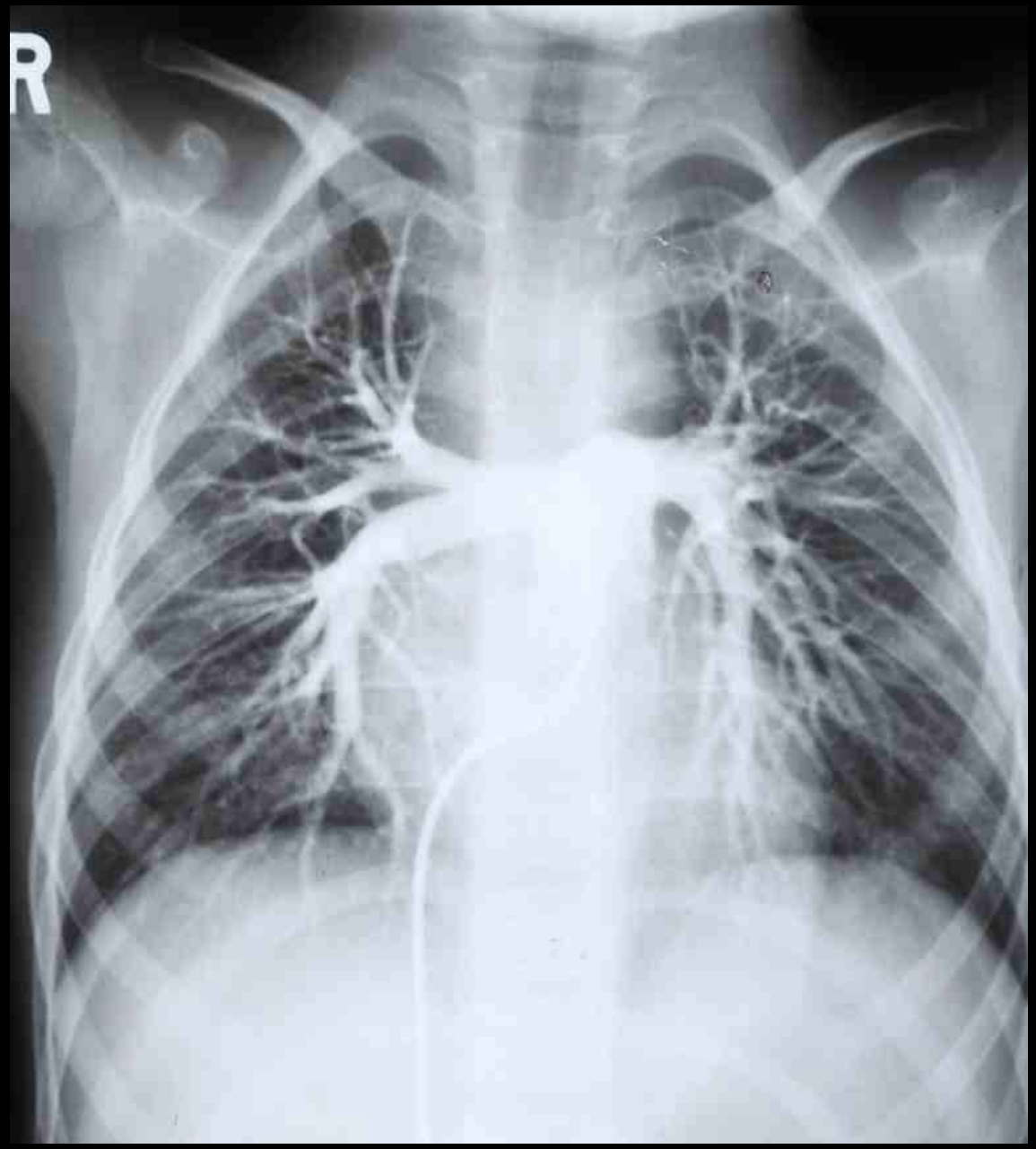
Normal/Good



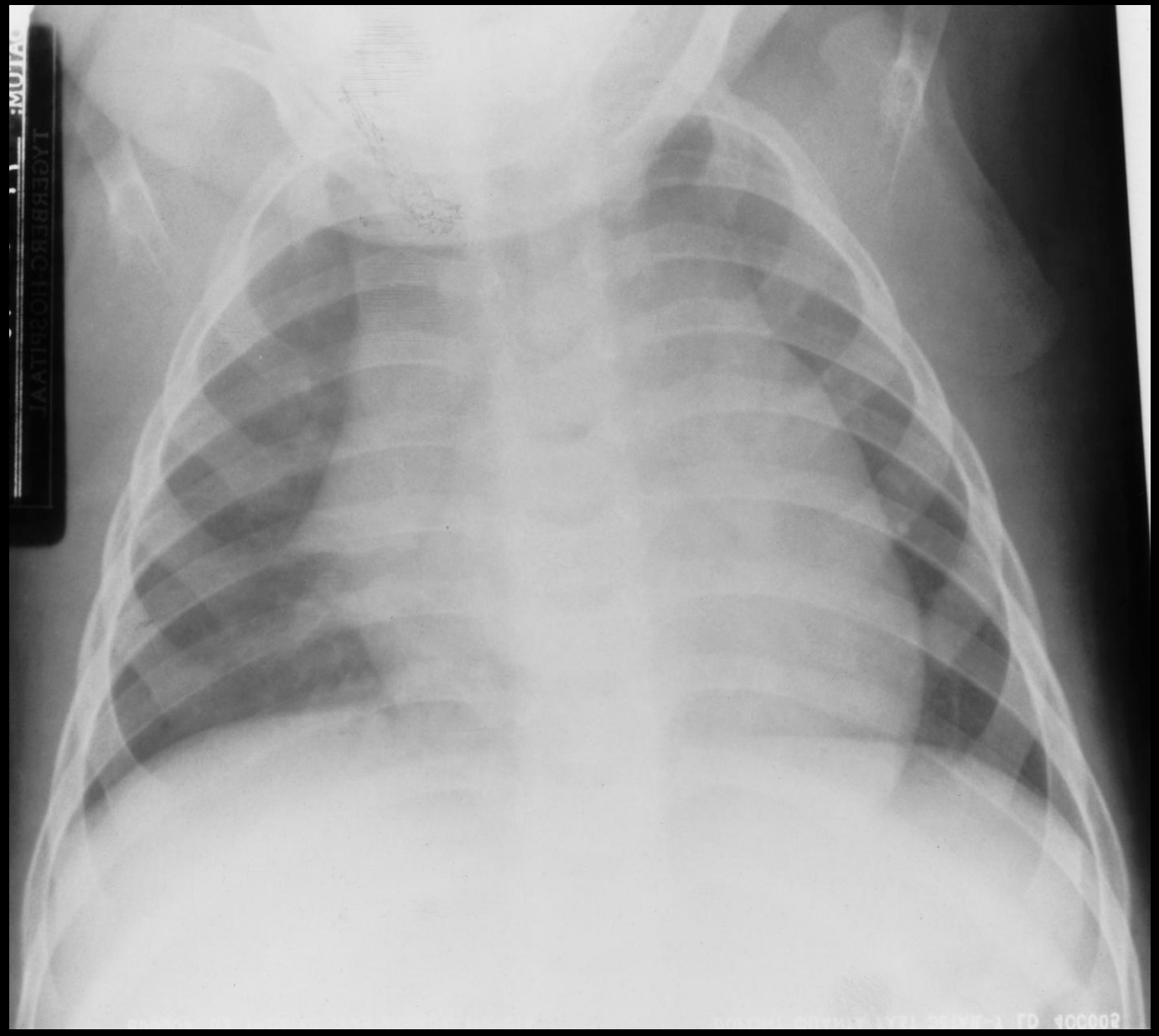
2. Differentiating pulmonary vessels from mediastinal lymph node enlargement

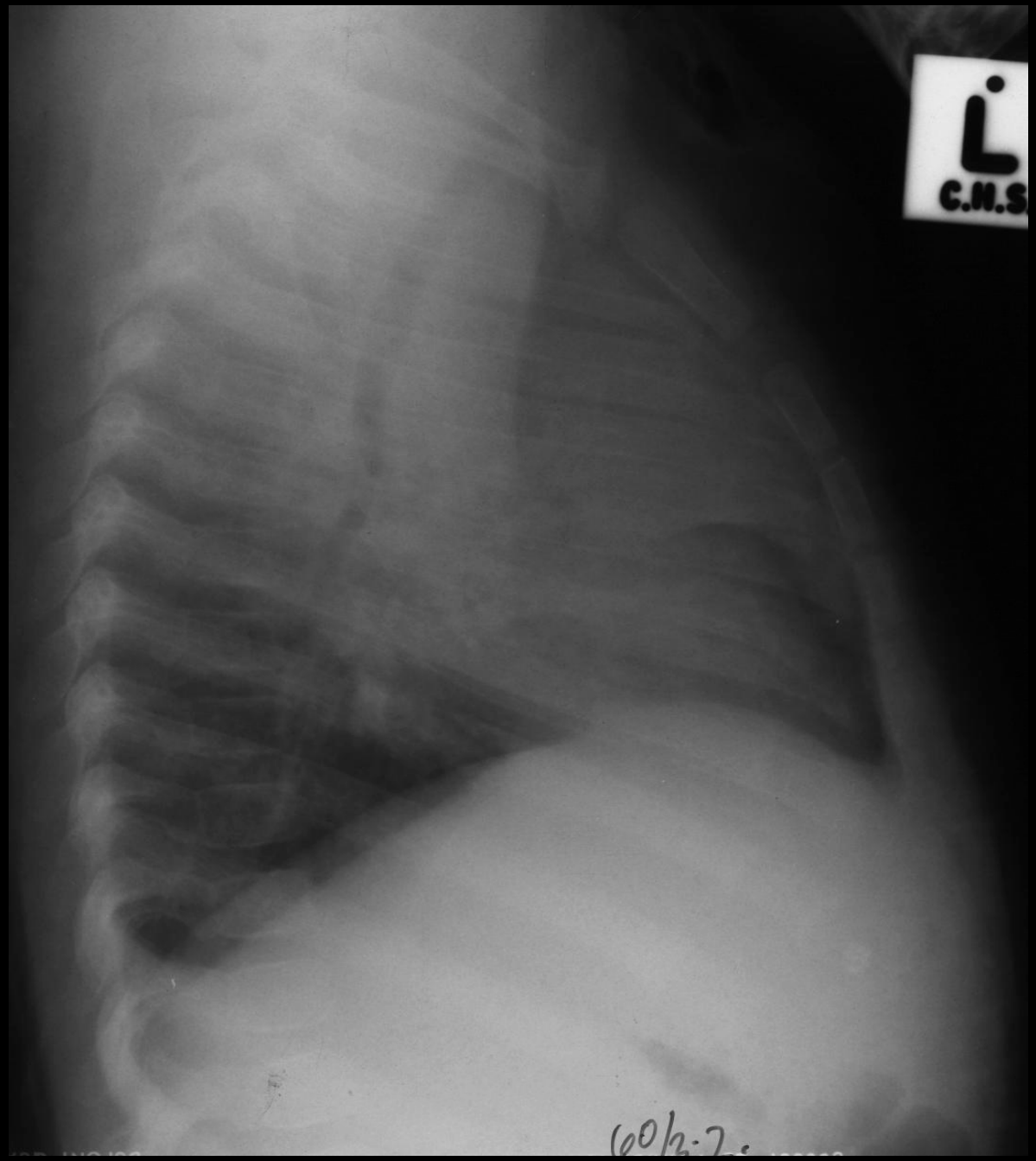


Cardiac Catheterization



3. Thymus.

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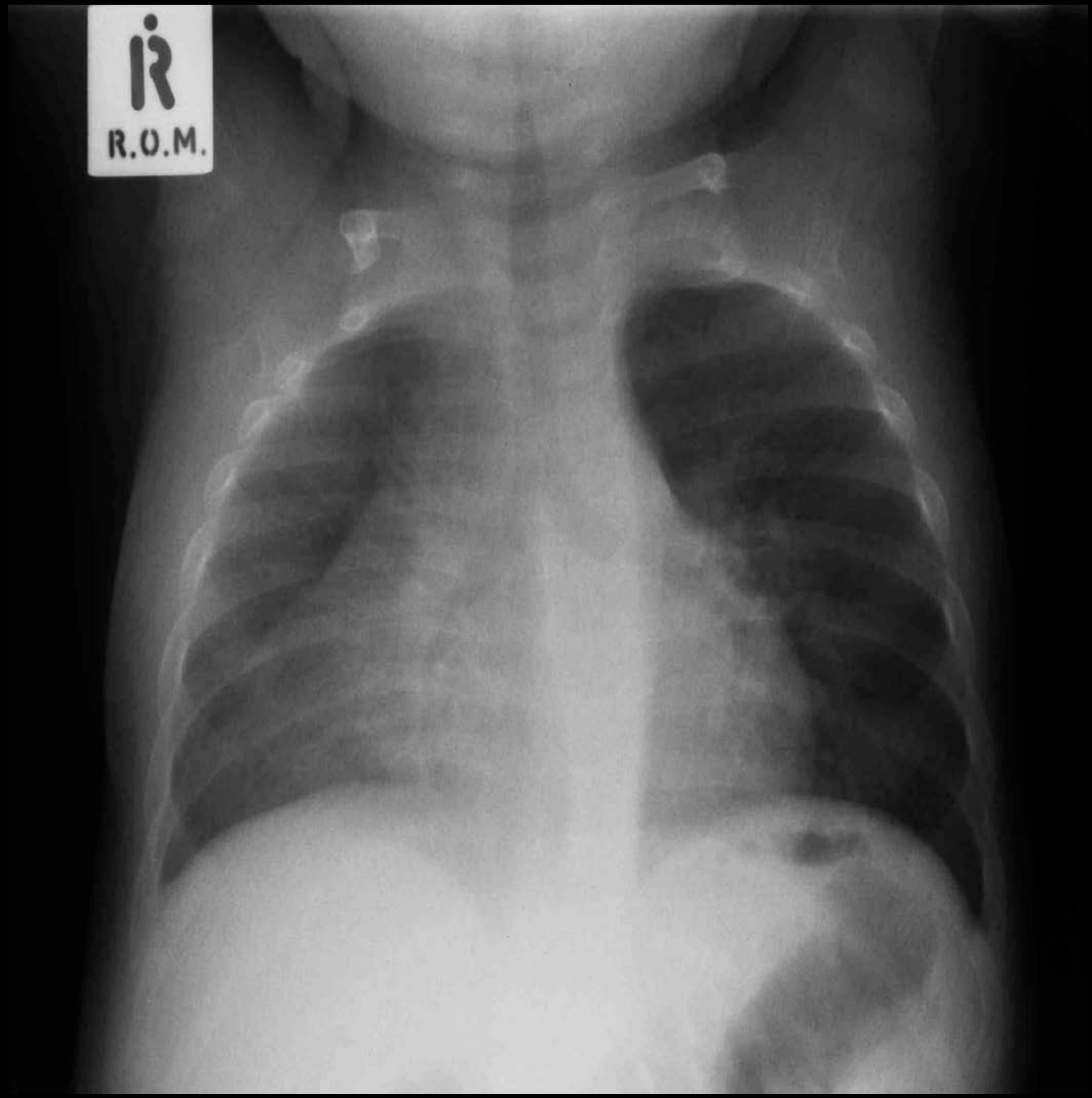
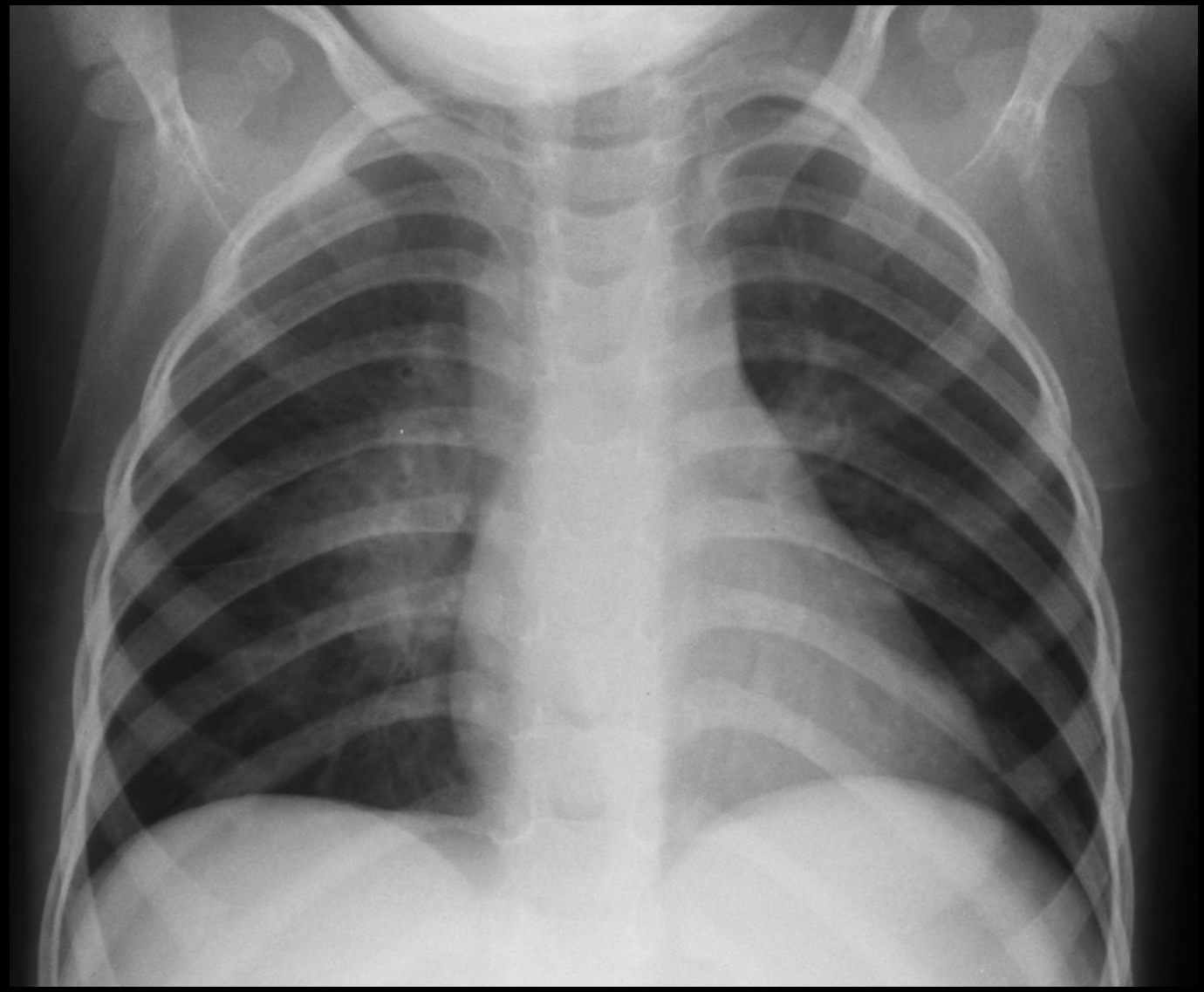
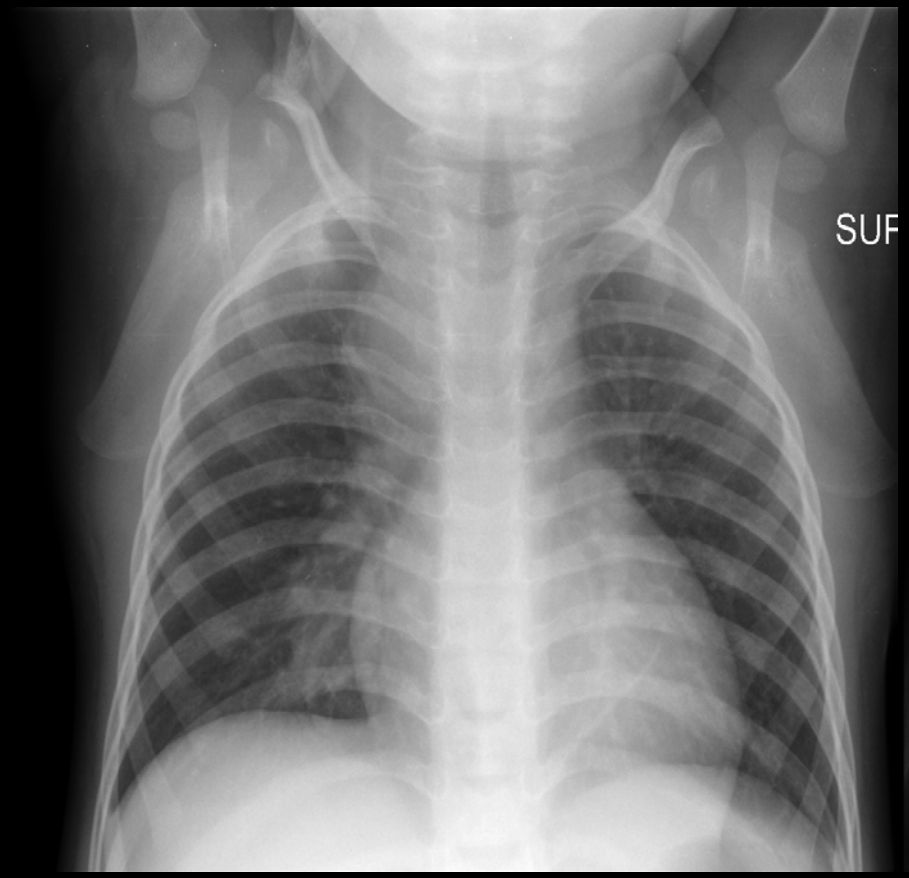
C.N.S


R
R.O.M.

4. Radiological images of enlarged TB lymph nodes

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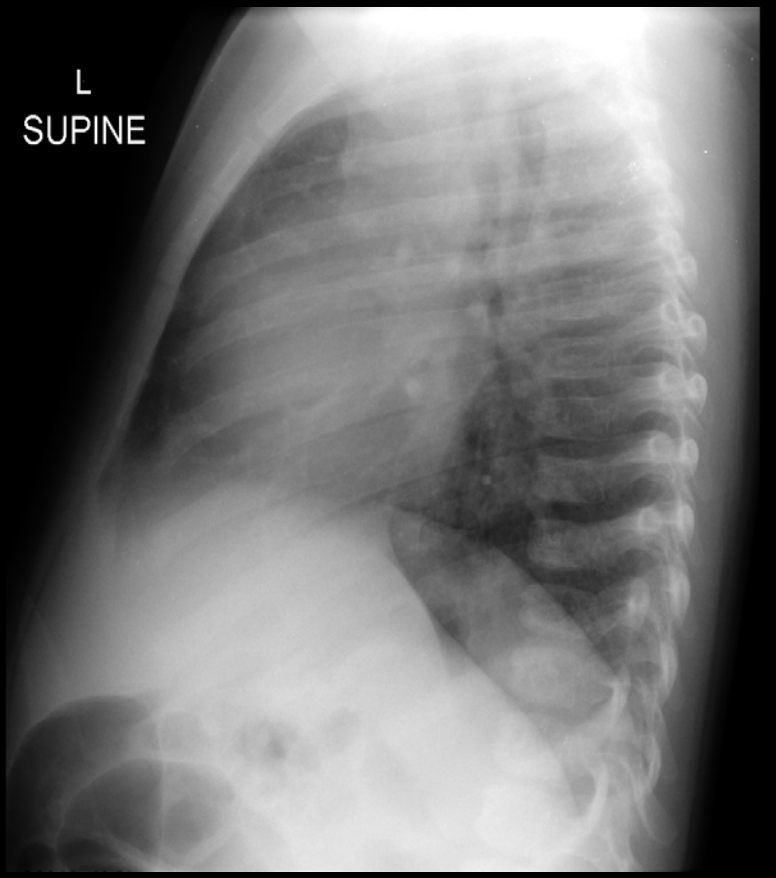
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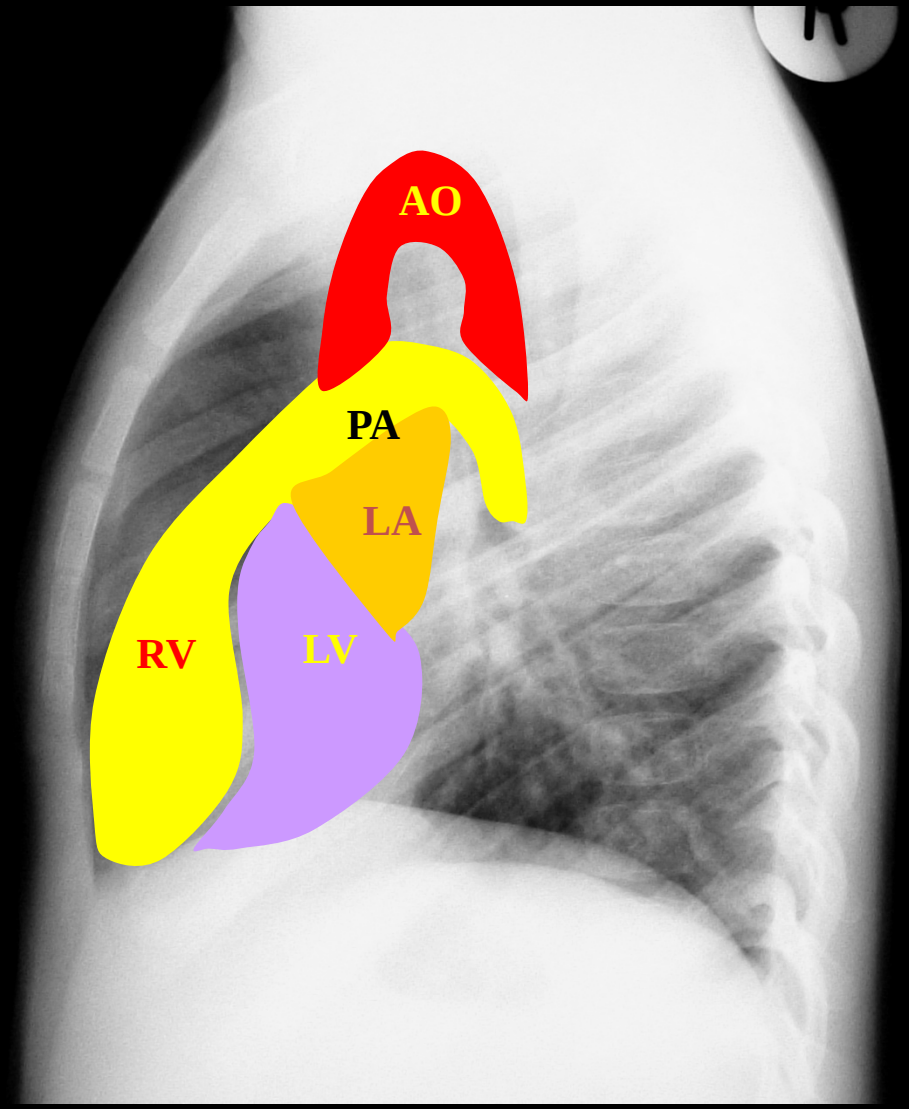
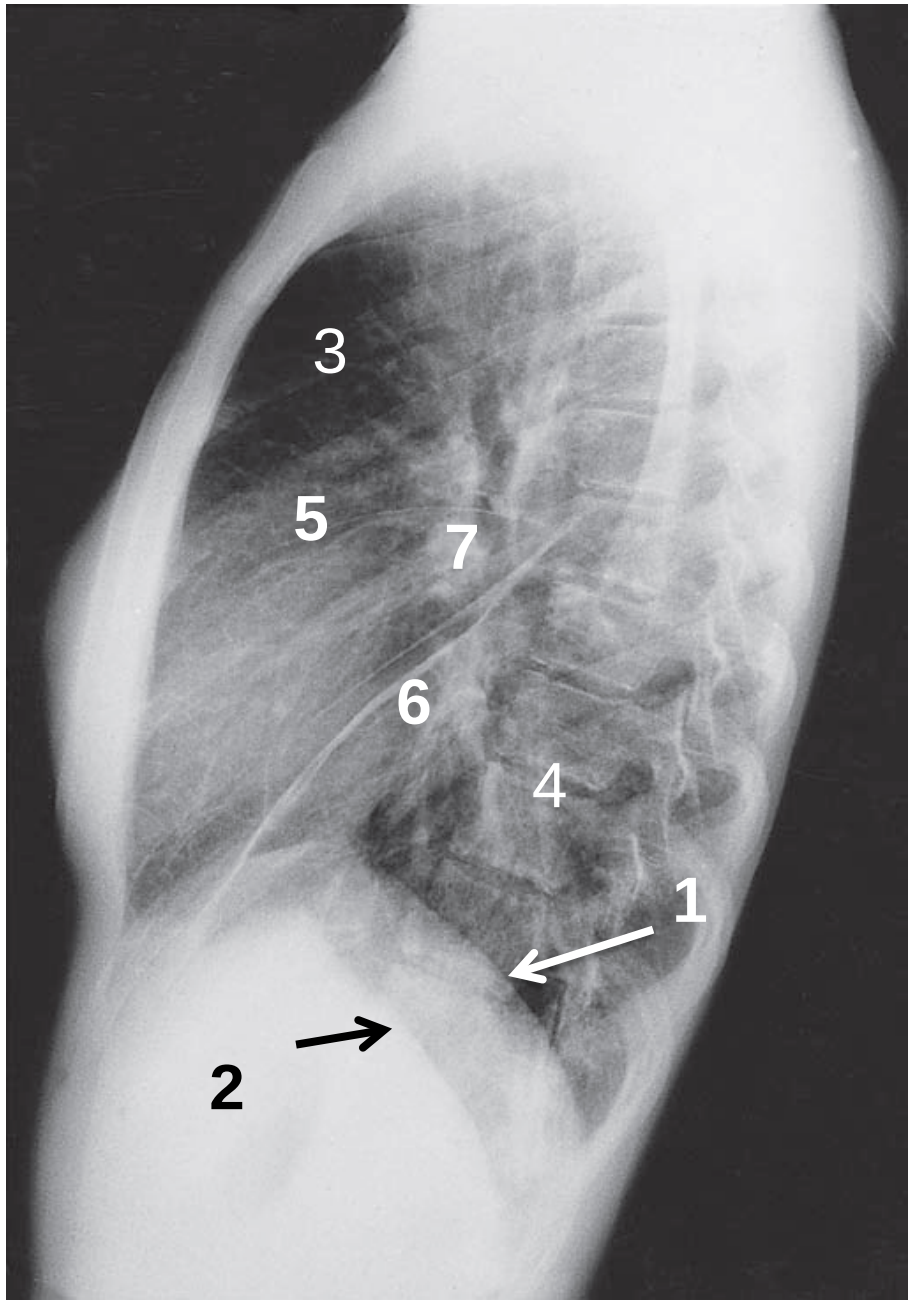
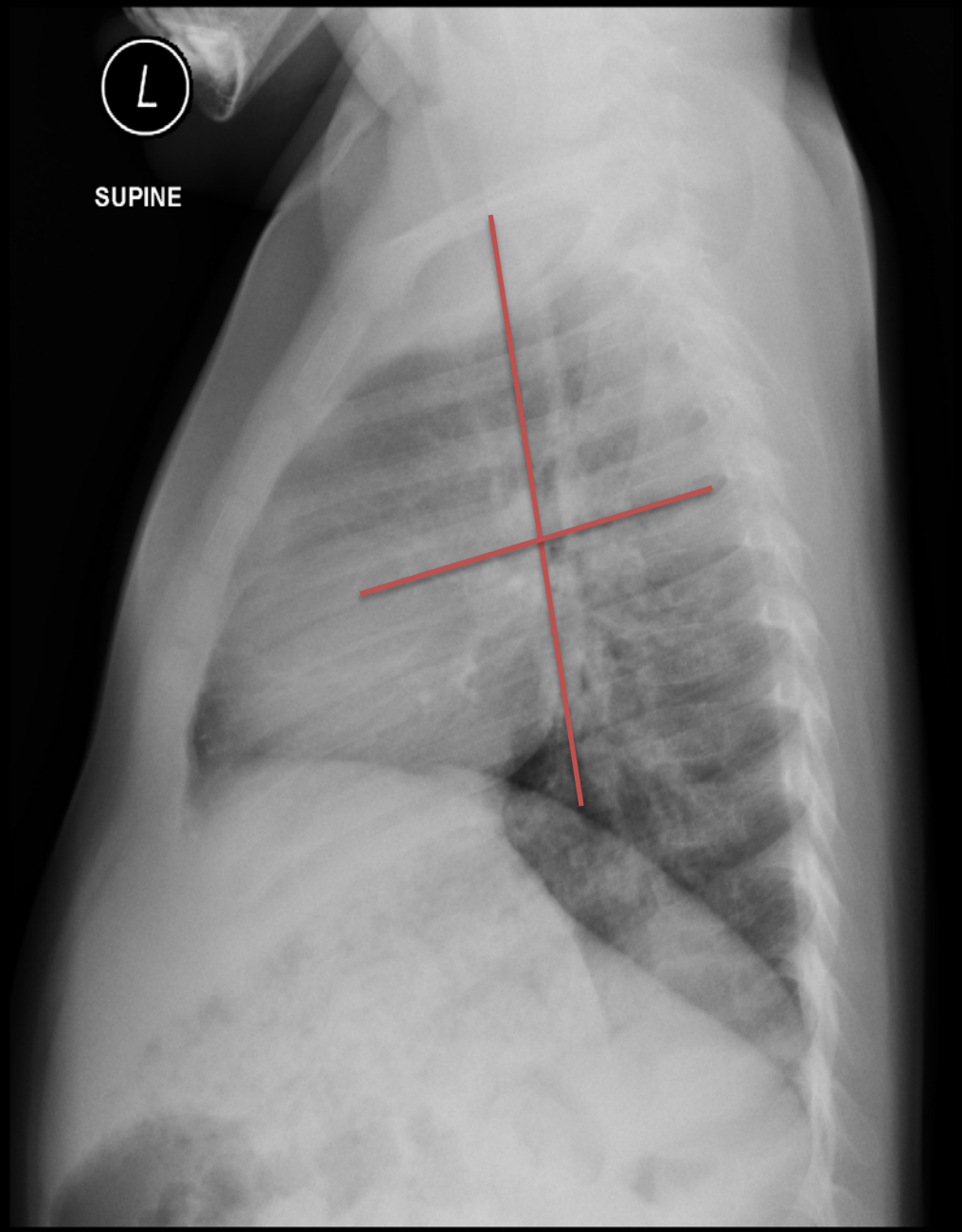
Challenges - Lateral CXR





Lateral CXR

1. Right hemidiaphragm
2. Left hemidiaphragm
3&4. Compare the appearance of the lung fields in front of and above the heart to those behind the heart - they should be of equal density (area 3 – thymus can obscure this)
5. Horizontal fissure
6. Oblique fissures
7. Hilar area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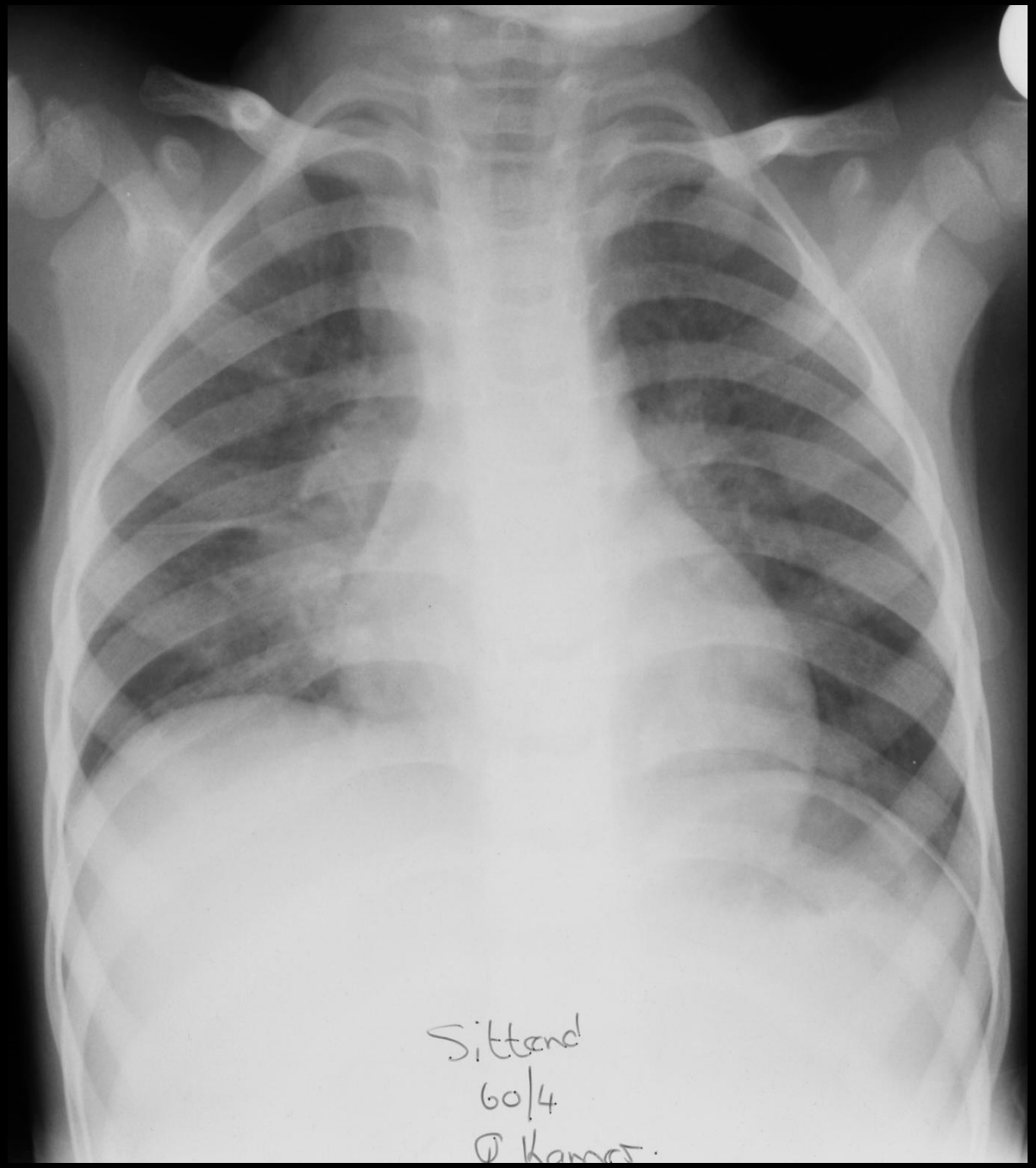
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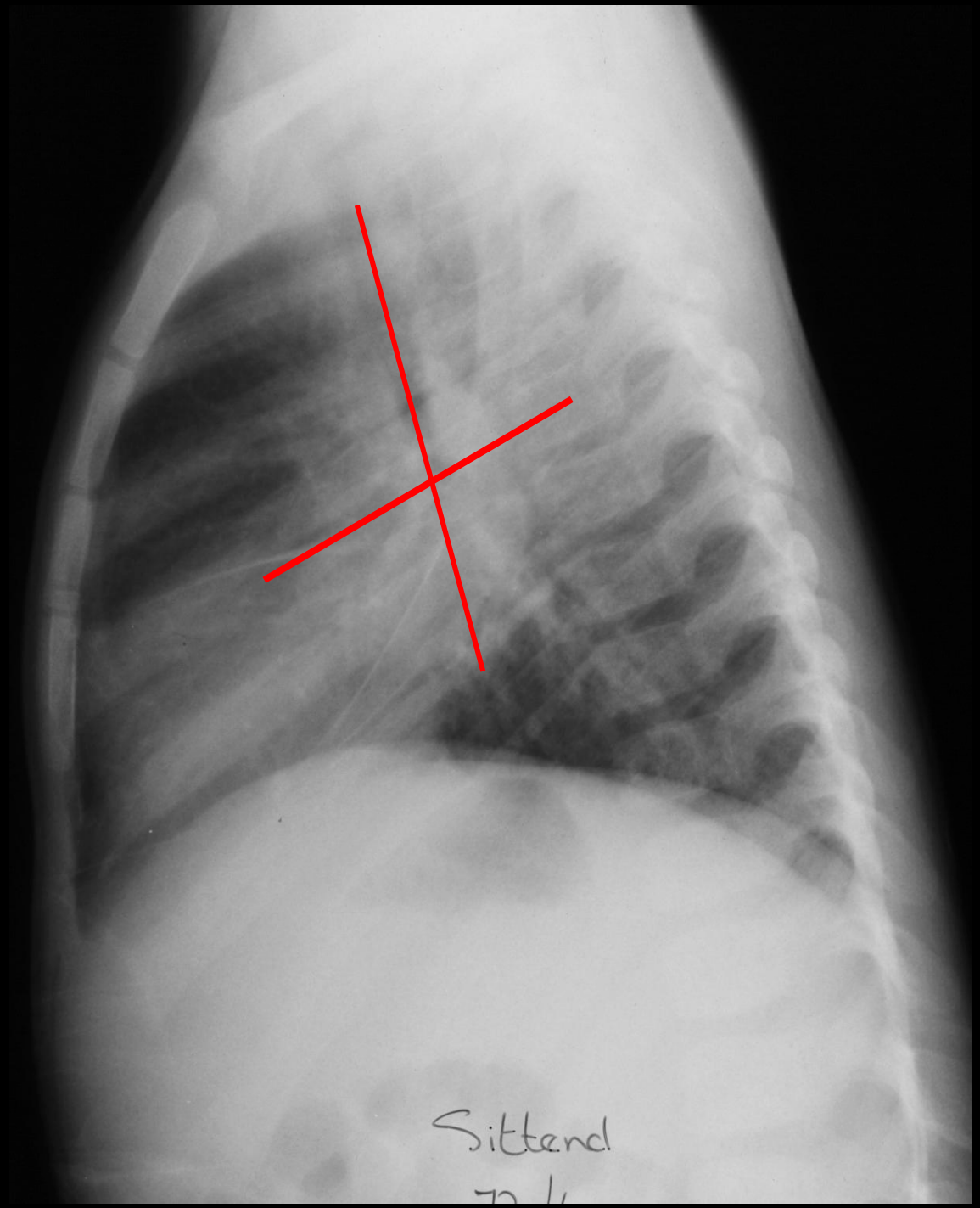
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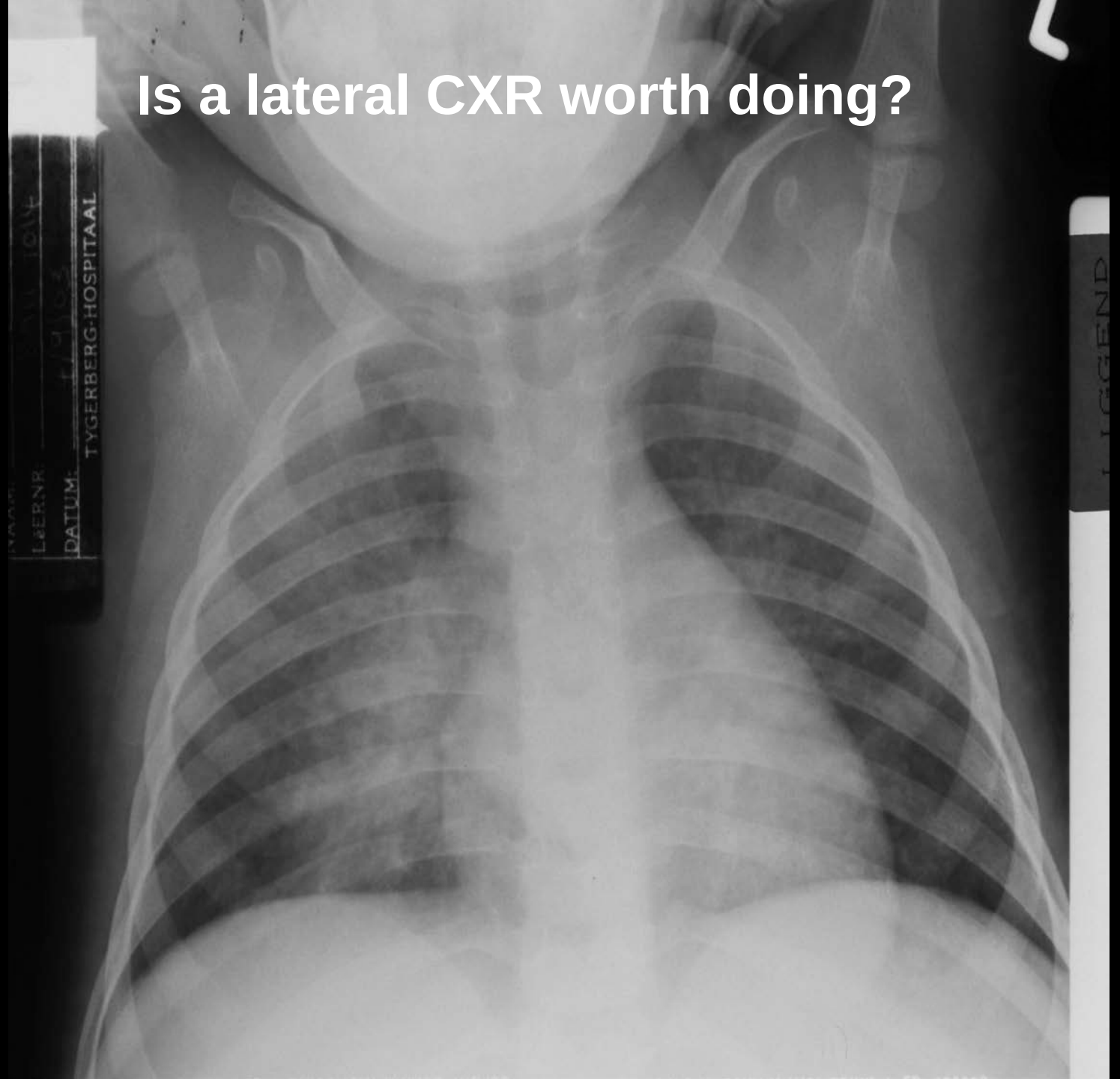
Is a lateral CXR worth doing?



DATUM

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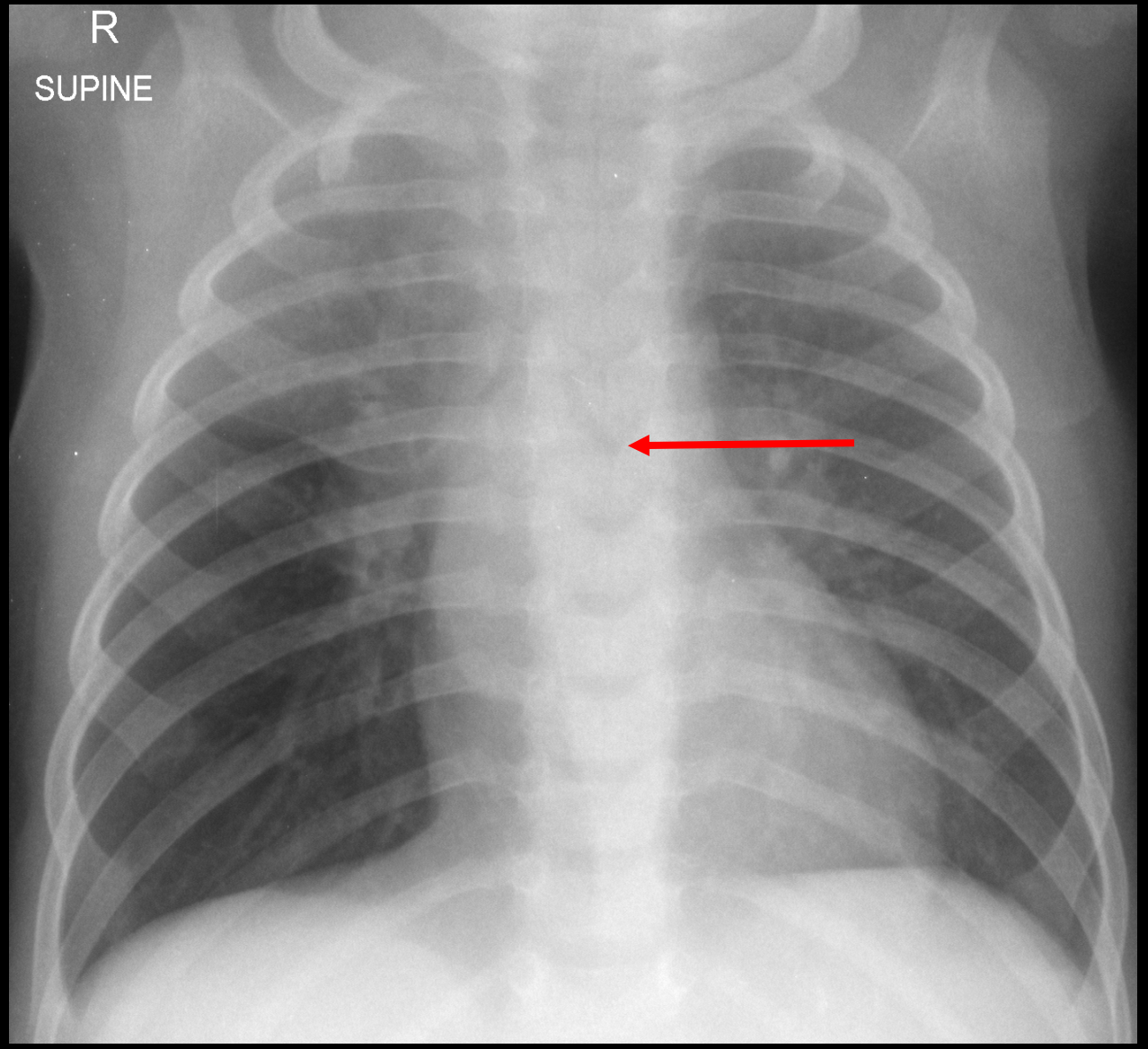
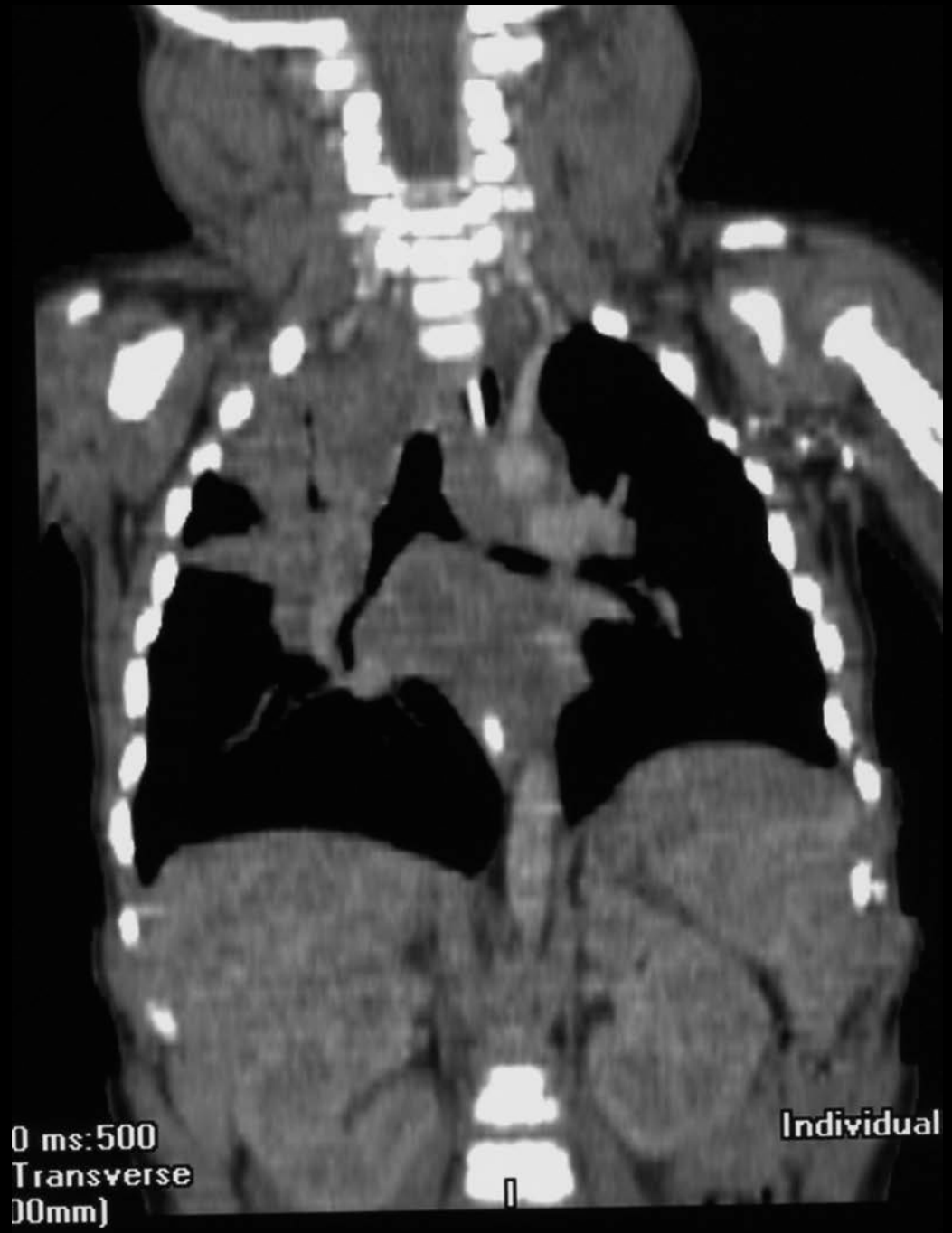
DUPONT QUANTA FAST DETAIL-7 LO 40005

Lymph node compression of the large airways

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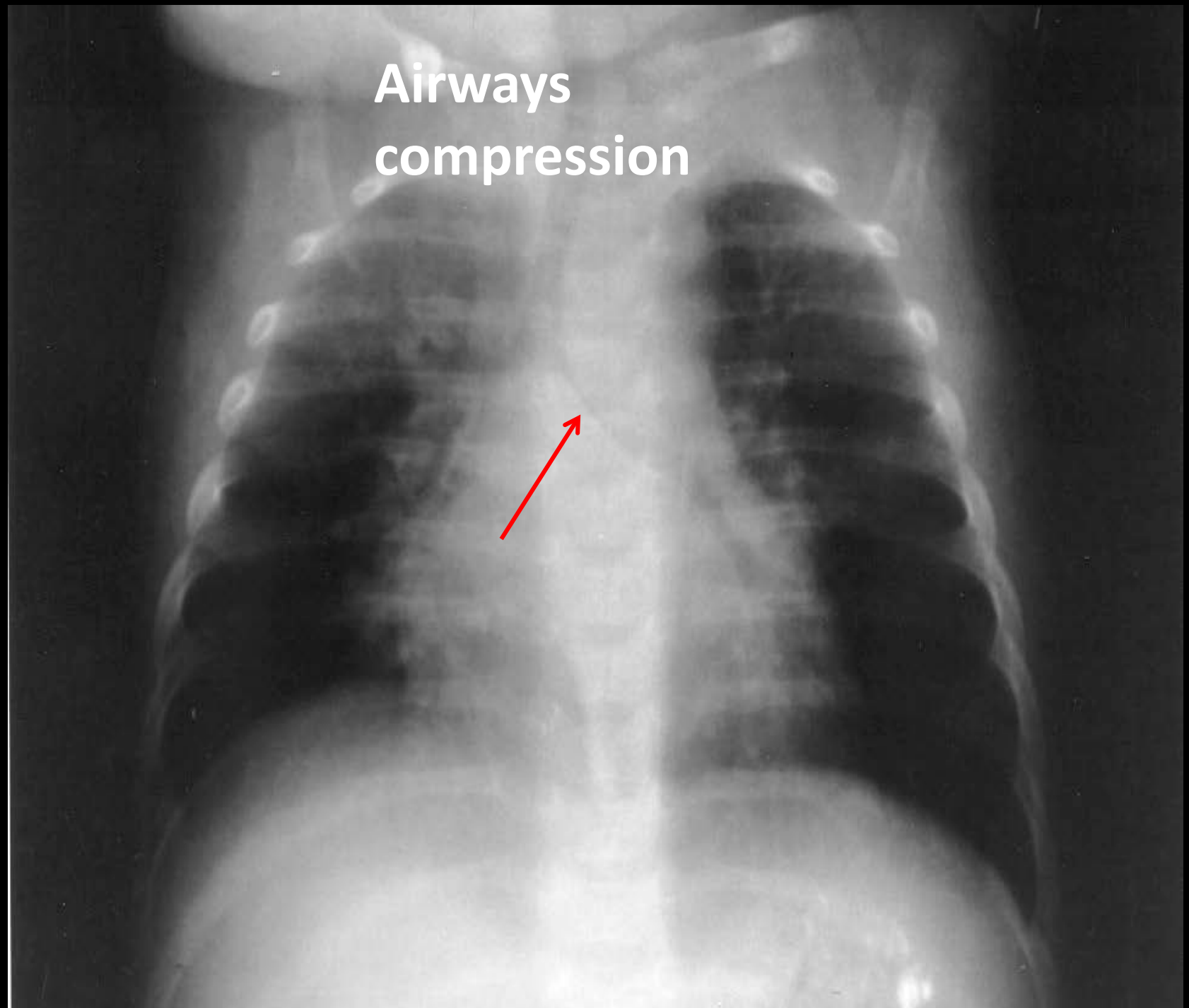
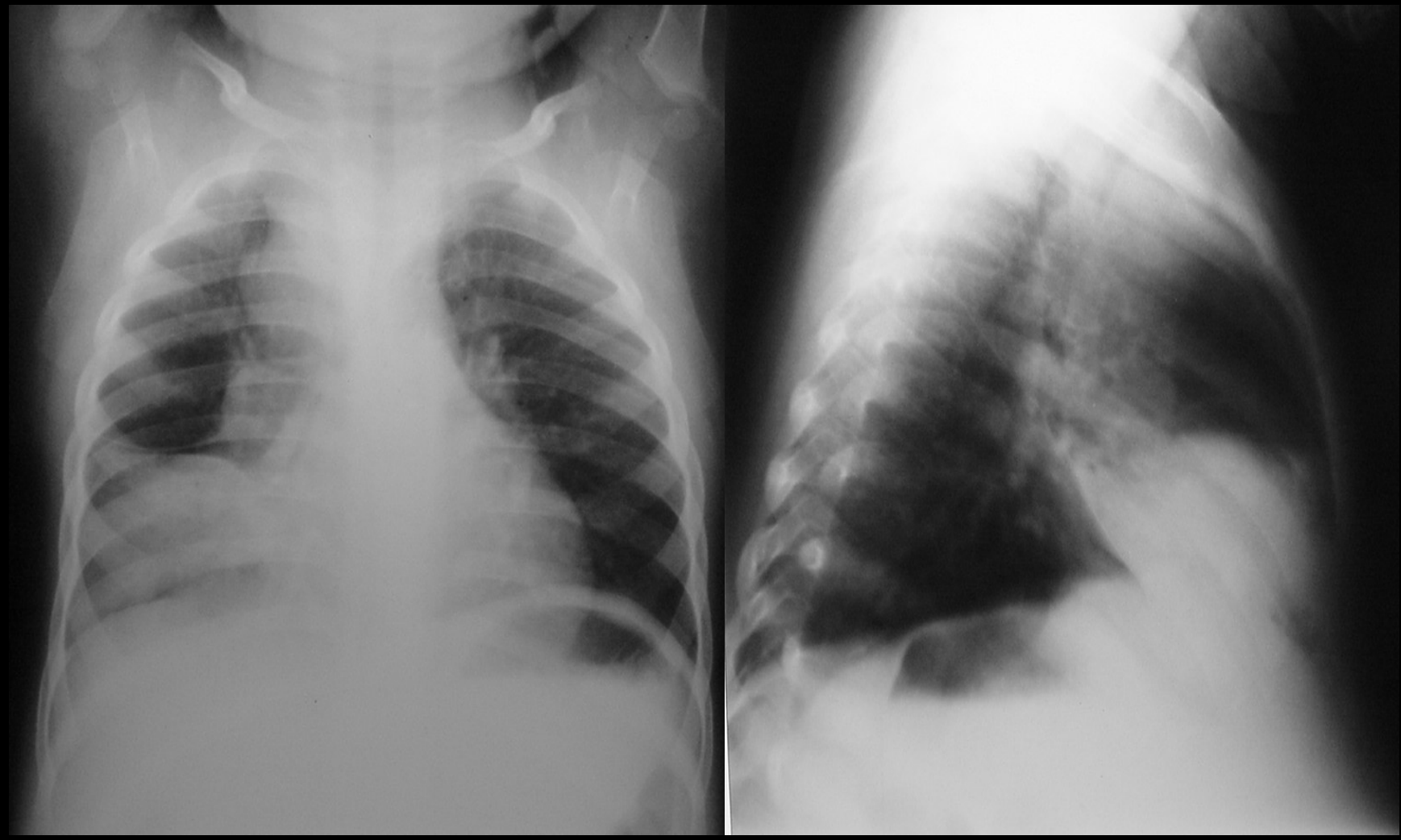
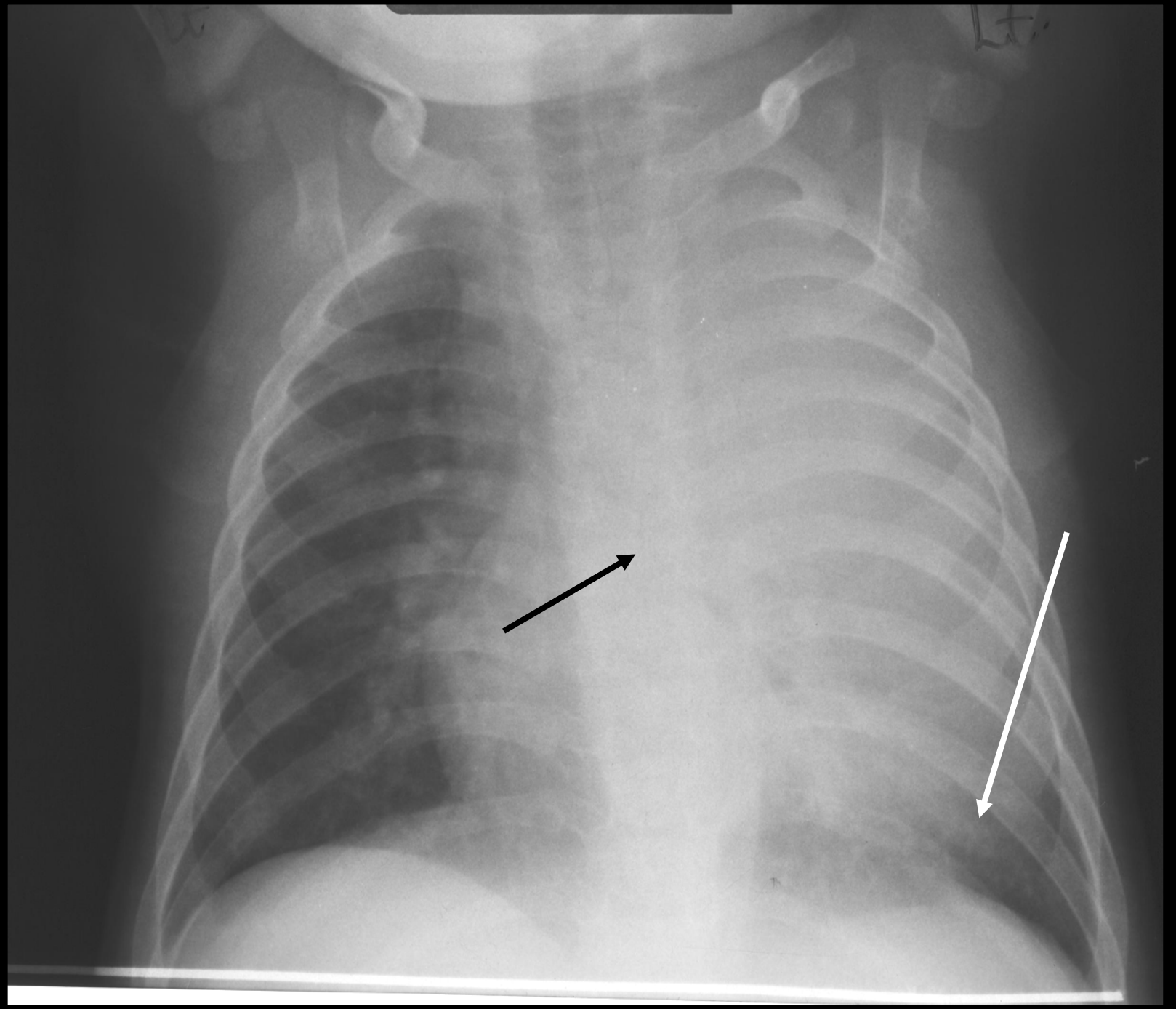
Individual

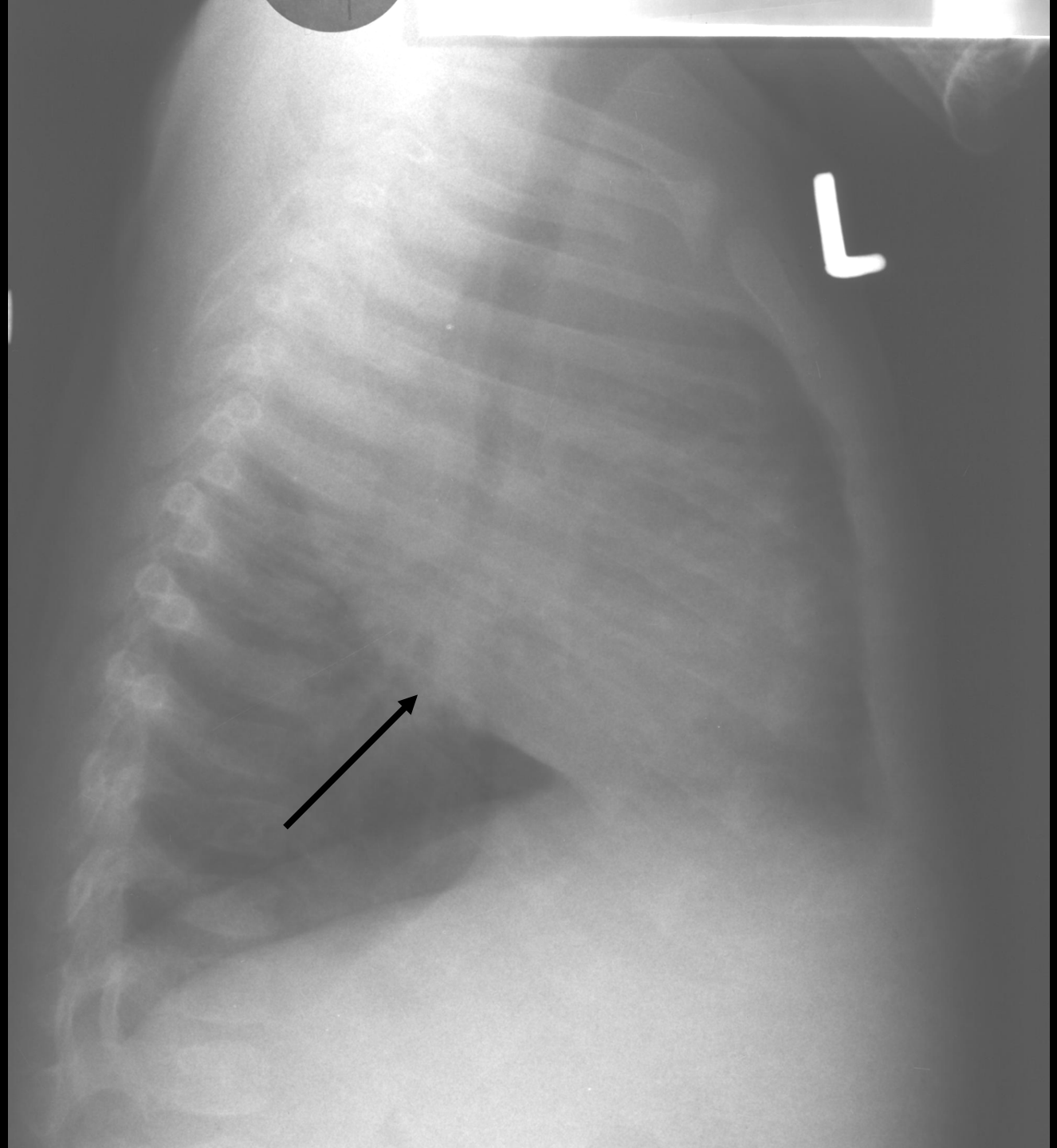

Airways
compression

Other common childhood TB images.

- In previous contact studies mediastinal lymph node enlargement was found in about 70-80% of the cases with probable pulmonary TB



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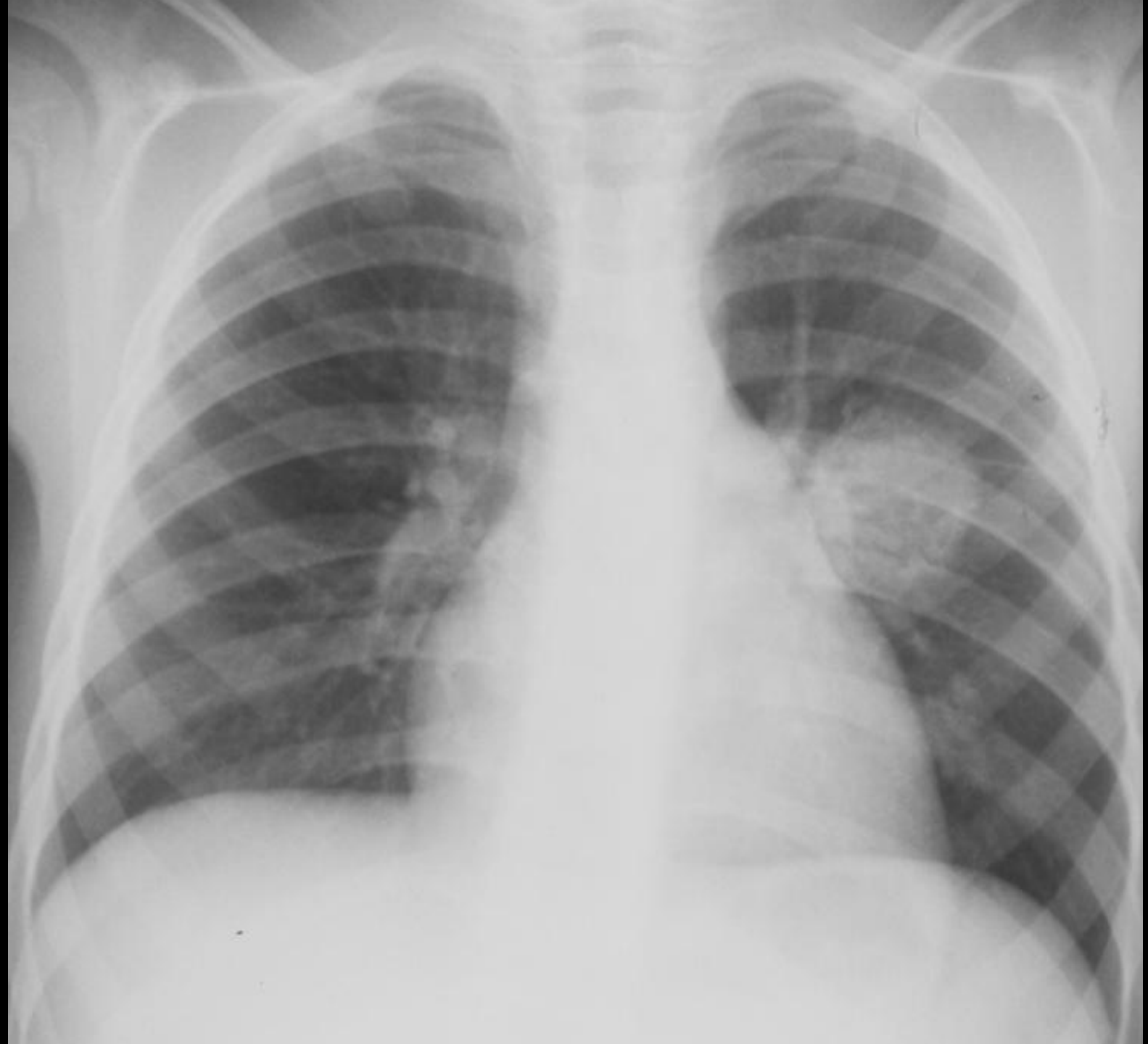
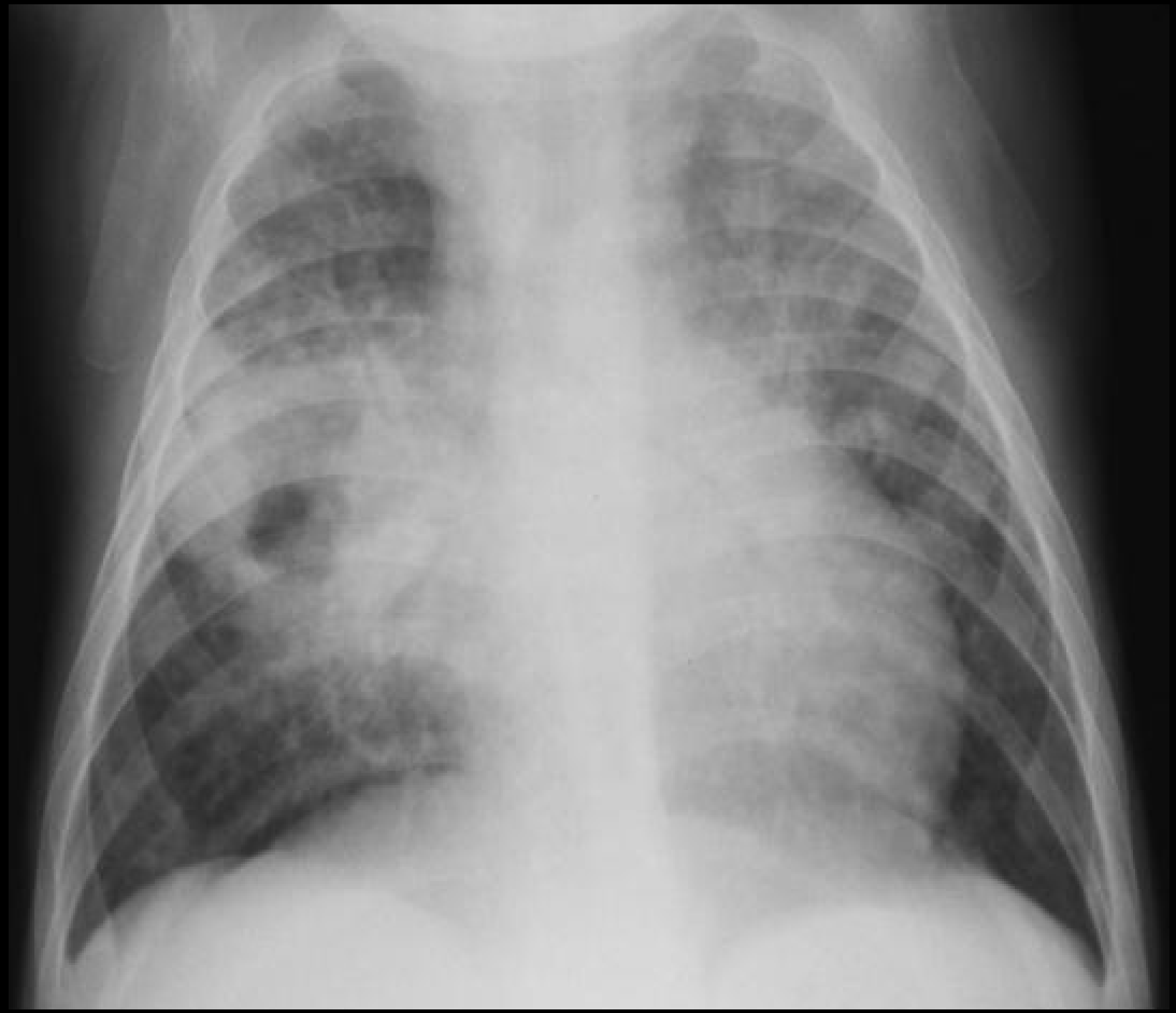
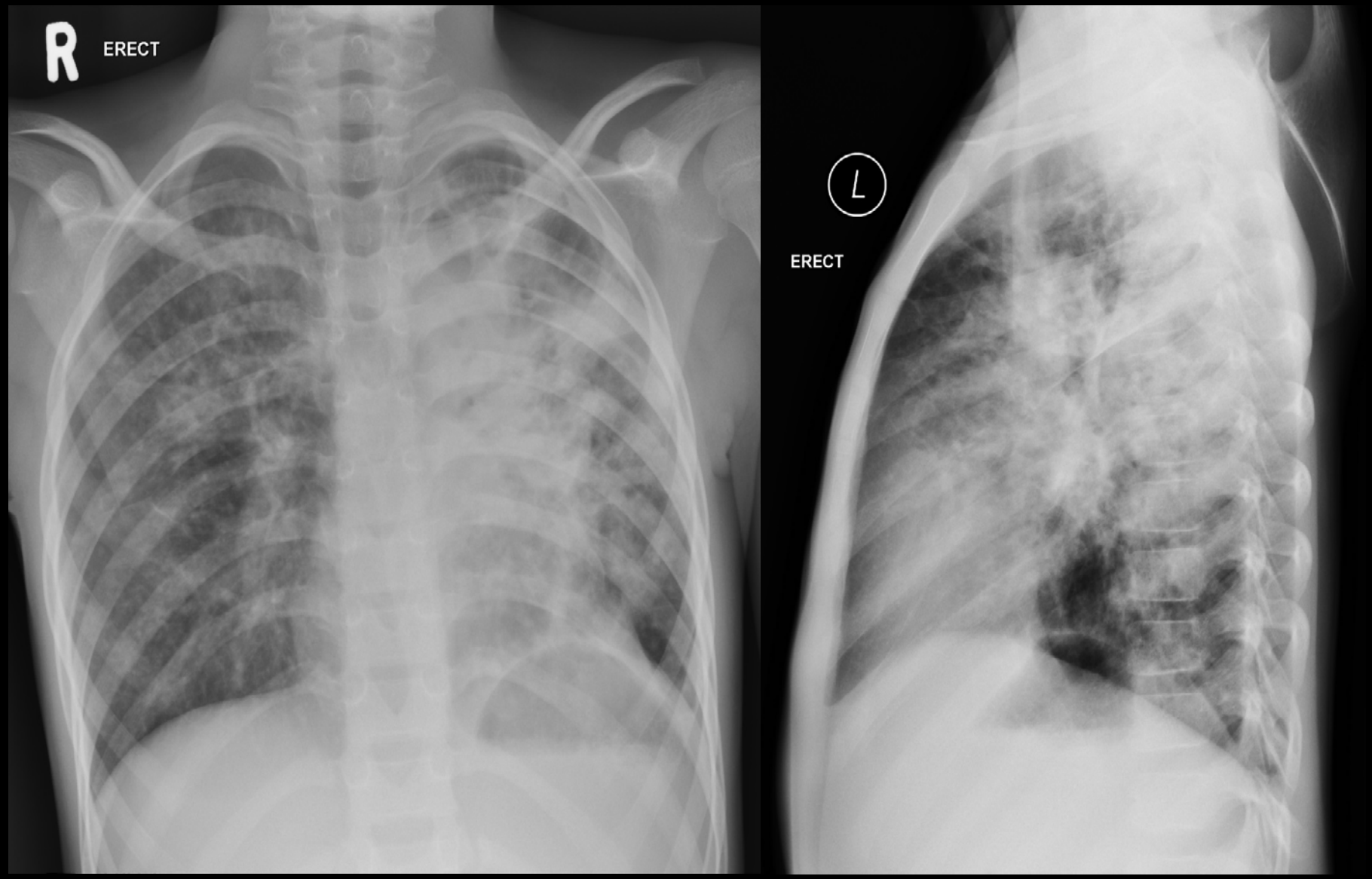
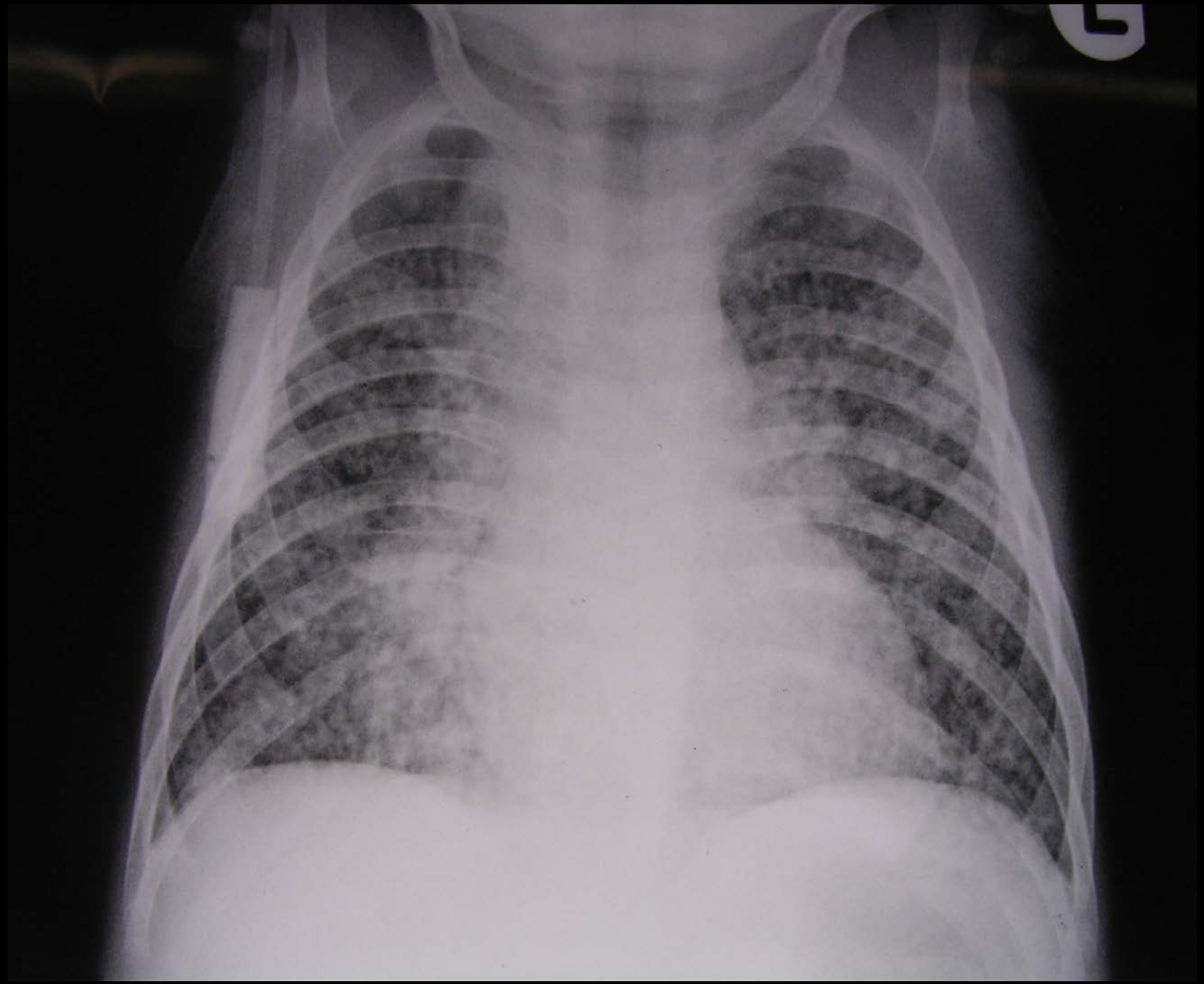
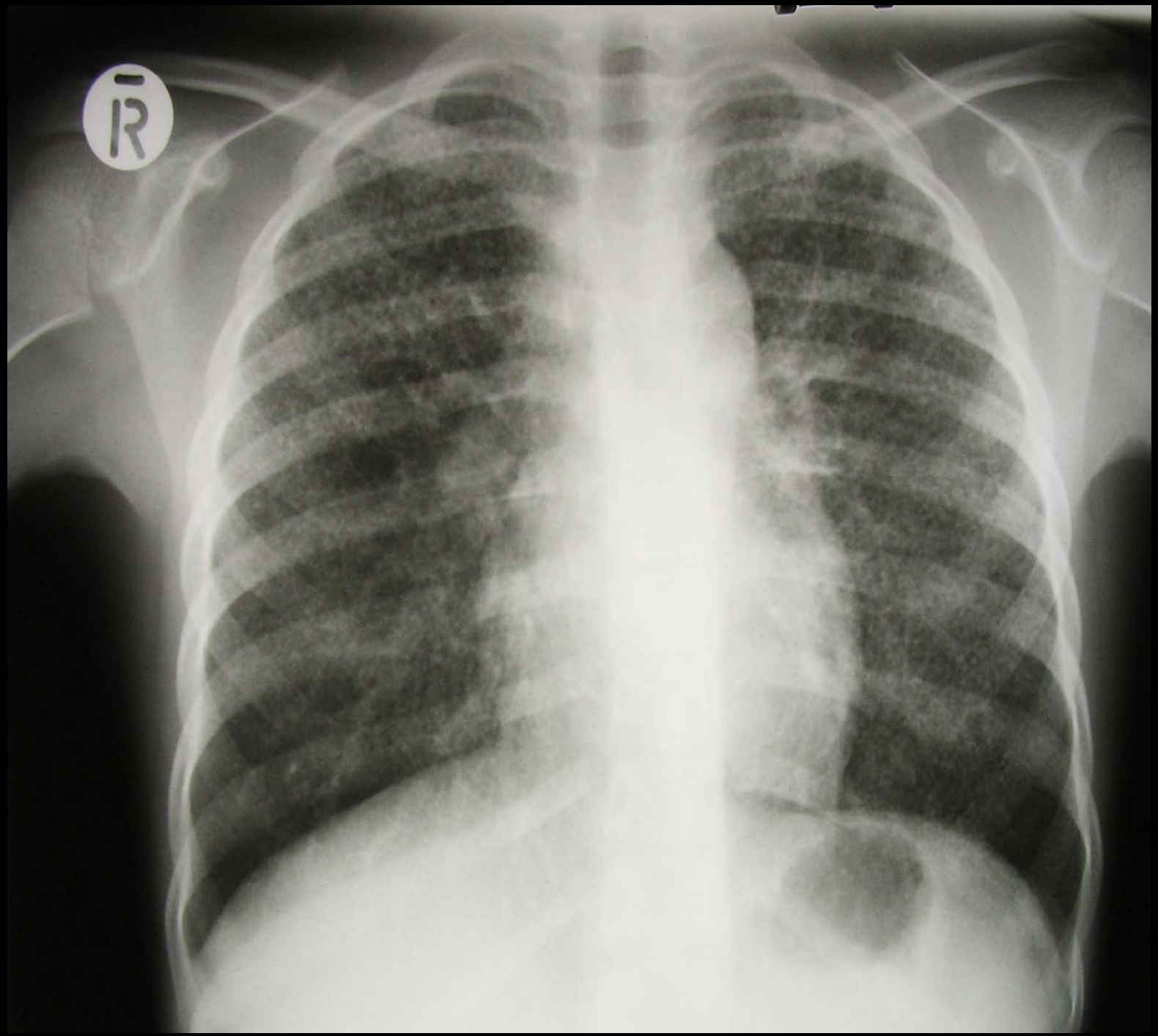






Adult type cavitary TB in 7-year-old girl with haemoptysis

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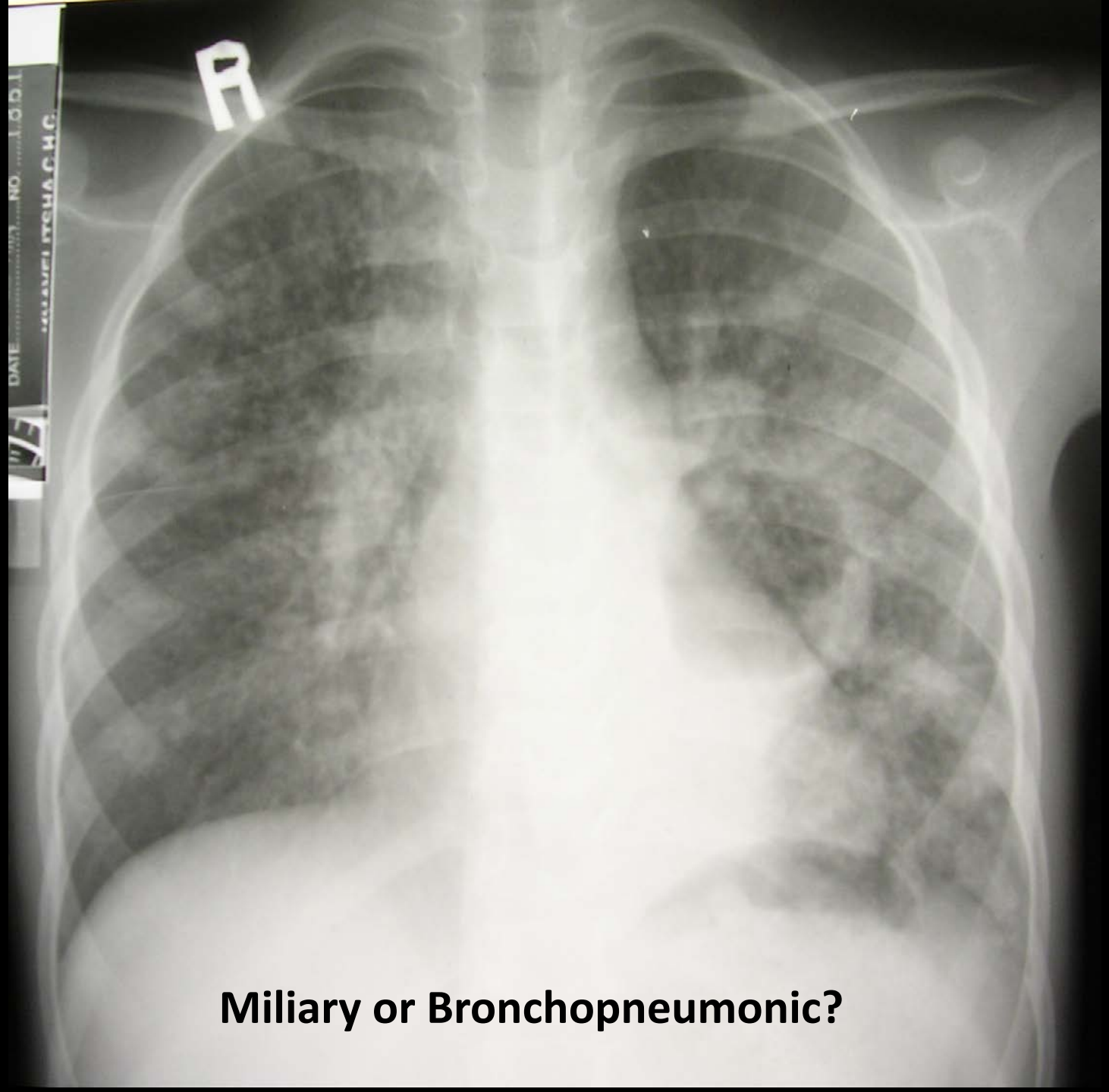
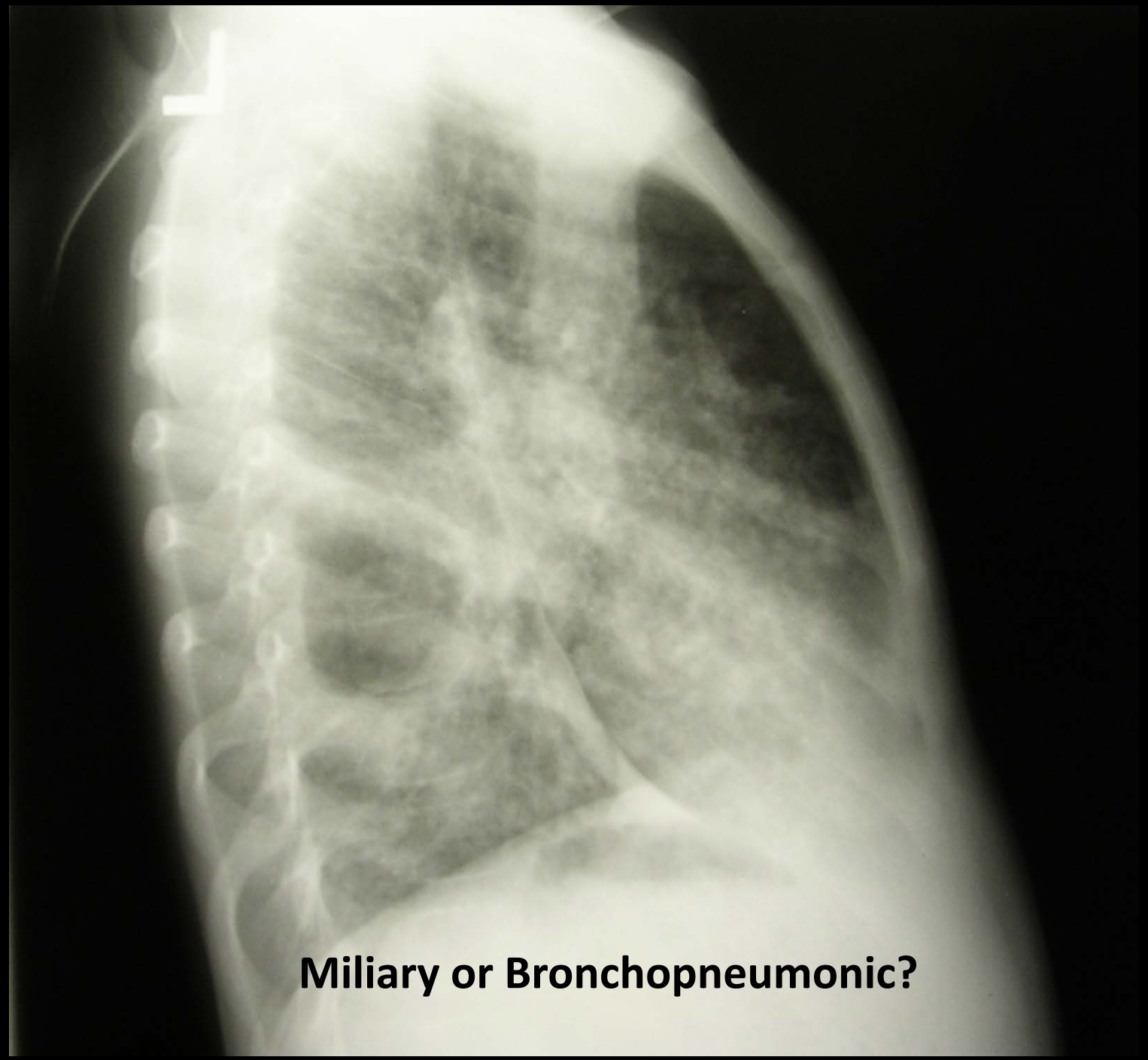
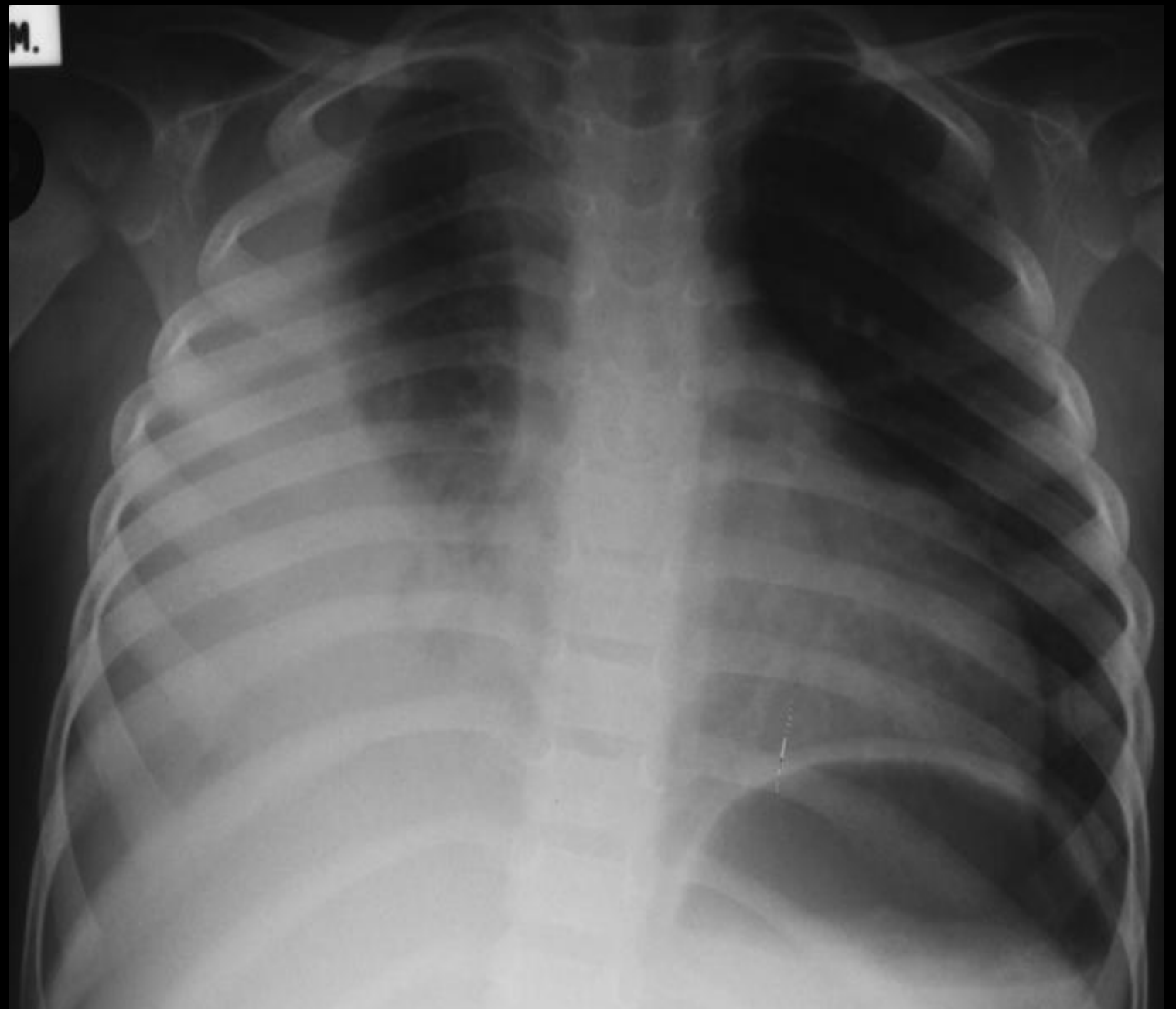


Miliary or Bronchopneumonic?


Miliary or Bronchopneumonic?

Pleural effusion

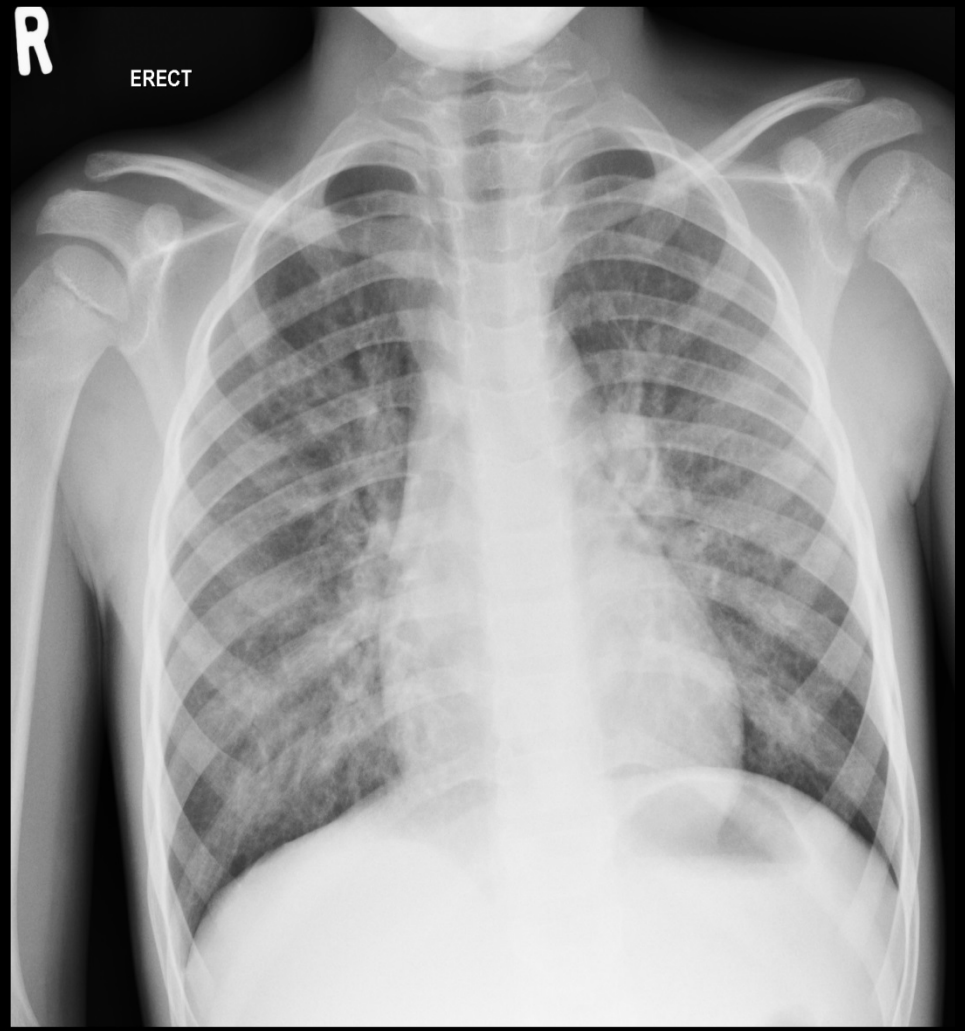


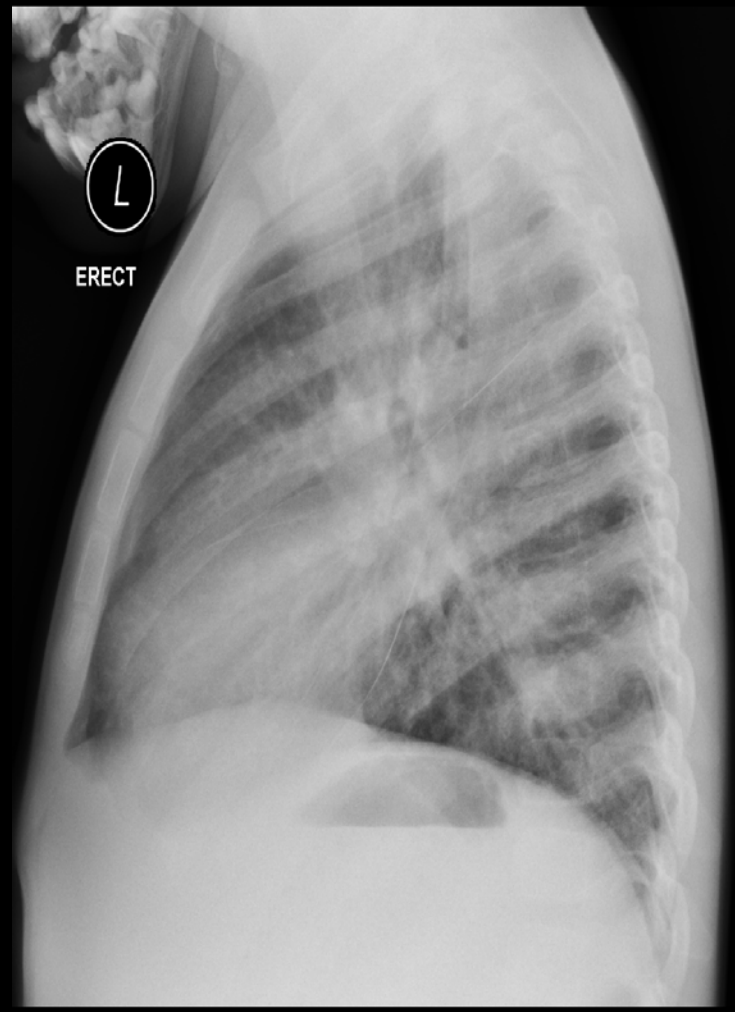
What about CXRs that are atypical of TB: can it be TB?

- In approximately 20% of children with confirmed TB the CXR does is not typical of childhood TB.
  - (Megan Palmer: Union conference 2016)

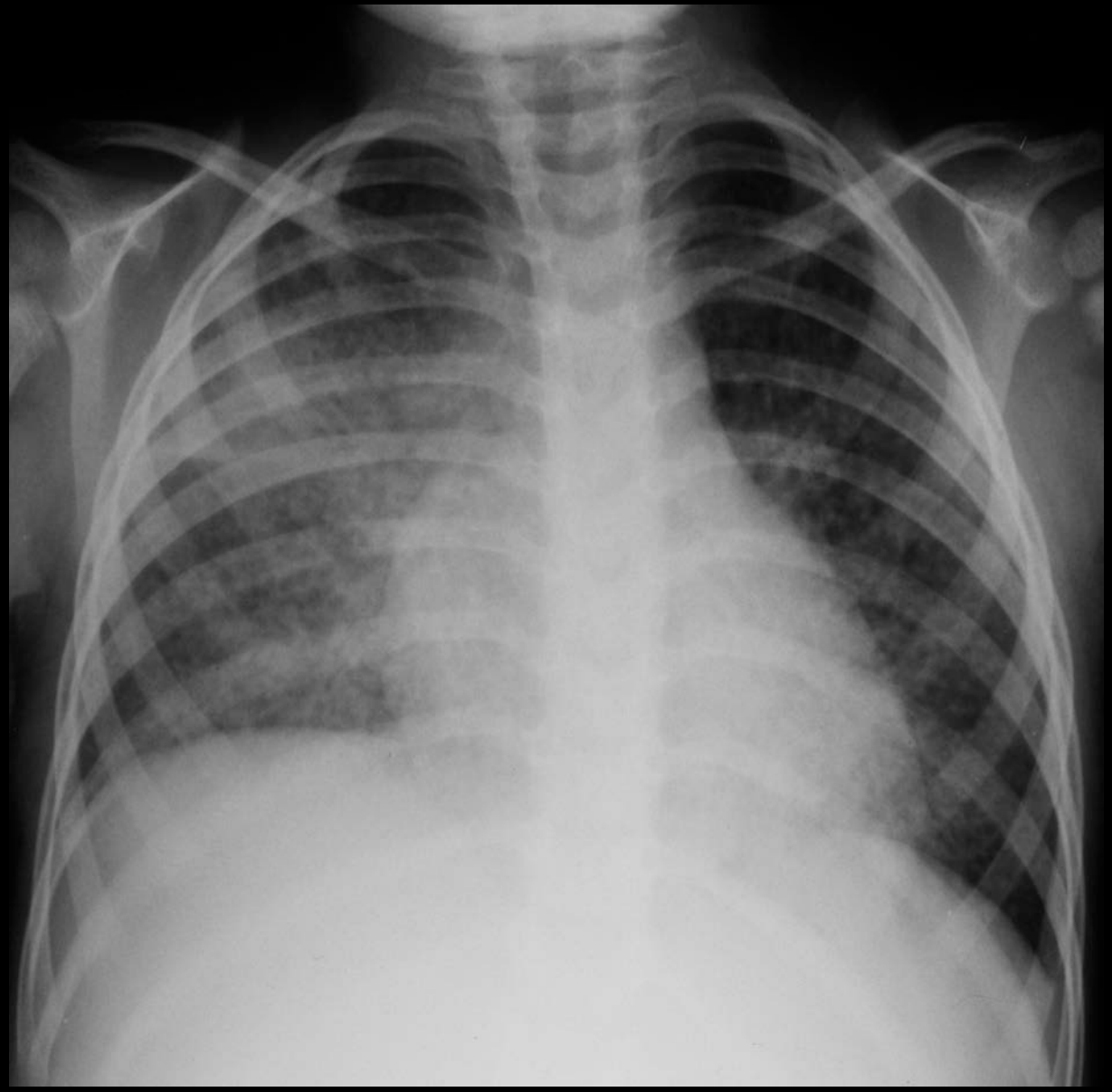
- The images include:
  - Perihilar infiltrates
  - Interstitial pneumonia
  - Bronchopneumonia
  - Segmental confluent opacification

Interstitial pneumonia

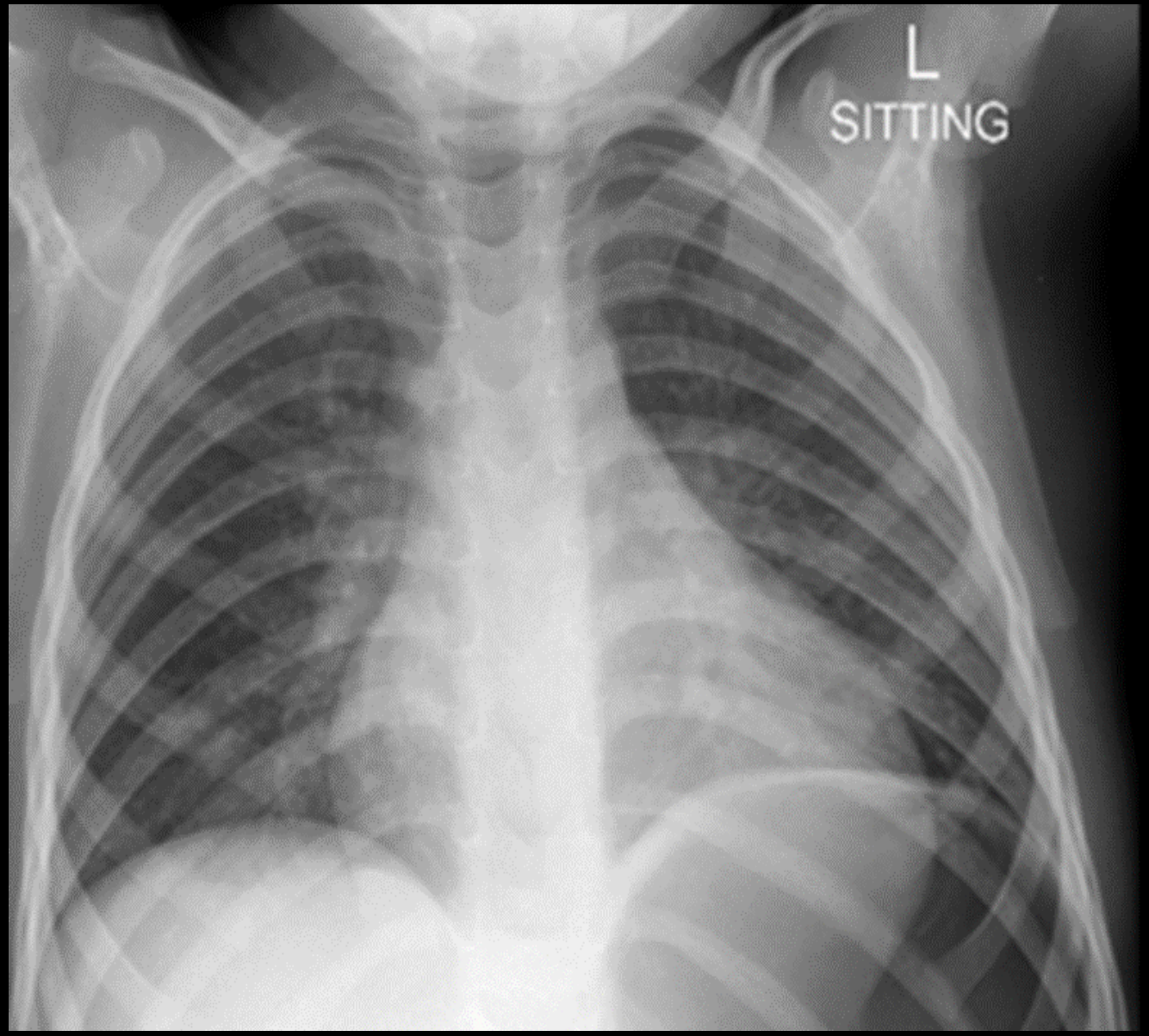




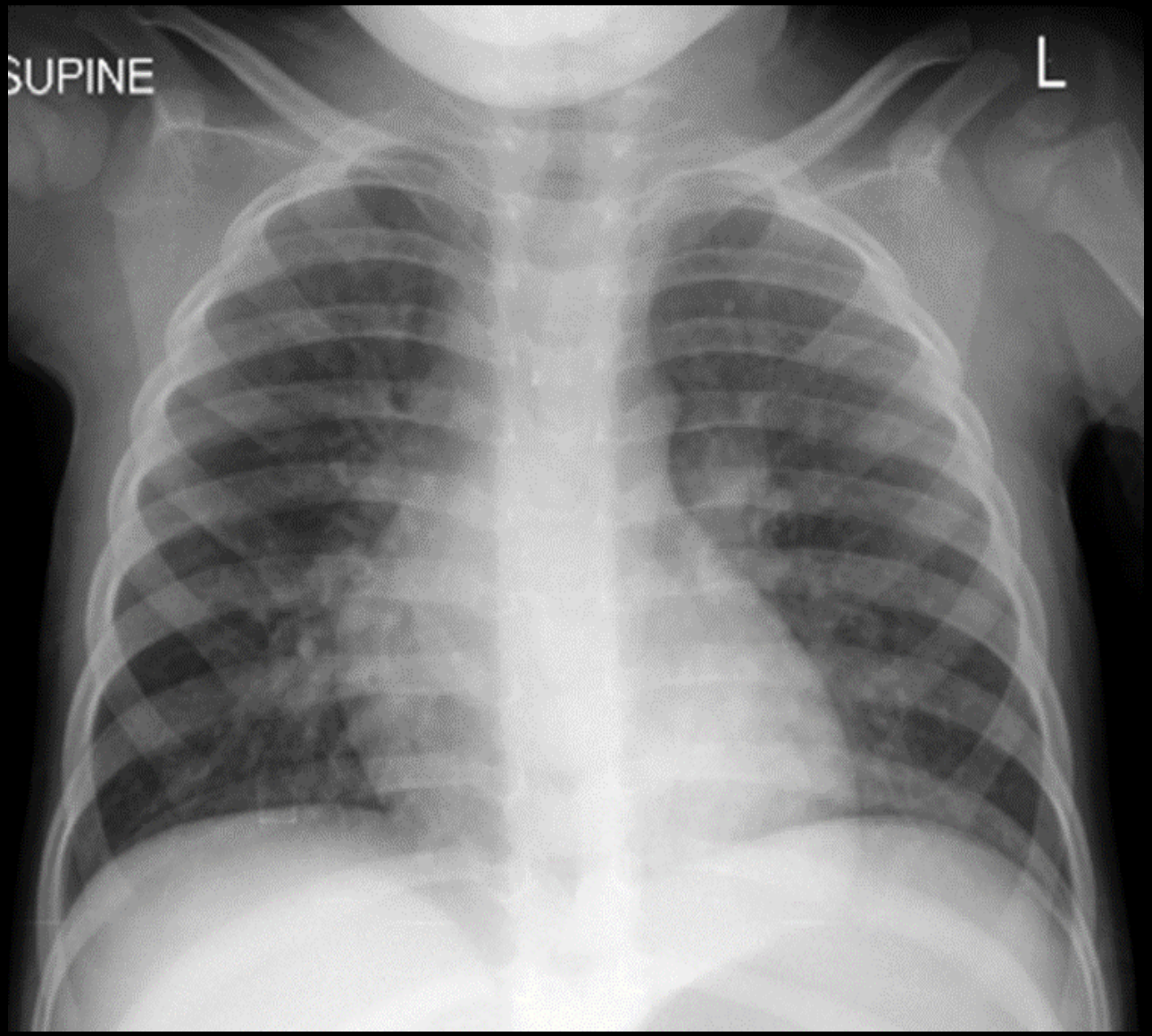
Interstitial pneumonia : LIP



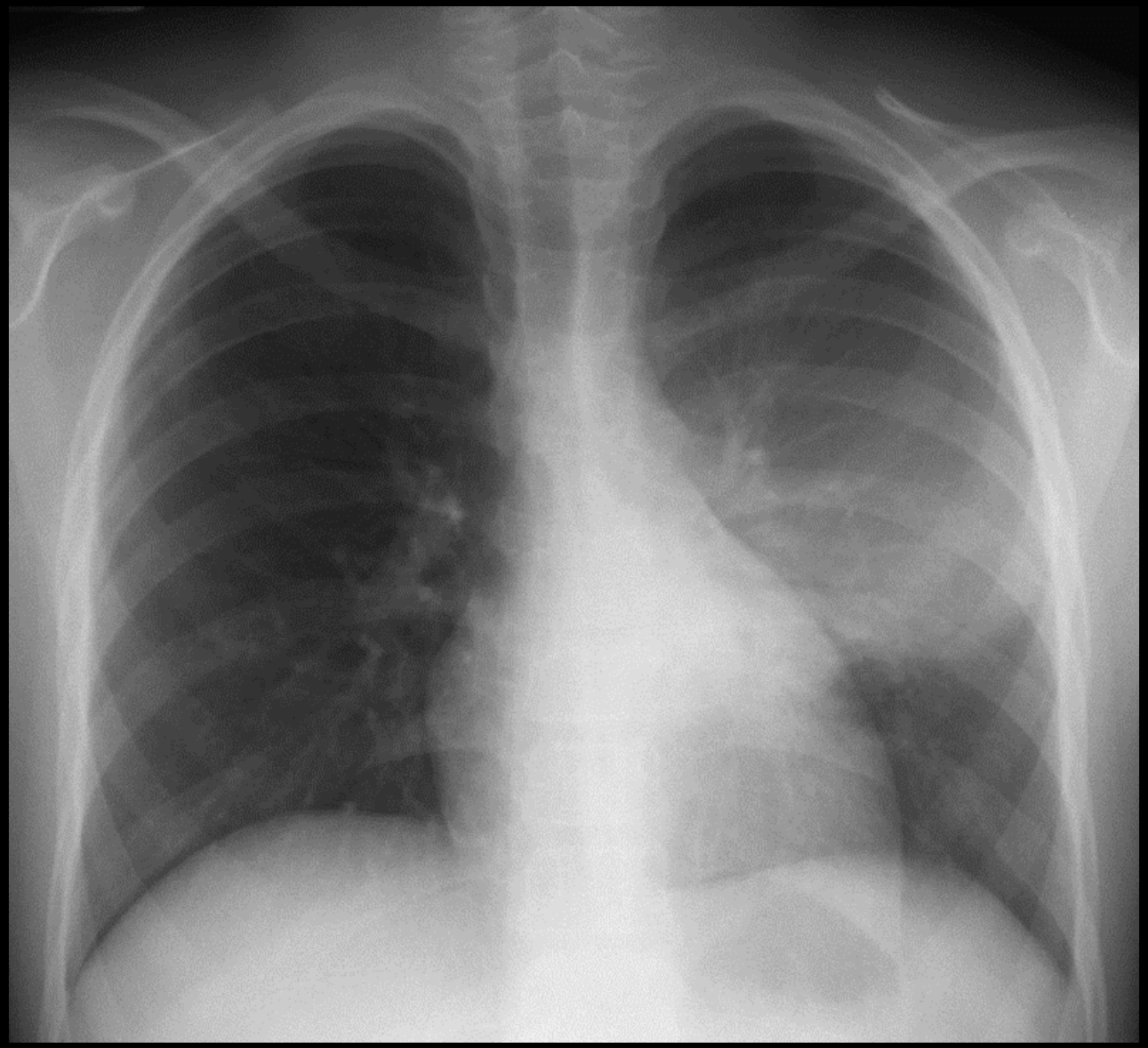
Perihilar infiltrates



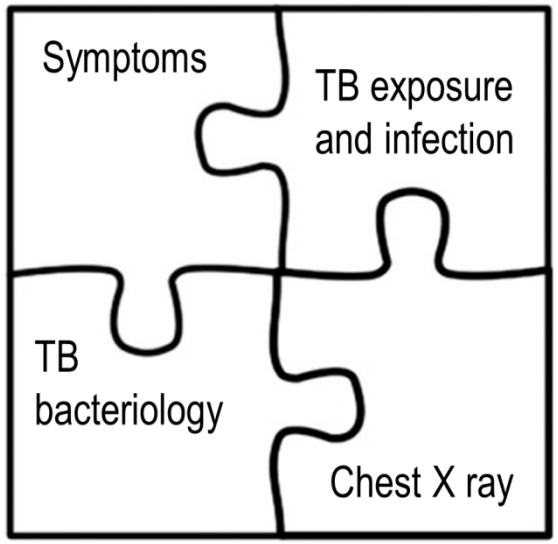
Isolated Bronchopneumonia



Isolated segmental opacification

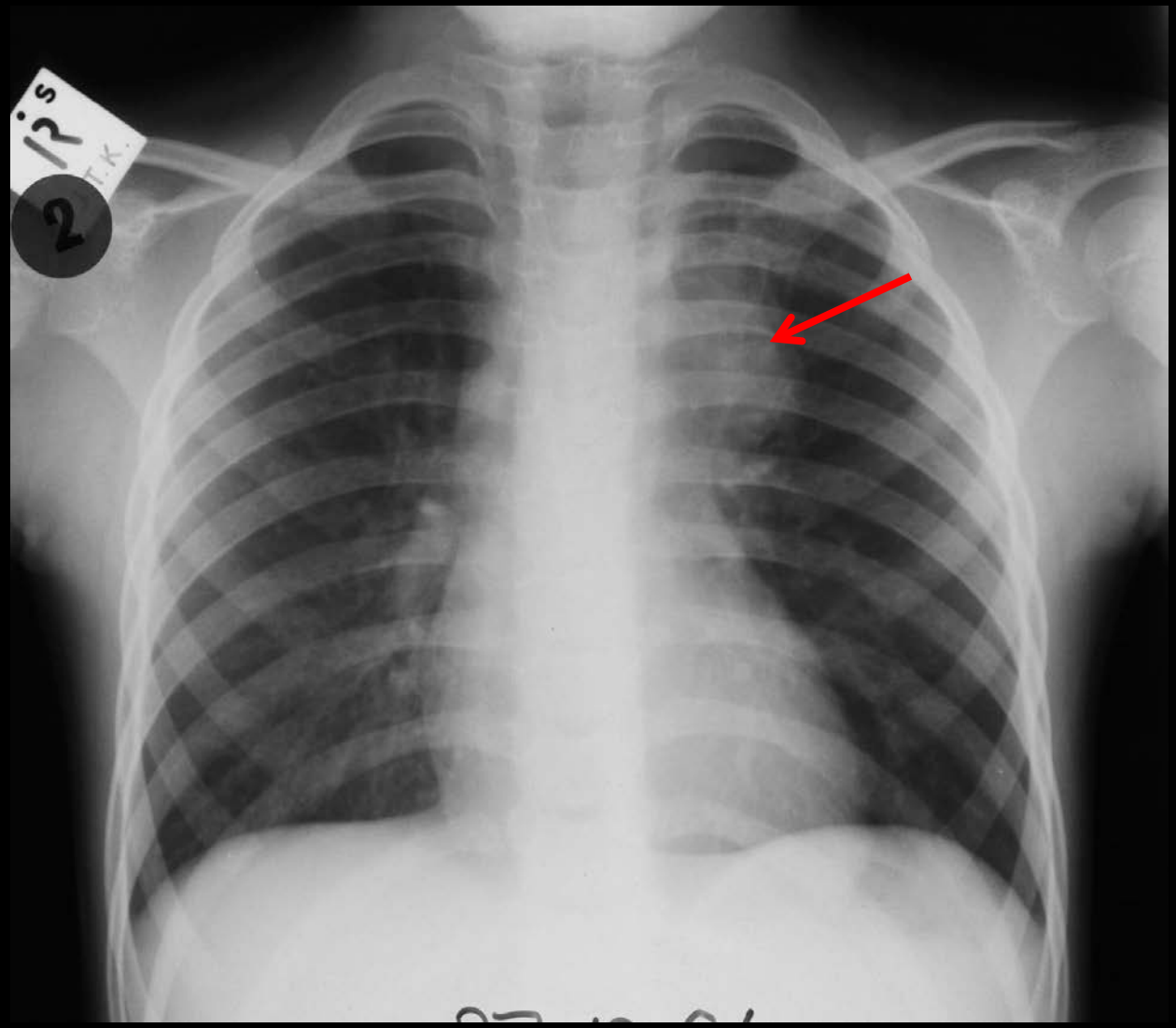


Please remember:
The following will help!

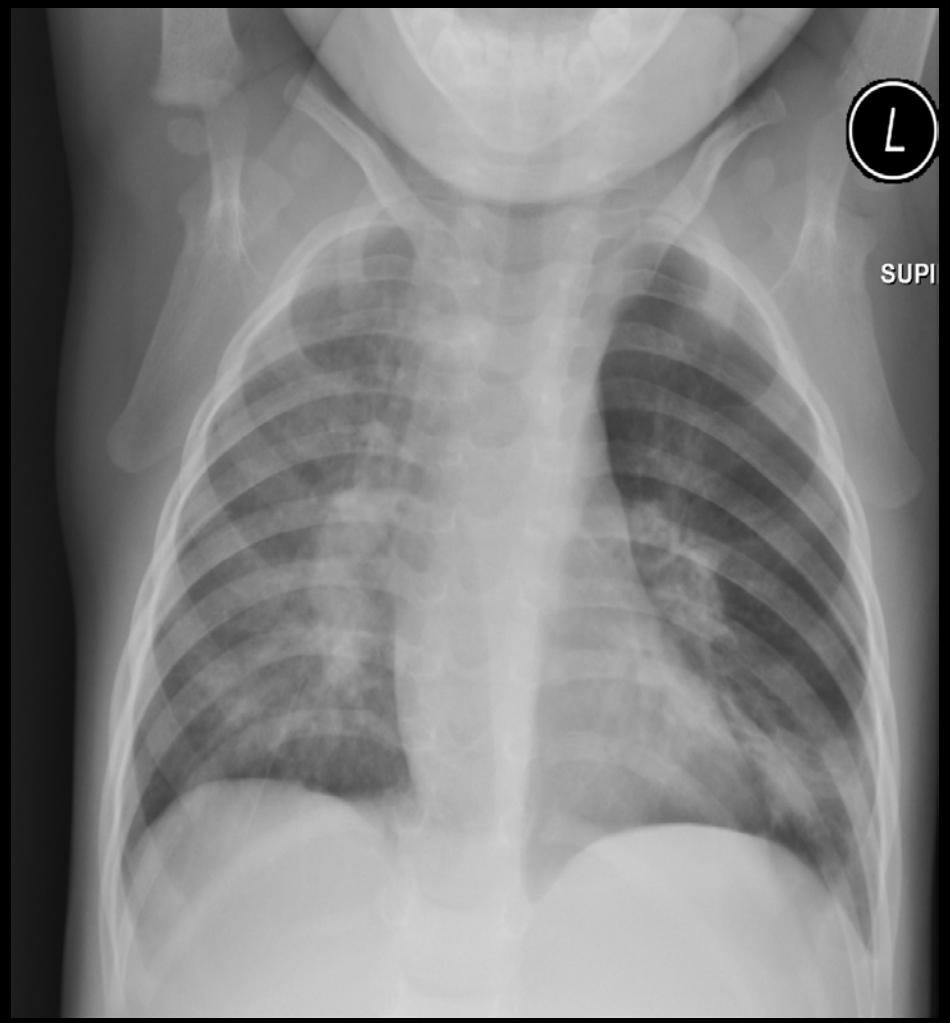


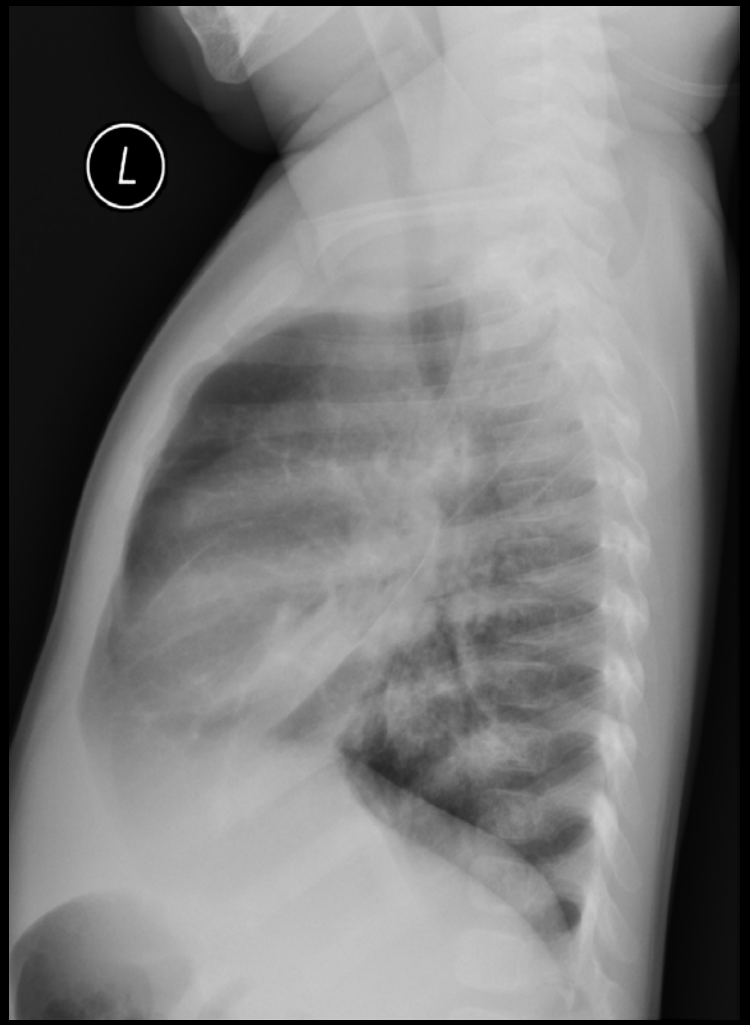
Careful clinical follow-up

Radiological images confused with pulmonary TB.

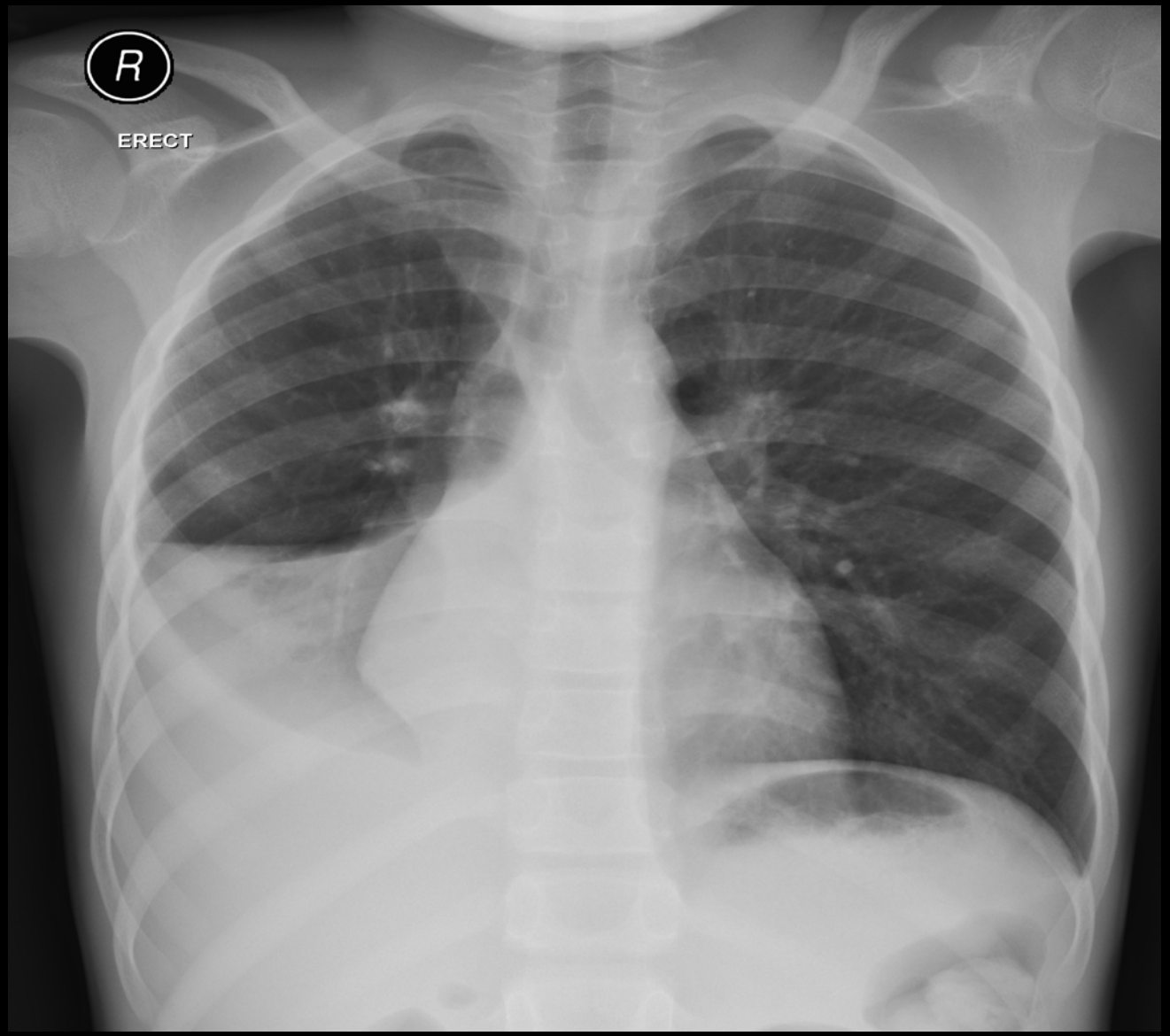


Cough for 2 weeks, not TB contact, decreased ventilation left chest

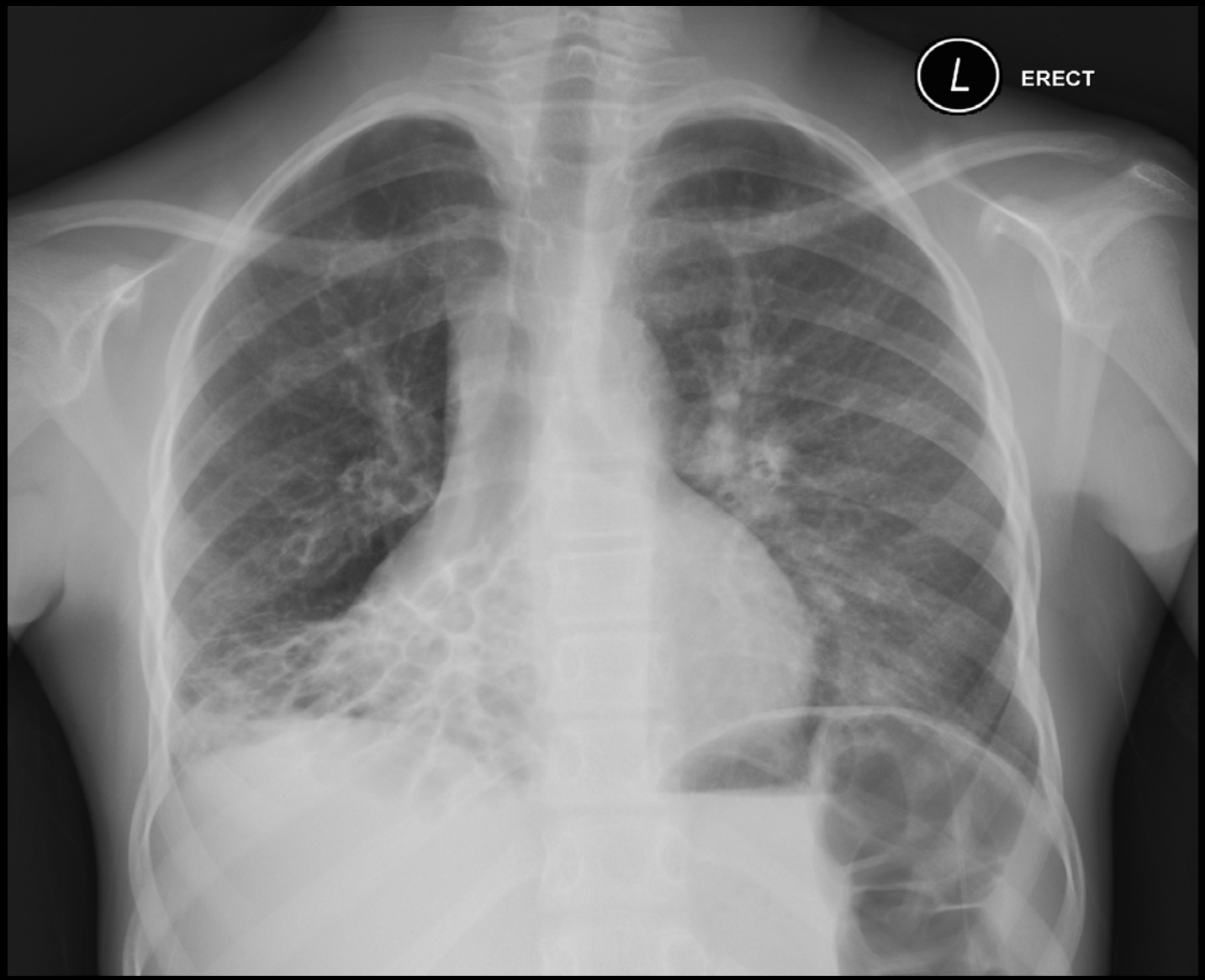




Patient not responding to adherent TB treatment for 5 months



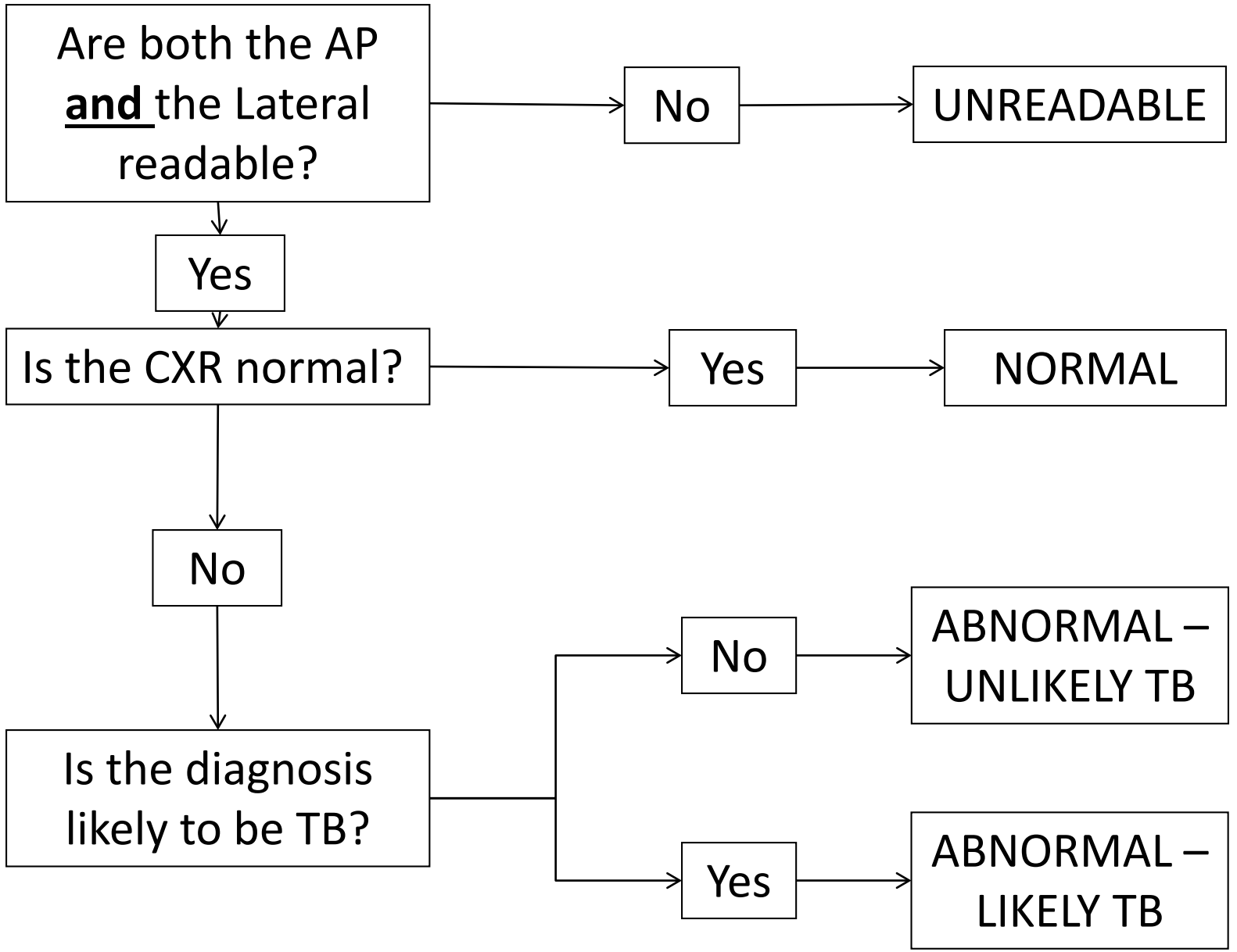
Chronic cough, not gaining weight, sputum production.



Aids the clinician

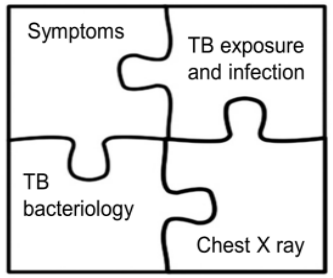
- Simple approach or Systematic approach to reading the CXR during the screening process
  - Technical aspects
  - Have a system to cover all aspects of the CXR

- Completion of the radiology form.


Are both the AP and the Lateral readable?
No
UNREADABLE
Yes
Is the CXR normal?
Yes
NORMAL
No
Is the diagnosis likely to be TB?
No
ABNORMAL – UNLIKELY TB
Yes
ABNORMAL – LIKELY TB

Practical cases:

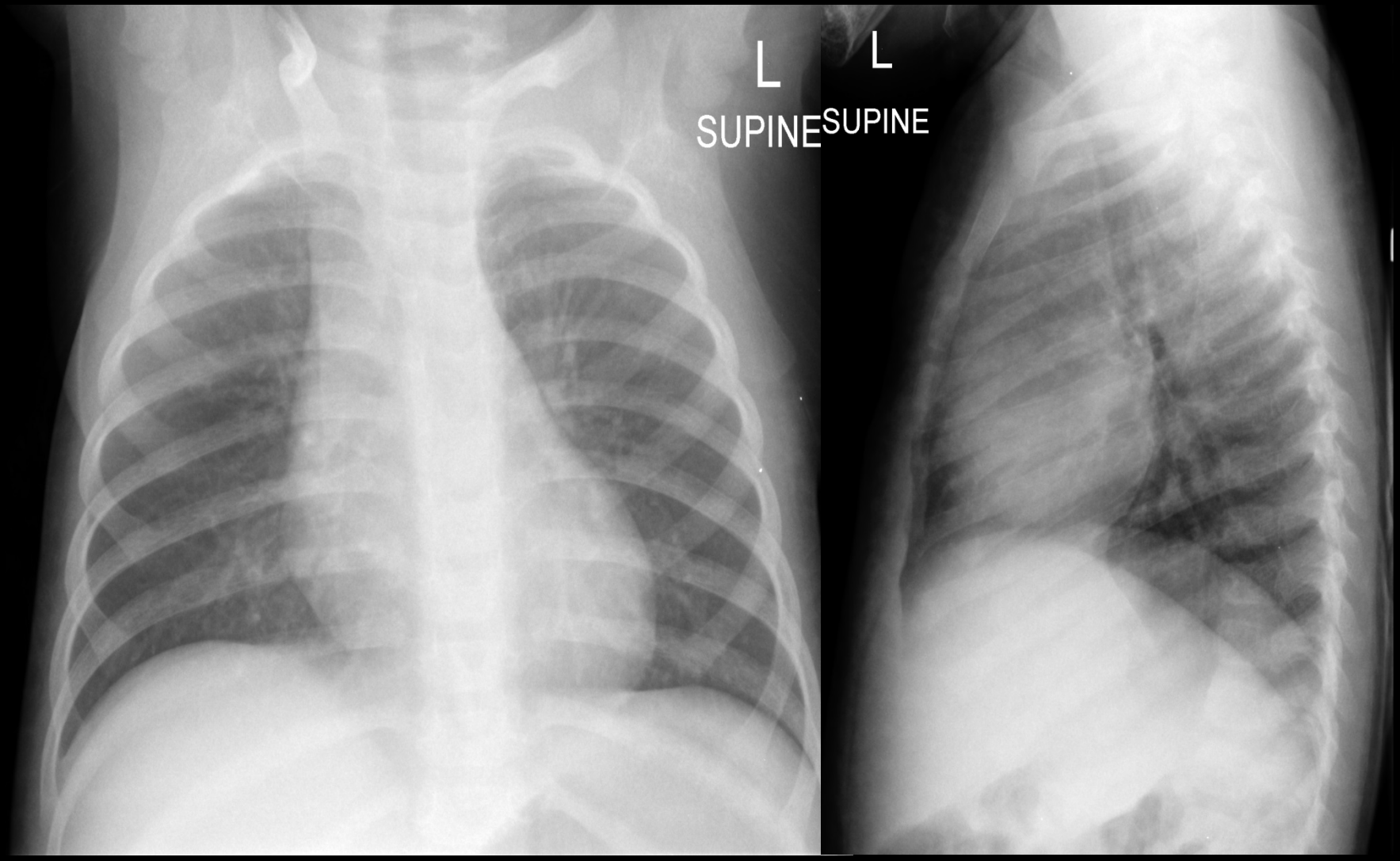
- For these practical cases we assume the following:
  - The children come from a house with a case of MDR TB.
  - The children are asymptomatic
  - They could be HIV infected or uninfected
  - The clinical examination is normal.
- Remember : the CXR shows pathology but not the cause



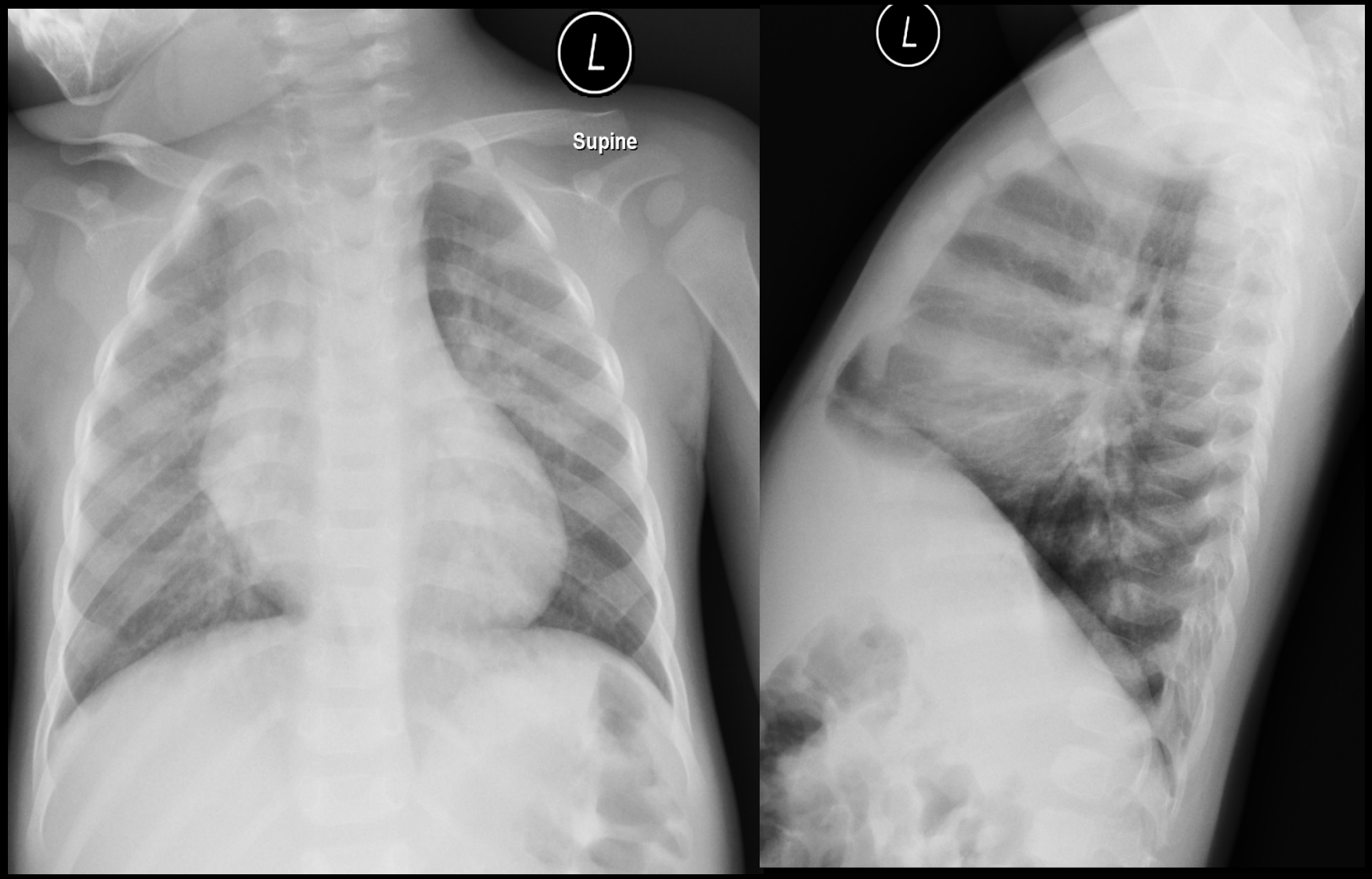
Basic approach:

1. Is this technical acceptable?
2. Is the normal or abnormal?
3. Is this suggestive of TB or not?

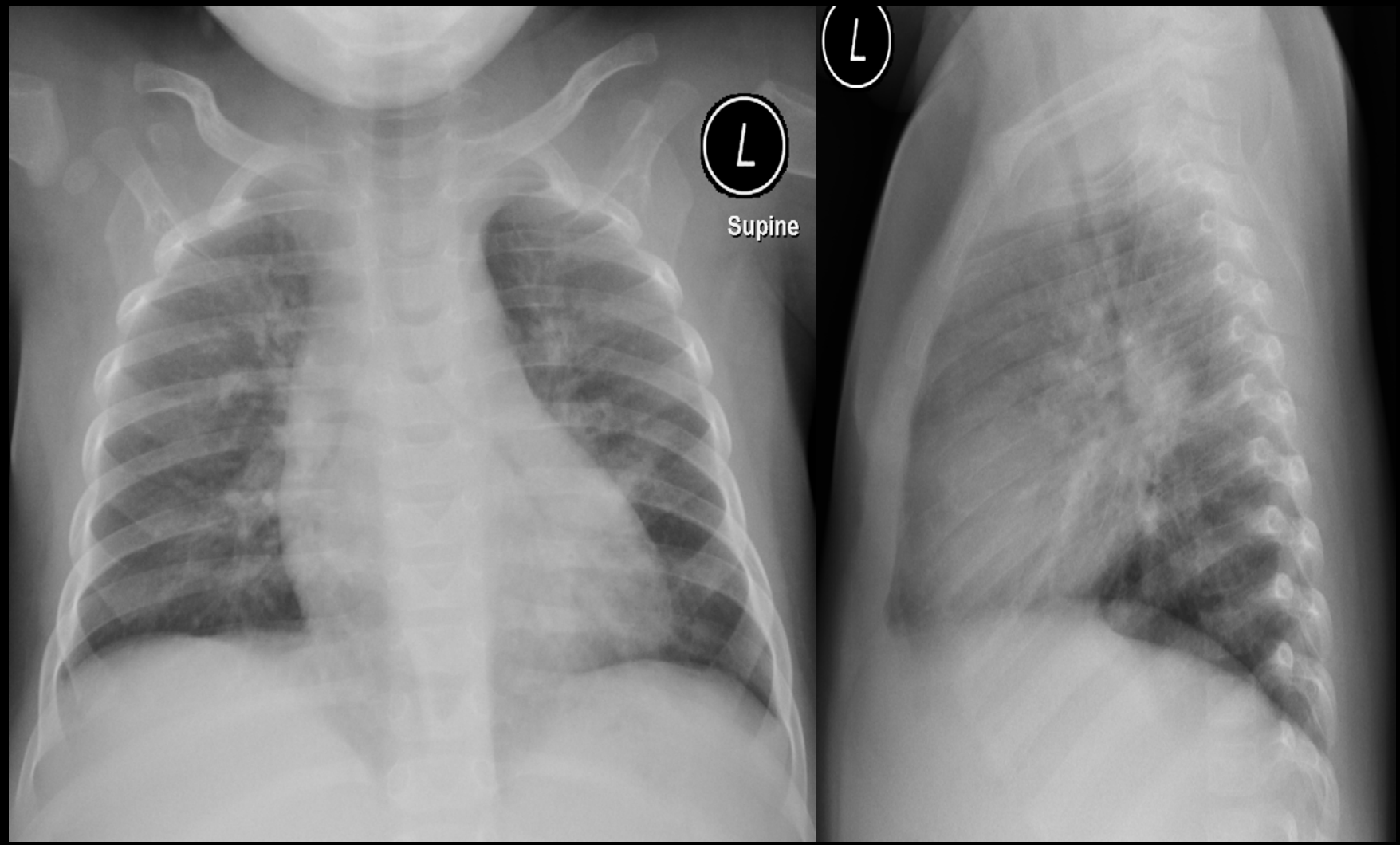
11-month-old girl: Mother 3+ smear-positive XDR-TB (AA)



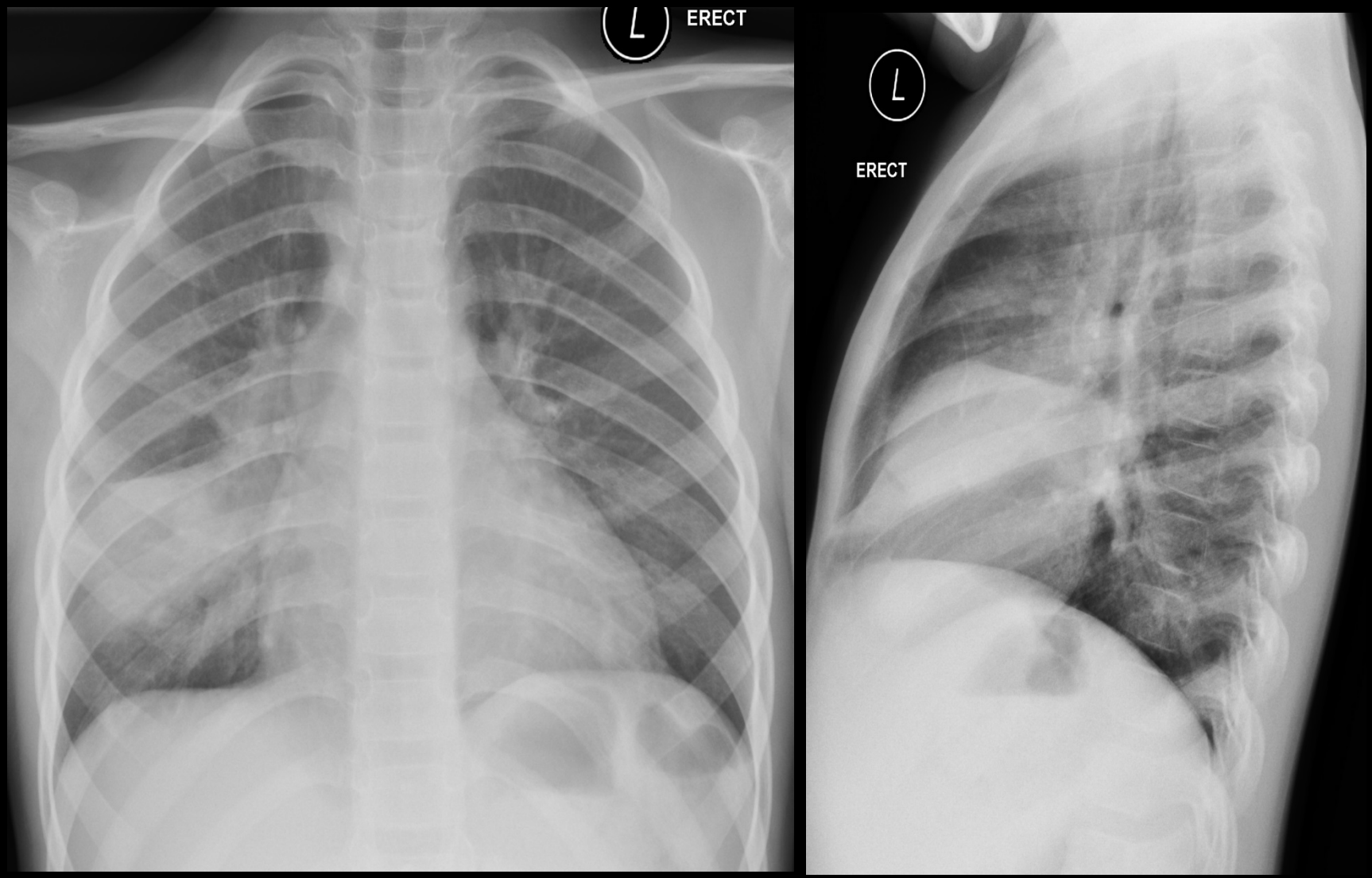
1-year-old MDR-TB contact; cough few days (ZK)



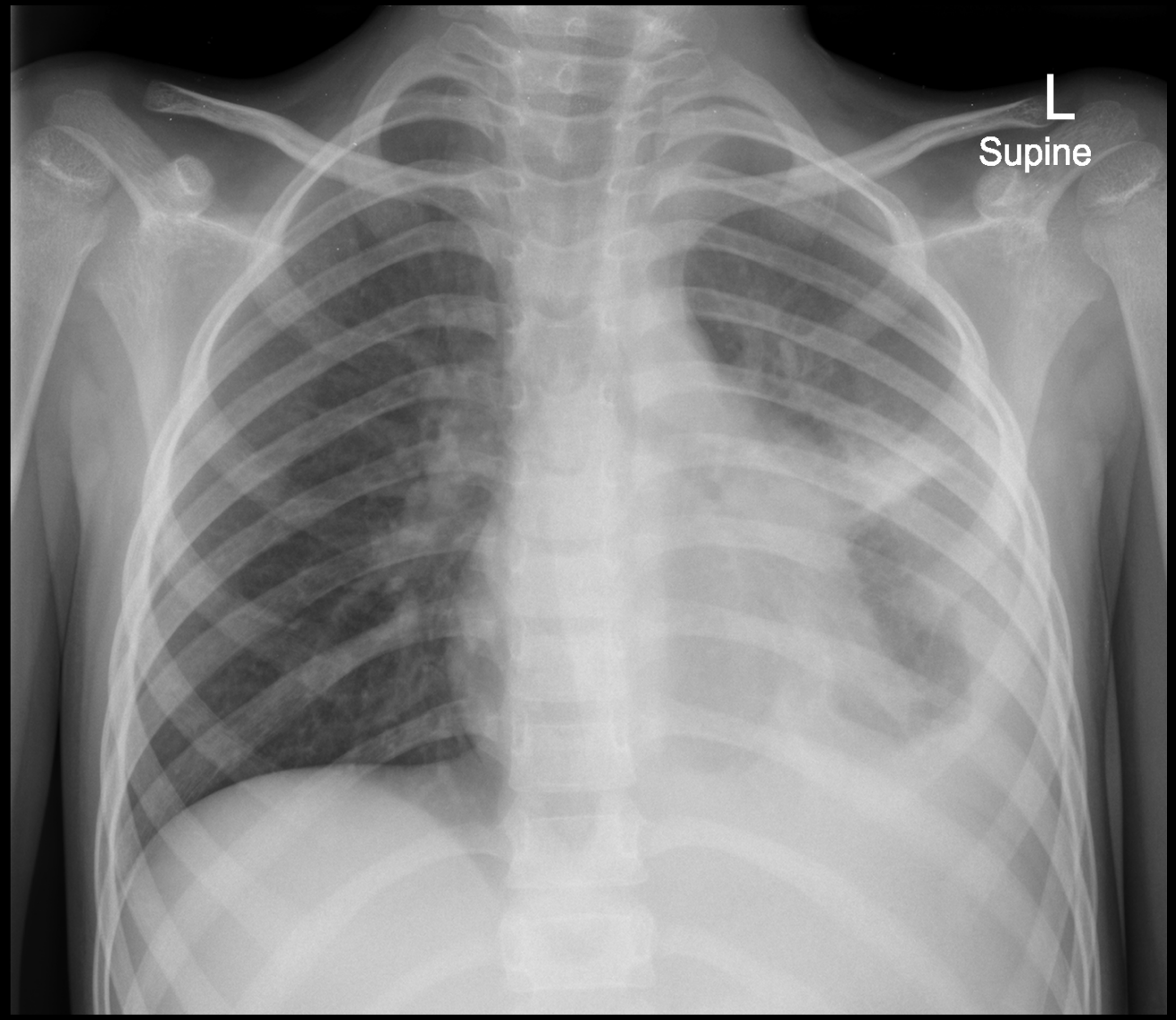
8-month-old-girl contact XDR-TB mother; RVD positive (IN)



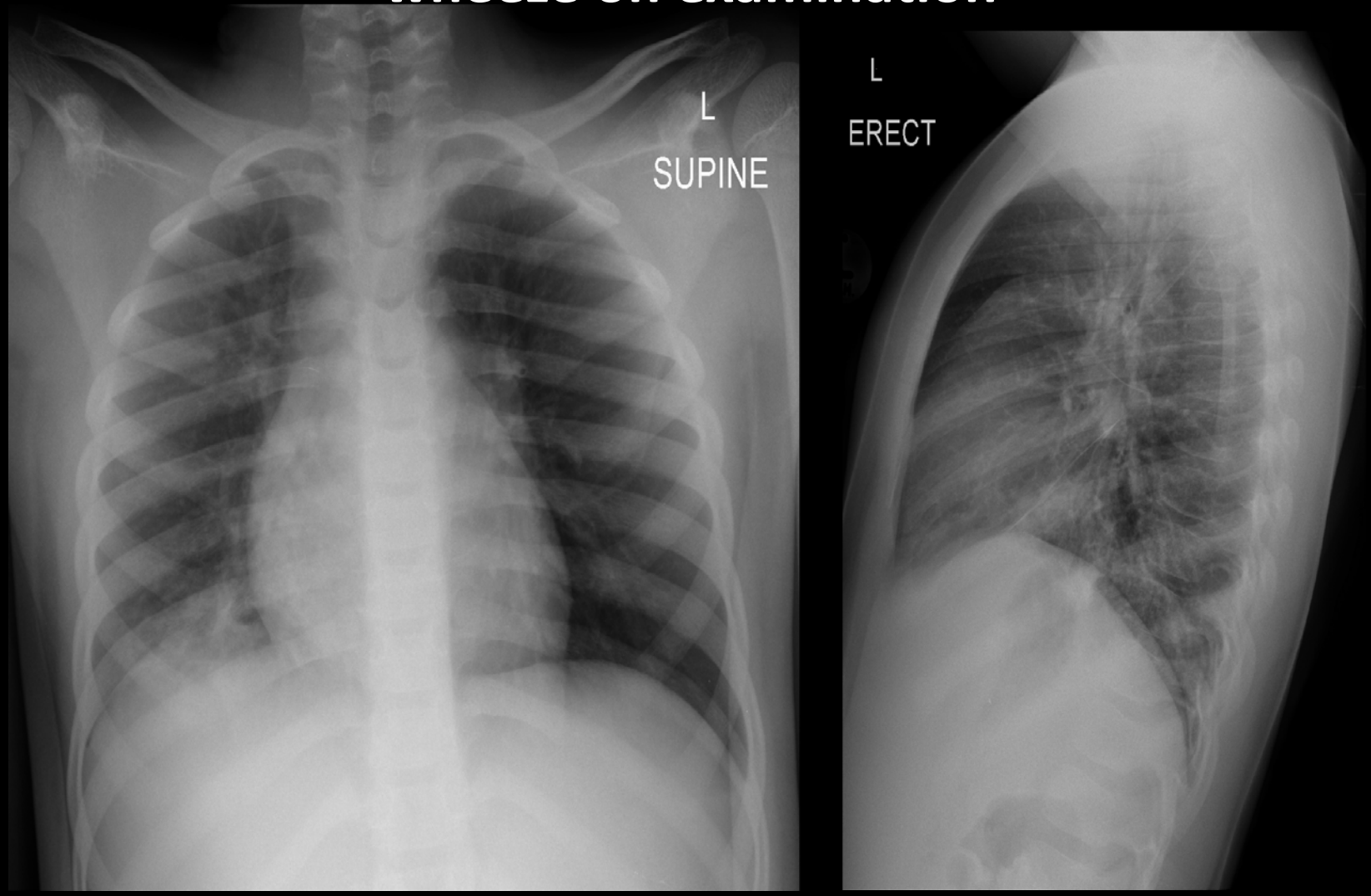
5-year-old girl; asymptomatic says mother; mother MDR-TB (JJ)



8-year-old boy: Father MDR-TB (GP)



2-year-old MDR-TB contact; no symptoms, but wheeze on examination



Summary

- CXR is only an aid to making the diagnosis
- An abnormal CXR only indicates pathology but not cause
- Most of the CXRs in PHOENIx will be normal
- Careful follow-up and a repeat CXR will solve most problems.
- Solve the puzzle!