

Pediatric High-Resolution Computed Tomography

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URLs

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◆ Slides at:

[http://www.cincinnatichildrens.org/
research/div/radiology/present.htm](http://www.cincinnatichildrens.org/research/div/radiology/present.htm)

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Pediatric HRCT

- ◆ What do I do with a request for an HRCT in a child?
- ◆ How can I get better images?
- ◆ What do I say about the images once I've got them?

High-Resolution CT

- ◆ HRCT provides a low dose sampling technique for diffuse or widespread abnormalities
- ◆ HRCT does not evaluate the mediastinum or central airways
- ◆ HRCT is very unlikely to be useful if conventional CT is normal

High-Resolution CT

- ◆ High-resolution CT is a misleading term
- ◆ “Limited sample parenchymal evaluation CT” is more accurate
- ◆ HRCT is more technically demanding than conventional CT
- ◆ HRCT is only useful if high quality images are obtained

HRCT Technique



HRCT Technique

- ◆ Weight/size/age based mAs
- ◆ kVp 80-120
 - Increased kVp markedly increases dose
- ◆ 1mm sections
- ◆ 7mm (infants) to 20mm (limited survey) intervals for inspiratory images
- ◆ Maximum 1:2 inspiratory to expiratory ratio, minimum of 4
- ◆ Fastest scan speed

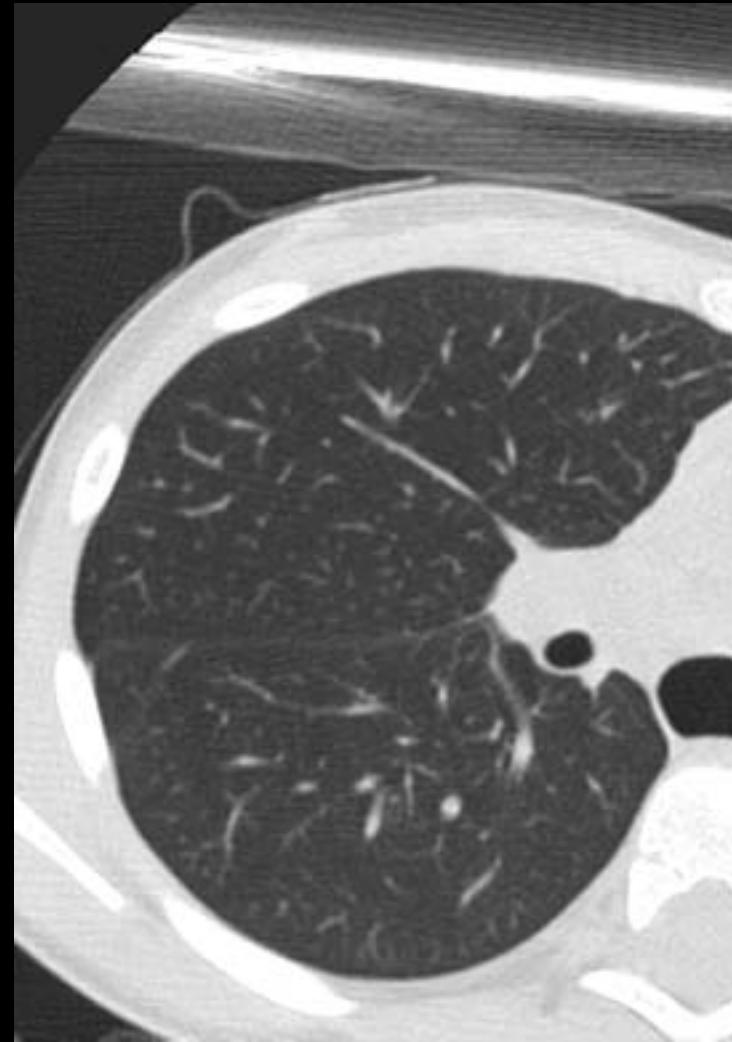
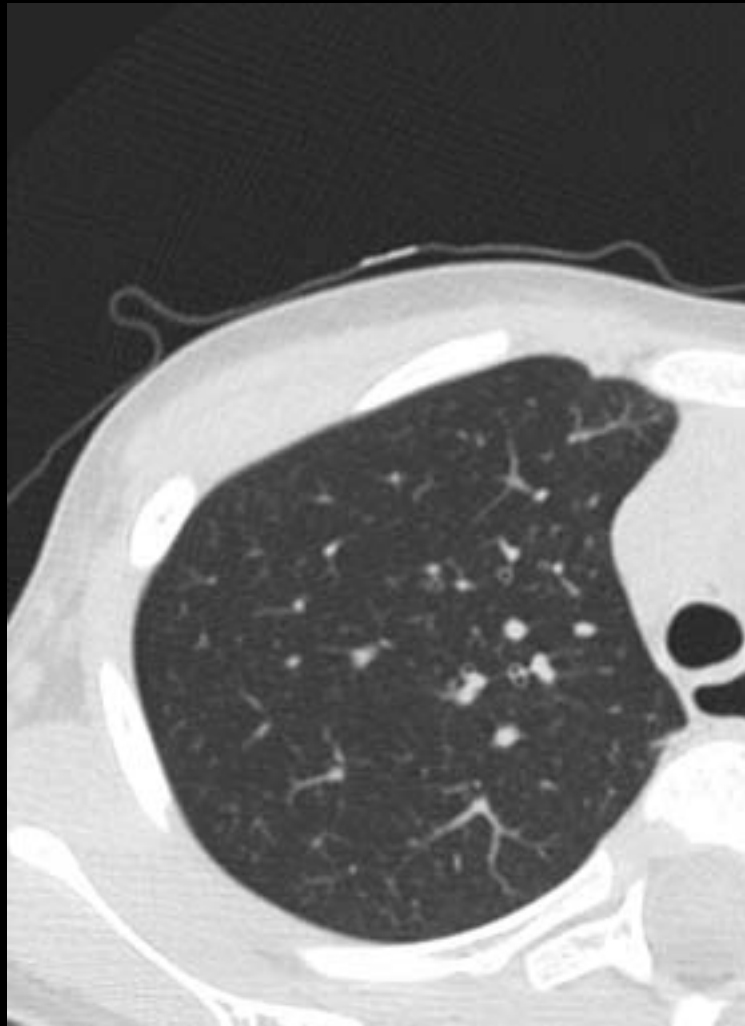
Dose Considerations

- ◆ Perform HRCT first if unsure whether to do conventional or HRCT
- ◆ Scan limited area when appropriate
- ◆ Evaluate the relative dose of available CT scanners
- ◆ Use breast shields

Cassese, et al. J Thorac Imaging. 2003;18:242-5

Fricke BL, et al. AJR 2003;180:407-11

Breast Shields



30% lower breast dose, no increase in noise

Patient Preparation for HRCT

- ◆ HRCT requires cooperation or control
- ◆ Inspiratory images 4 to 6 years old
- ◆ Expiratory images 6 to 8 years old
- ◆ Coach in room helpful until 10-12 years old

Patient Preparation

- ◆ Explain and practice the procedure before entering the scan room
- ◆ Practice again on the scanner table
- ◆ Talk your patient through the entire procedure
- ◆ It helps if an adult stays in the room during scanning

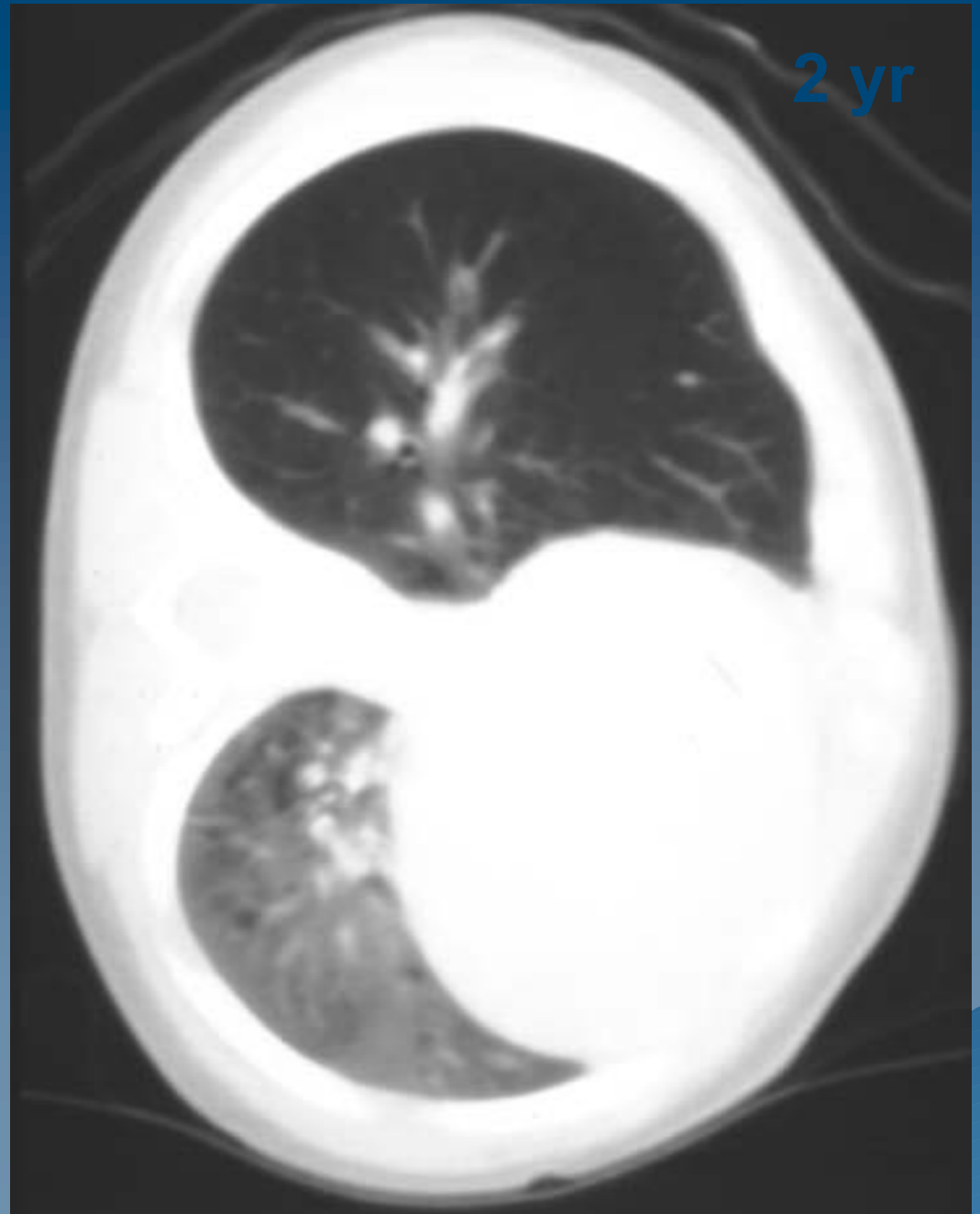
New Imaging Techniques

- ◆ Imaging quietly breathing young children is not adequate for HRCT
 - Motion degrades images
 - Lung volumes are variable, and level of inspiration is unknown
 - Comparable inspiratory and expiratory images cannot be obtained

Controlling Lung Volume

- ◆ Decubitus imaging
- ◆ Controlled ventilation CT
- ◆ General anesthesia

Decubitus Imaging



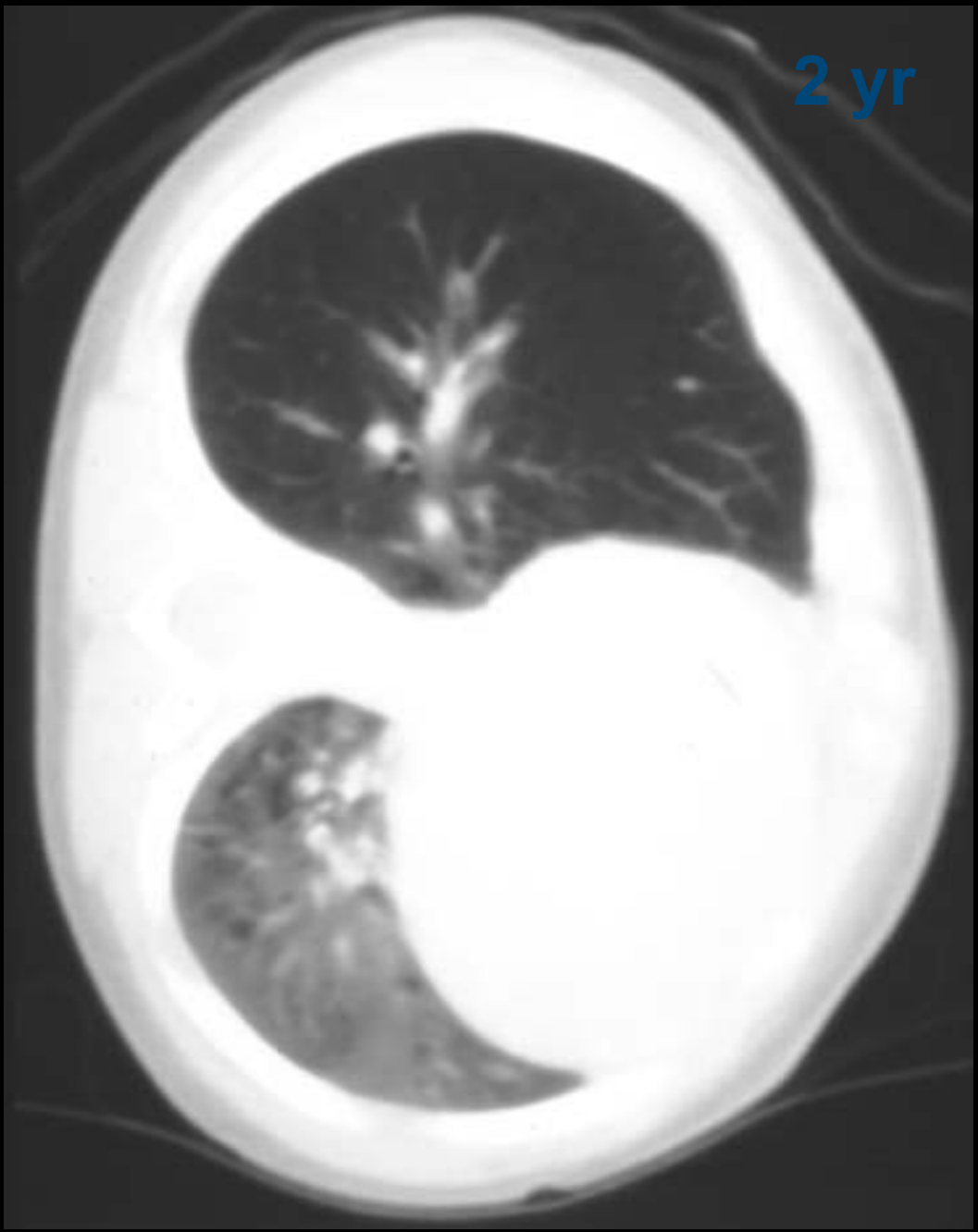
Decubitus Imaging

- ◆ Perform initial HRCT
- ◆ Place child in lateral decubitus position
- ◆ Down side is expiratory, up side is well inflated

Lucaya, et al. AJR 2000 174:235-41

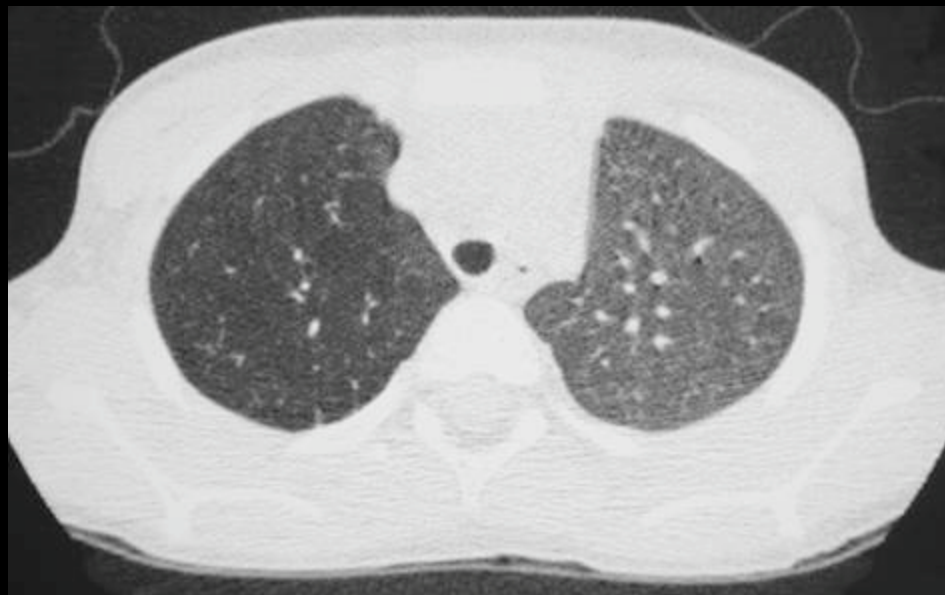
2 yr

2 Year Old
Normal
appearance



Courtesy Javier Lucaya, MD

Multiple Bronchial Atresias

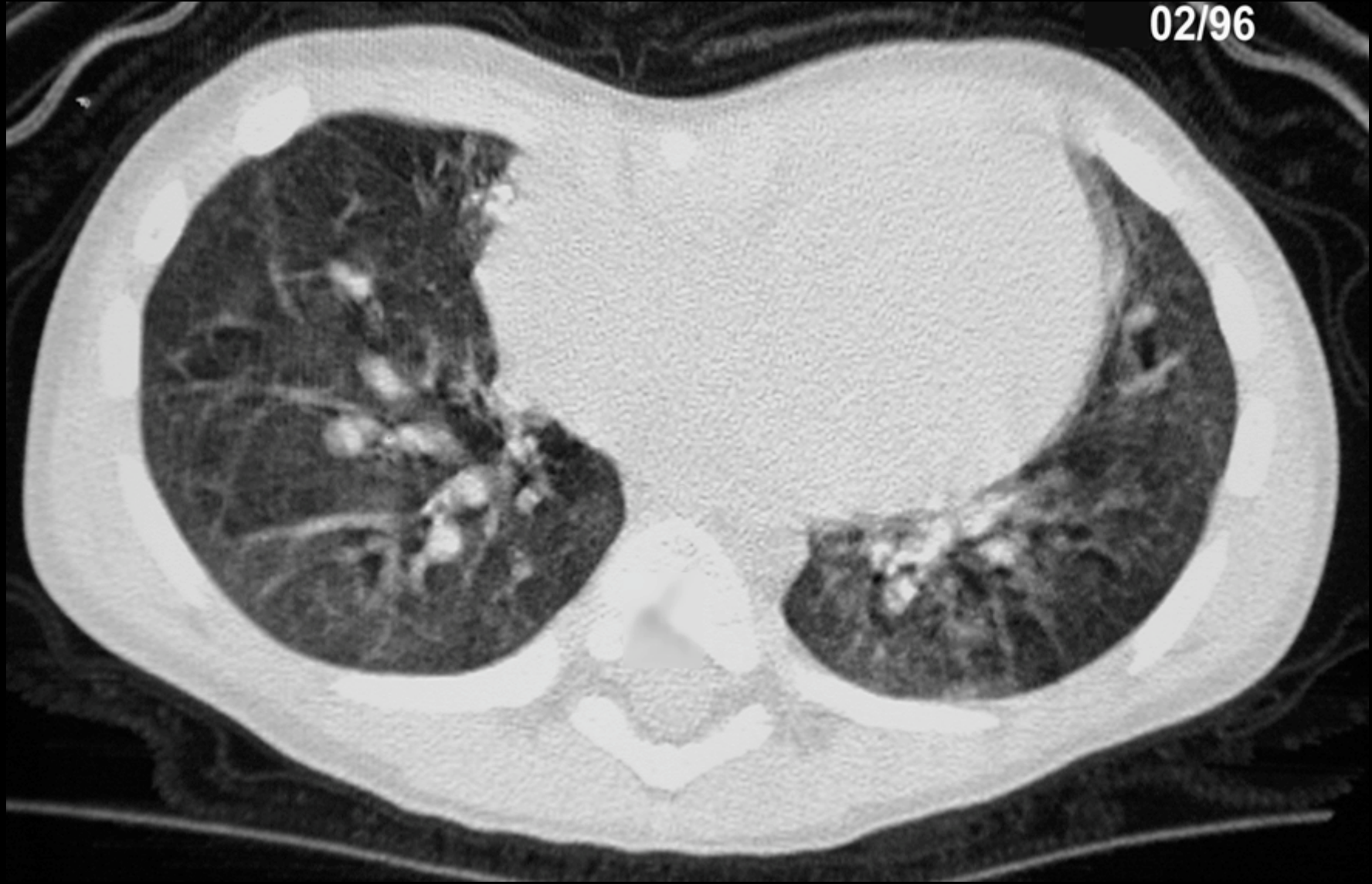


Courtesy Javier Lucaya, MD

5 Year Old, ? Bronchiectasis

CASE 4

02/96



Courtesy Javier Lucaya, MD

5 year old

**Bronchi abut the
mediastinal
pleura indicating
bronchiectasis**



LLD
Courtesy Javier Lucaya, MD

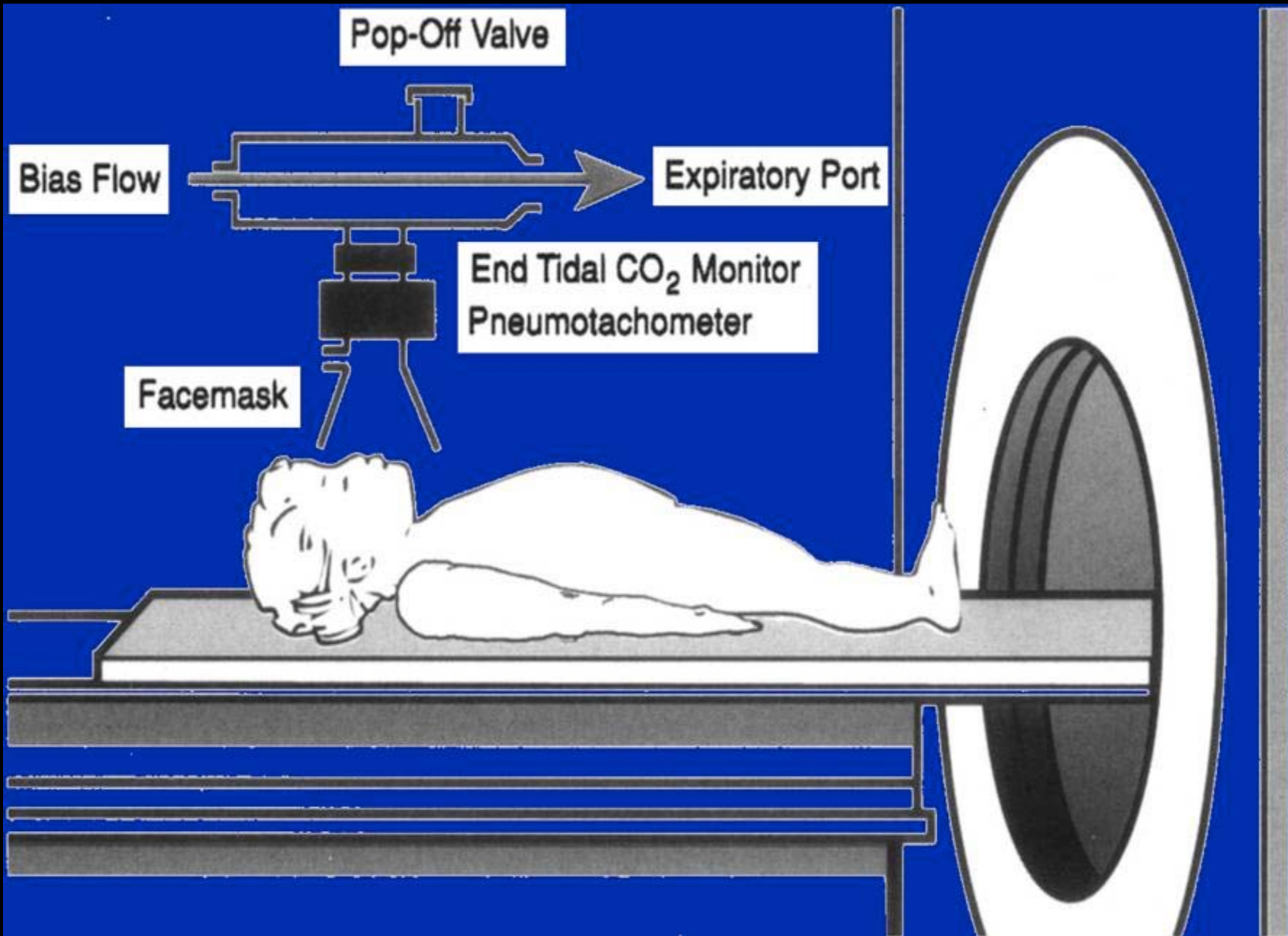
Controlled Ventilation CT



Controlled Ventilation CT (CVCT)

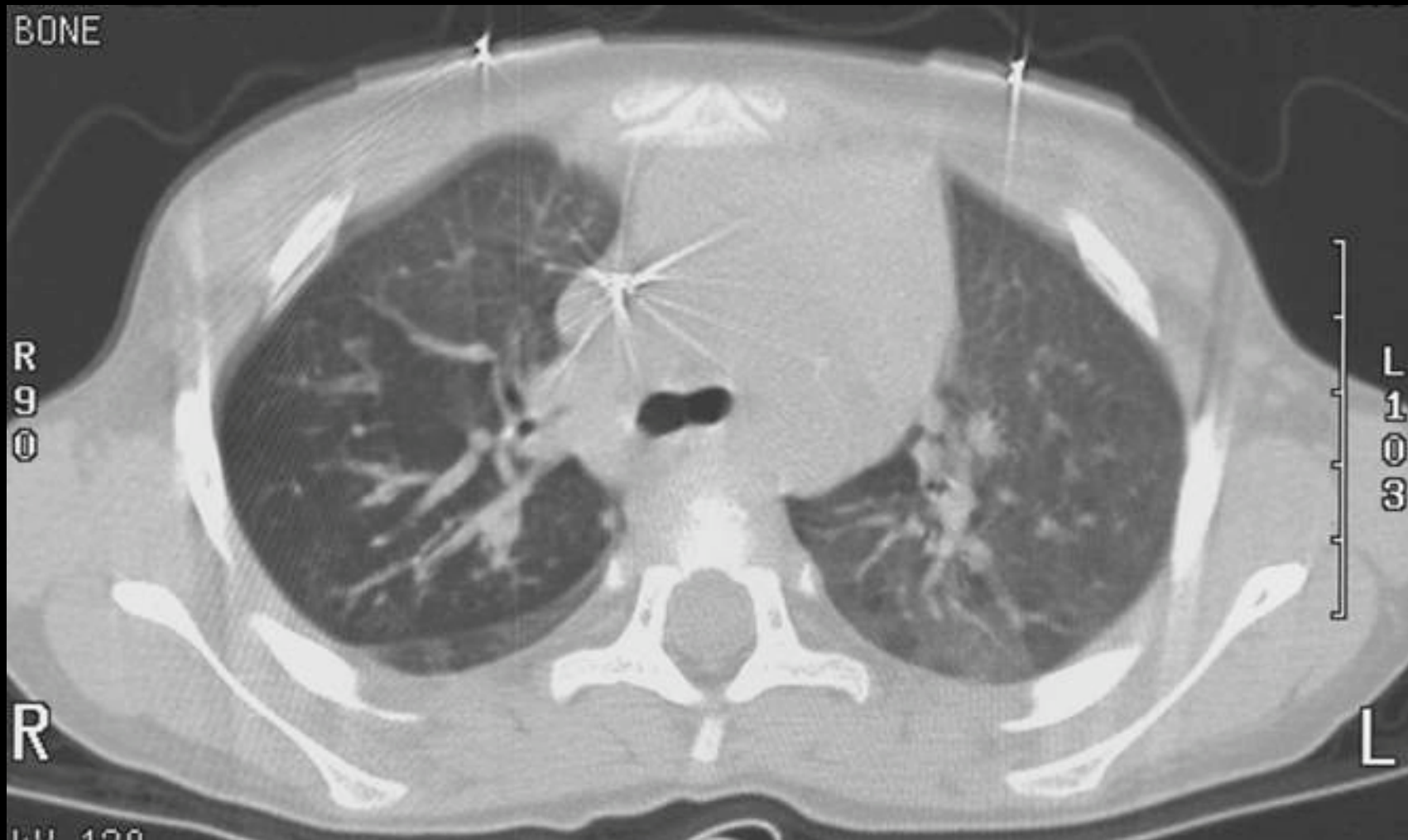
- ◆ Mask ventilate sedated child
- ◆ CO₂ and chest stretch receptors produce 10-15 seconds of apnea
- ◆ Obtain inspiratory and expiratory images during apneic period

Long et al. Radiology, Aug 1999; 588-93





2 Year Old with CF



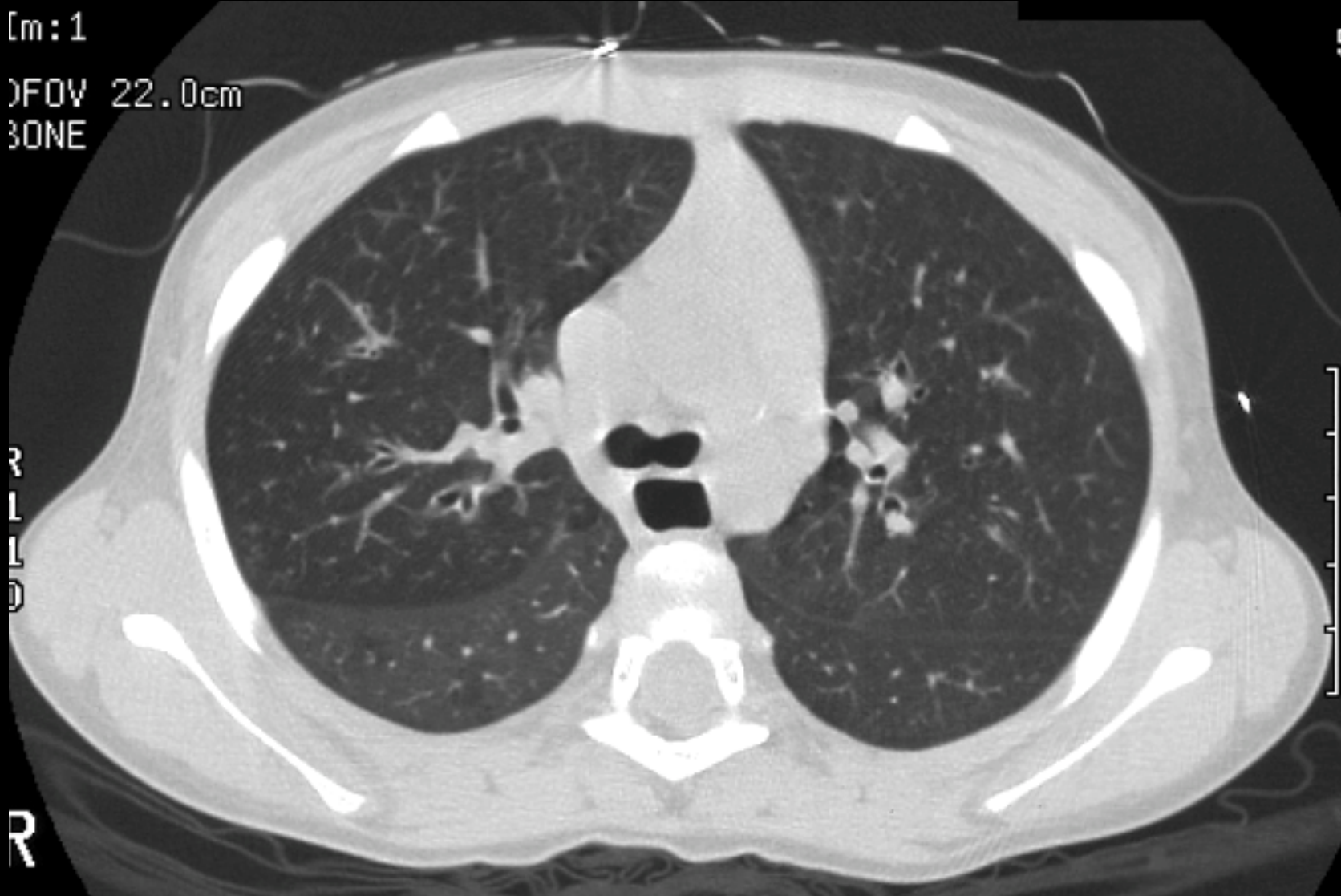
Courtesy Frederick R. Long, MD

2 yo with CF, Inspiratory CVCT

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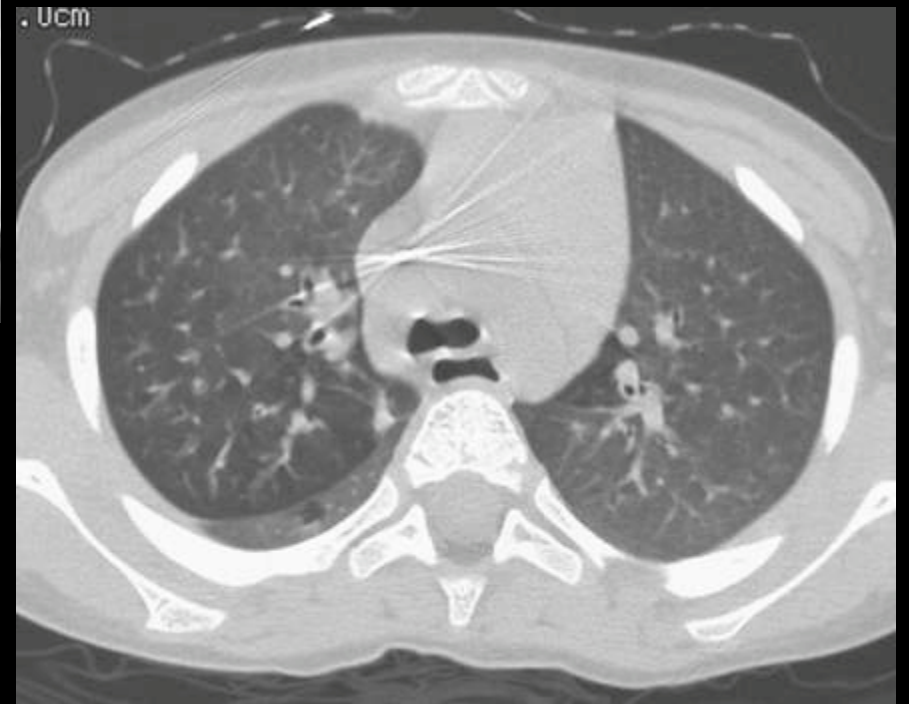
)FOV 22.0cm

30NE



Courtesy Frederick R. Long, MD

2 yo with CF, CVCT

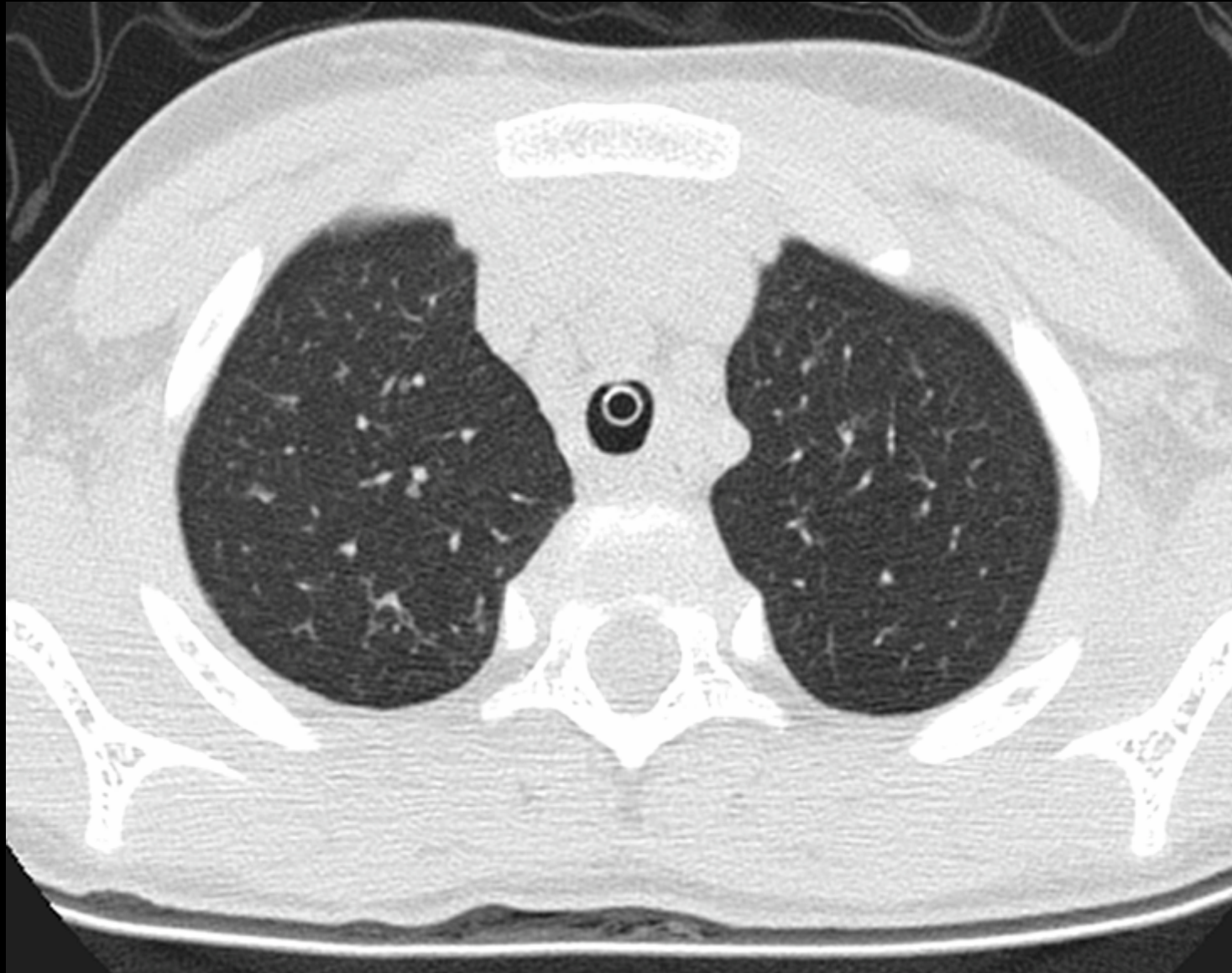


Courtesy Frederick R. Long, MD

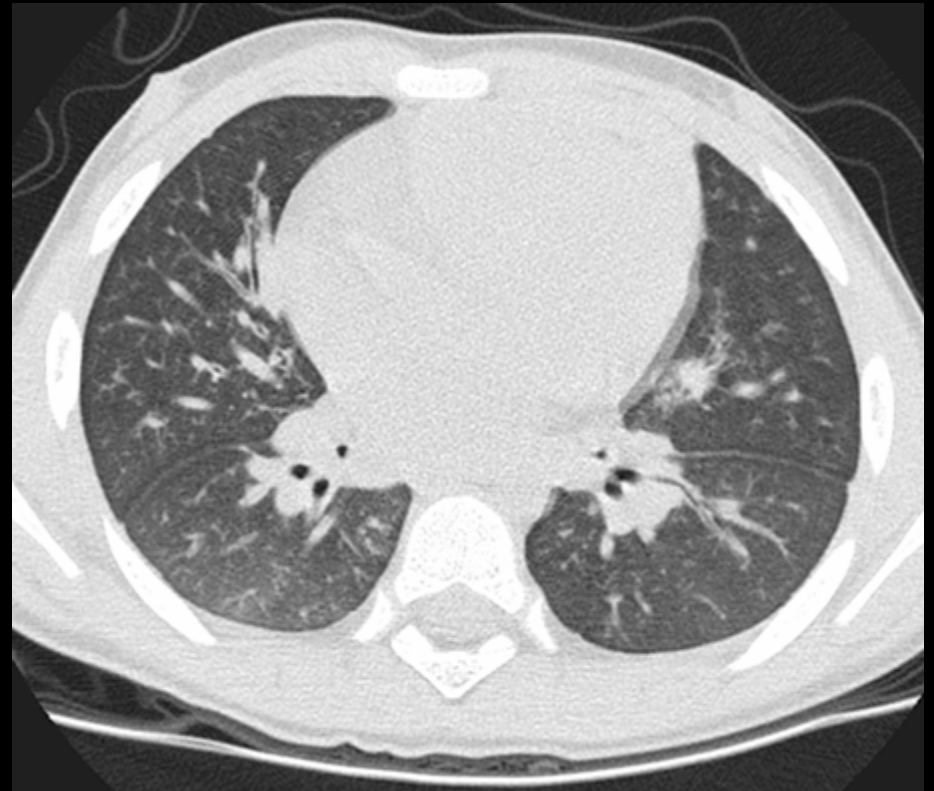
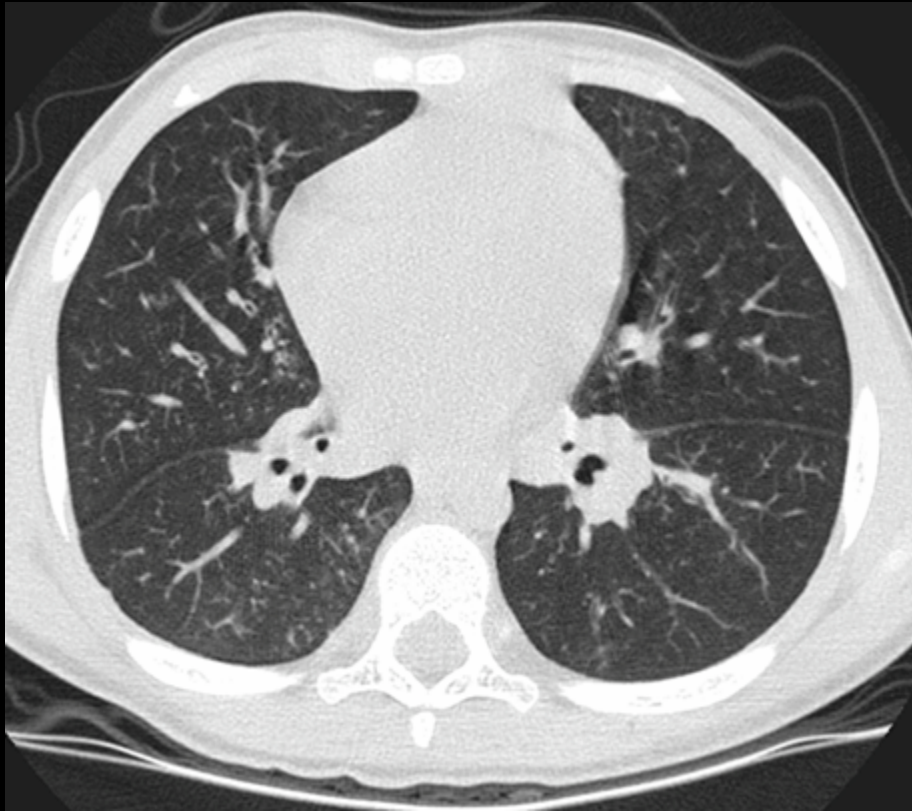
Controlled-Ventilation CT

- ◆ Safe; technique used for infant PFTs on thousands of children
- ◆ Effective; success rate > 90%
- ◆ Requires a trained RT or other HCP
- ◆ Must have a well-established sedation program in place

General Anesthesia



General Anesthesia Inspiratory and Expiratory Images



General Anesthesia

- ◆ The greatest technical problem is atelectasis
- ◆ Begin scanning as soon as possible
- ◆ Maintain 30 cm water inspiratory pressure with frequent sighs
- ◆ Insist on prone images if posterior opacities are present

Interpreting Pediatric HRCT



Interpreting Pediatric HRCT

- ◆ “Evaluation of the lung parenchyma is not straightforward in neonates and infants”

David Hansell, HRCT of Diffuse Lung Disease, Radiol Clin North Am, Nov 2001

Interpreting Pediatric HRCT

- ◆ Evaluate the large and small airways
- ◆ Identify the predominant parenchymal abnormalities
 - Ground glass Nodules Cysts
 - Emphysema Linear / reticular densities
- ◆ Adult terms work well for description
- ◆ Diagnostic possibilities are often very different

Illustrative Cases

- ◆ Children are not little adults
- ◆ Common things occur commonly
- ◆ Make friends with your pathologist
- ◆ A pediatric pulmonologist may be more helpful than a radiologist

15 Year Old, Shortness of Breath



?? Idiopathic Pulmonary Fibrosis ??

- ◆ Appearance in children often associated with autoimmune/ connective tissue disorders
- ◆ Little fibrosis on biopsy
- ◆ May respond to steroids or hydroxychloroquine
- ◆ Often stable for long periods of time

Ideopathic pulmonary fibrosis in infants: good prognosis with conservative management.
Hacking, et al. Arch Dis Child 2000;83:152-157

?? Idiopathic Pulmonary Fibrosis ??

- ◆ Increasingly restrictive criteria in adults
- ◆ “Adult” IPF rarely seen in children
- ◆ Should not be diagnosed by imaging appearance without biopsy

11 yo with Frequent Infections

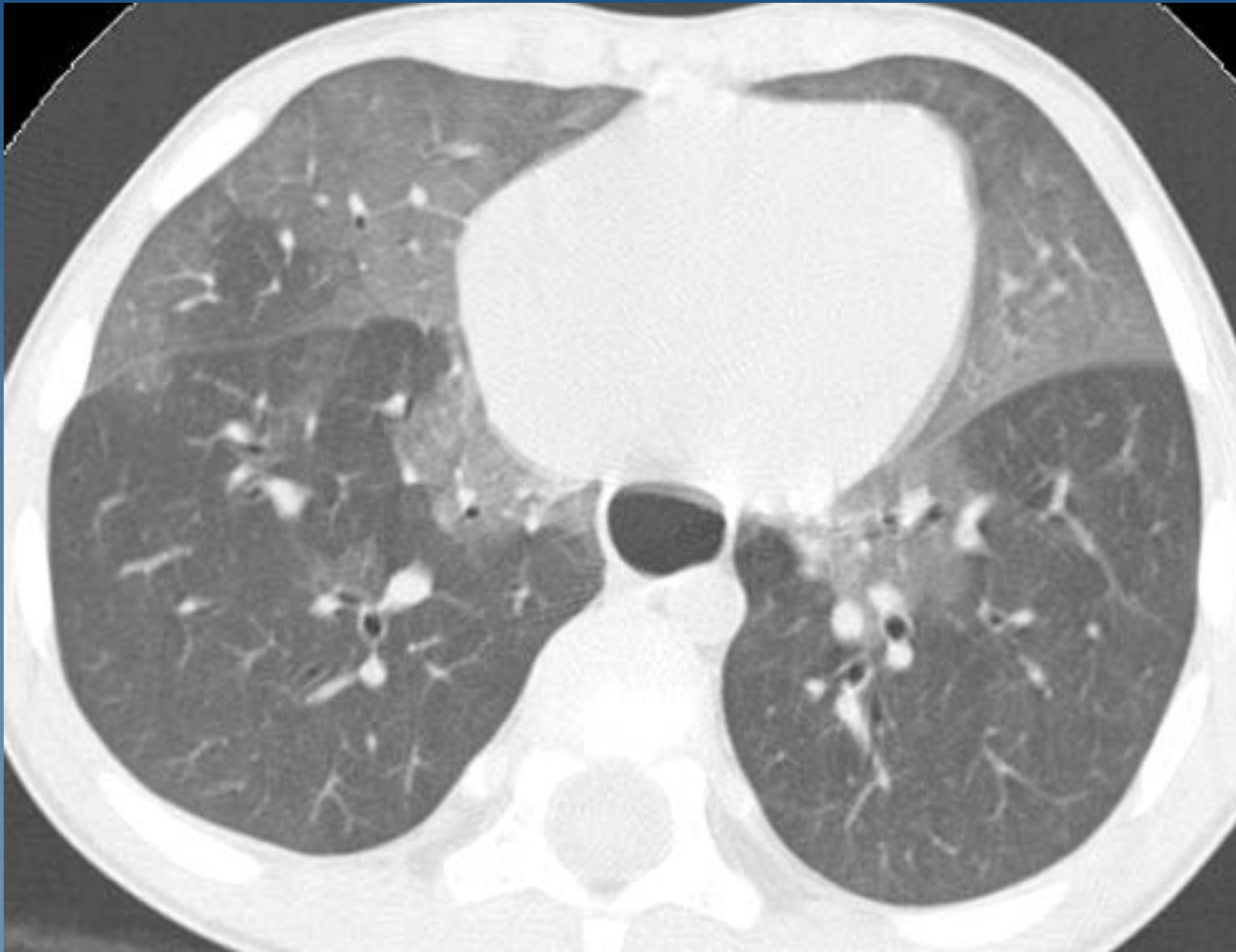




Tree-In-Bud

- ◆ Inspissated material in distal bronchioles
- ◆ Frequently ascribed to infection, especially non-tuberculous mycobacterium
- ◆ In children without an underlying condition probably most often seen with chronic aspiration

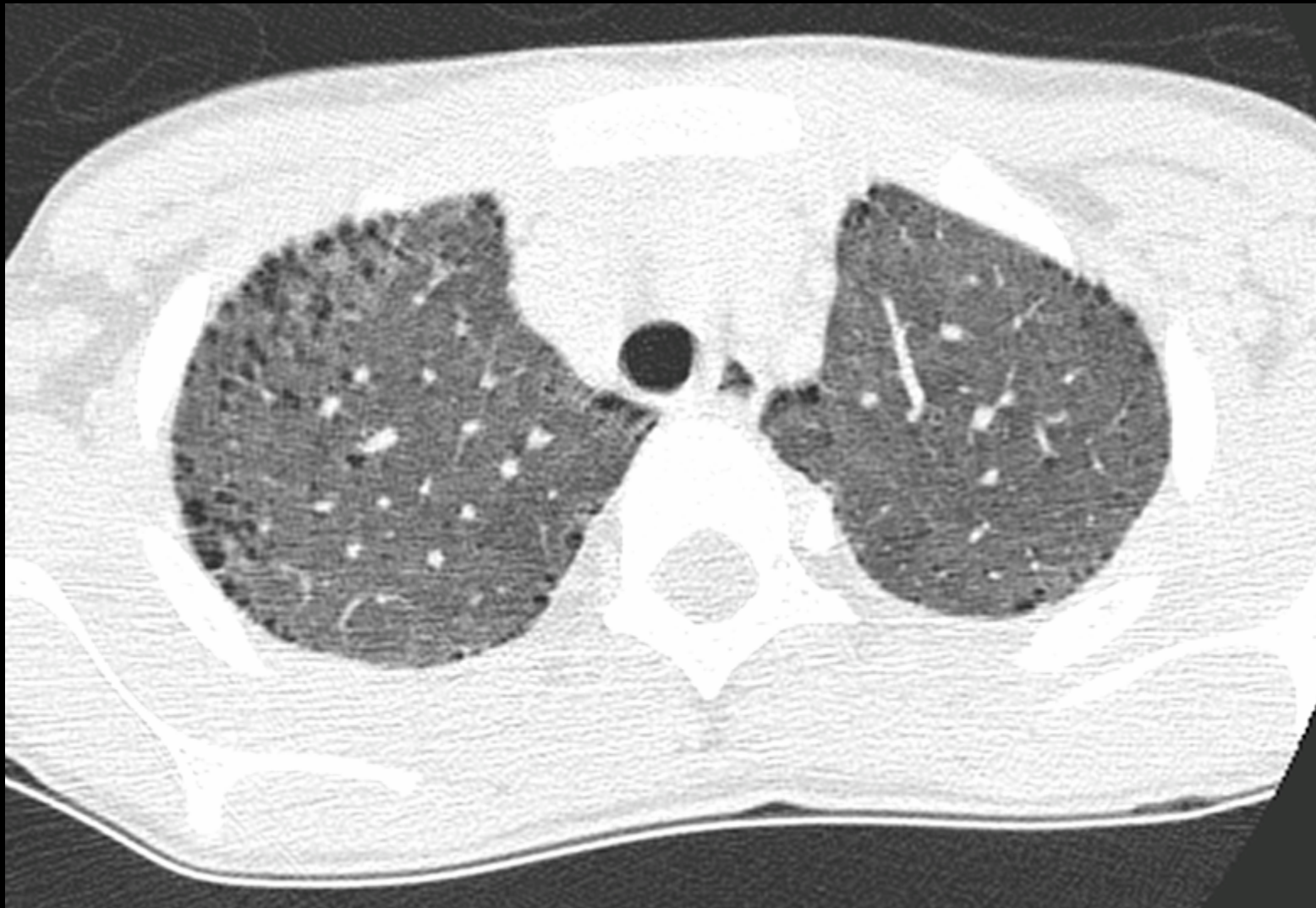
Three Children with Tachypnea



2 year old, Follicular Bronchiolitis



8 year old, Follicular Bronchiolitis



4 year old, Nonspecific Cellular Infiltrate



Follicular Bronchiolitis



Nonspecific Cellular Infiltrate



Follicular Bronchiolitis

- ◆ Commonly associated with HIV, collagen vascular disease, and congenital immune deficiency
- ◆ Good prognosis in adults, can be progressive in children

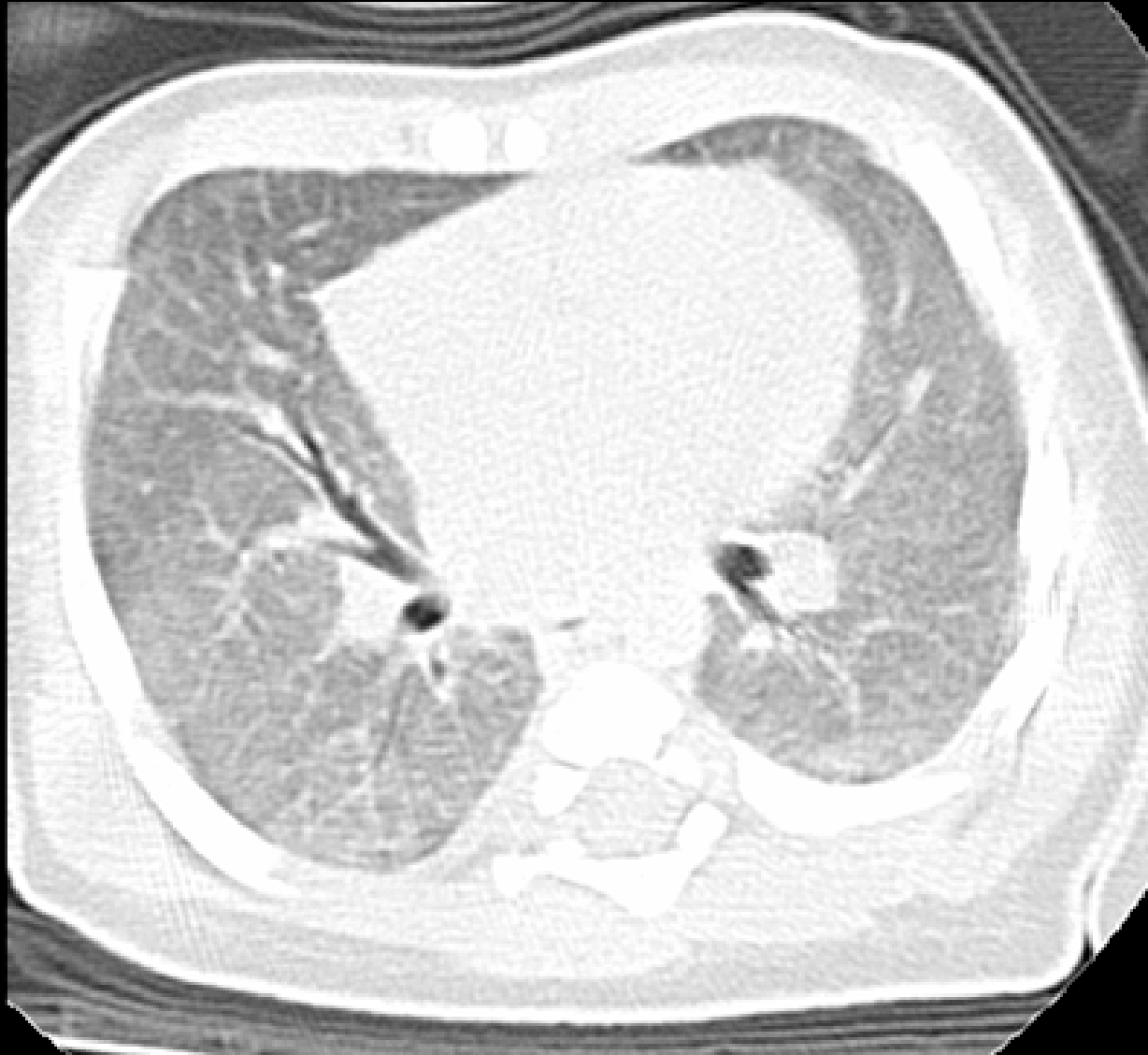
Lymphoid Infiltrative Disorders of the Lung

- ◆ Lymphocytic bronchiolitis
 - ◆ Lymphoid interstitial pneumonitis
 - ◆ Follicular Bronchiolitis
 - ◆ Lymphocytic alveolitis
-
- ◆ Pathologic diagnosis depends on the predominant cell type, the location, and the degree of follicle formation

Pathology Slide Review

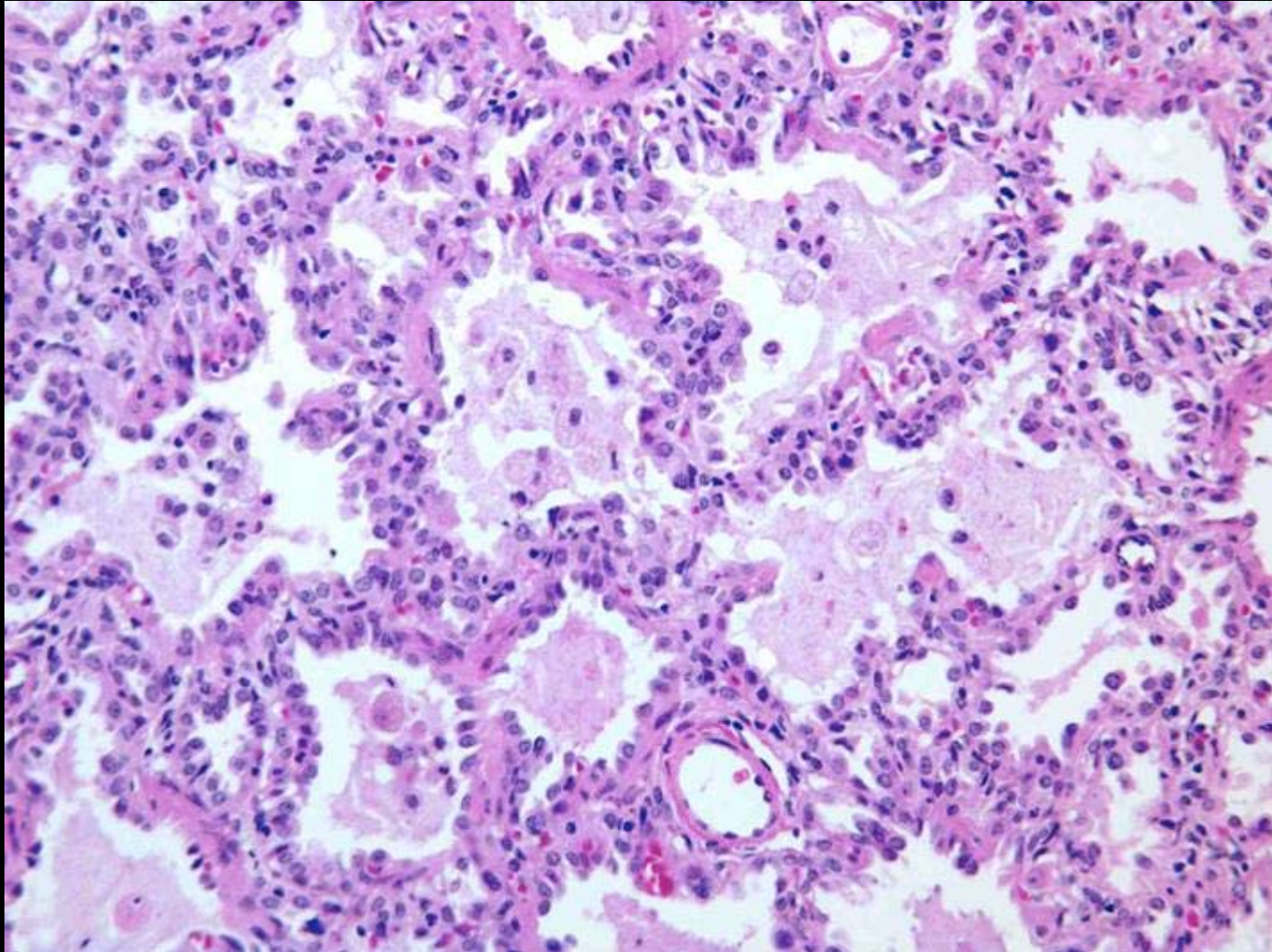
- ◆ The 2 yo with follicular bronchiolitis and the 4 year old with a nonspecific cellular infiltrate had a nearly identical pathologic appearance
- ◆ Diagnosis was most likely lymphoid bronchiolitis in both cases
- ◆ The 8 year old with follicular bronchiolitis had a very different appearance

Neonate with Cyanosis



Courtesy Robin Deterding, MD

Congenital Pulmonary Alveolar Proteinosis



Pulmonary Alveolar Proteinosis

- ◆ Proteinaceous fluid fills alveoli
- ◆ Variable prognosis, usually poor in newborns
- ◆ PAP is a specific pulmonary response to insult, but it is not an etiology
- ◆ Associations include surfactant protein abnormalities, inhalation exposure, lipoid aspiration, immune compromise

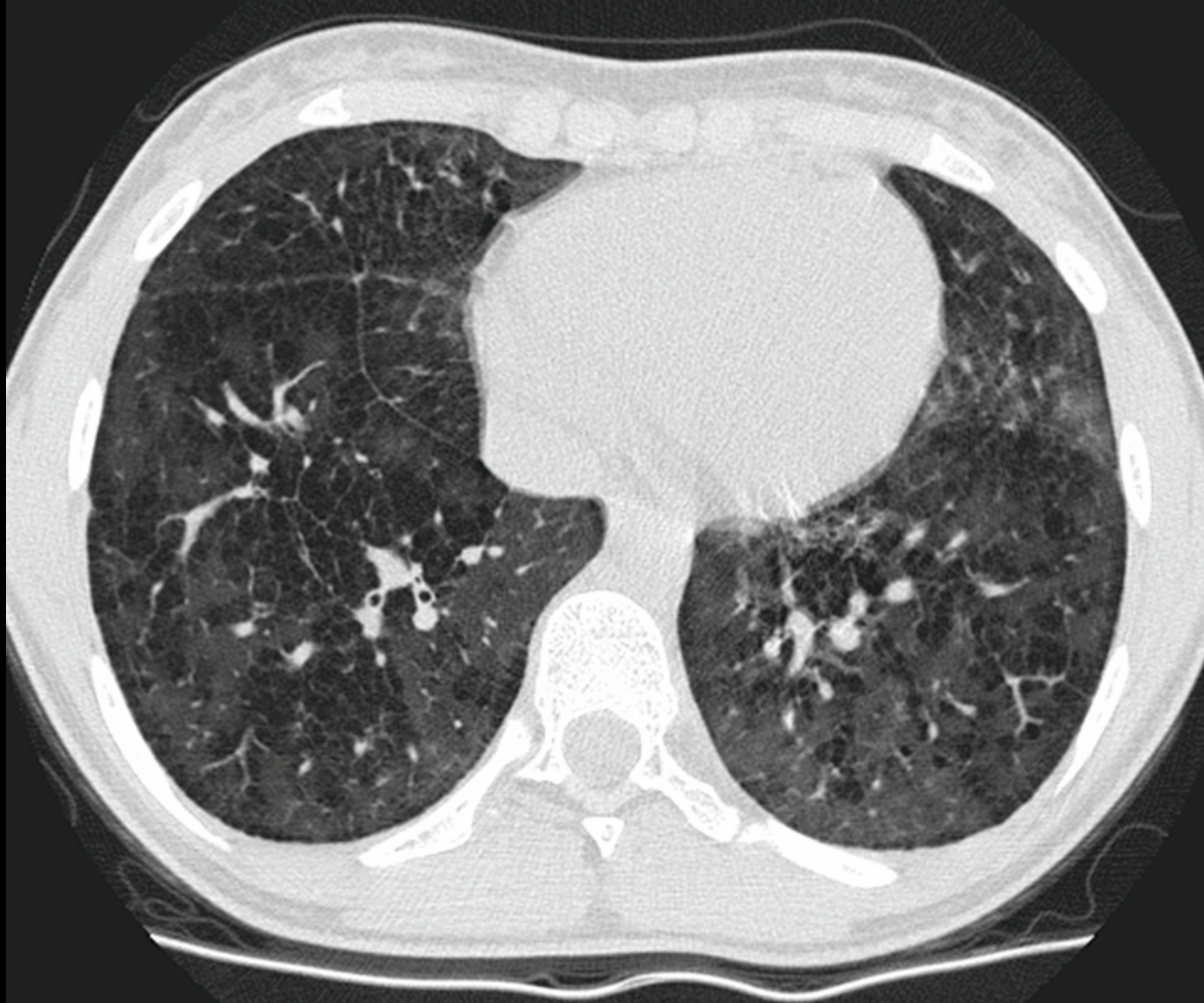
Pulmonary Alveolar Proteinosis

- ◆ Prognosis in children depends on etiology
- ◆ Identification of PAP requires a complete evaluation for known associations

Five yo with Chronic Lung Disease



13 yo with Chronic Lung Disease



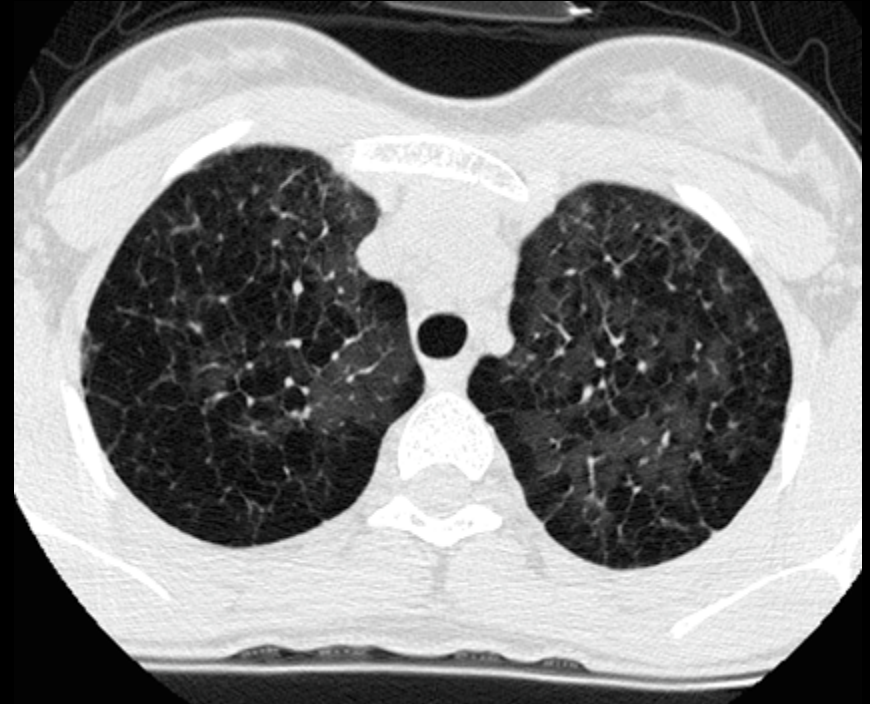
Surfactant Protein C Deficiency

- ◆ One of several surfactant protein abnormalities
- ◆ Increasingly recognized as a cause of chronic lung disease
- ◆ Variable course and presentation
- ◆ Infection likely causes lung damage out of proportion to the infection

Sisters with Surfactant Protein C Deficiency

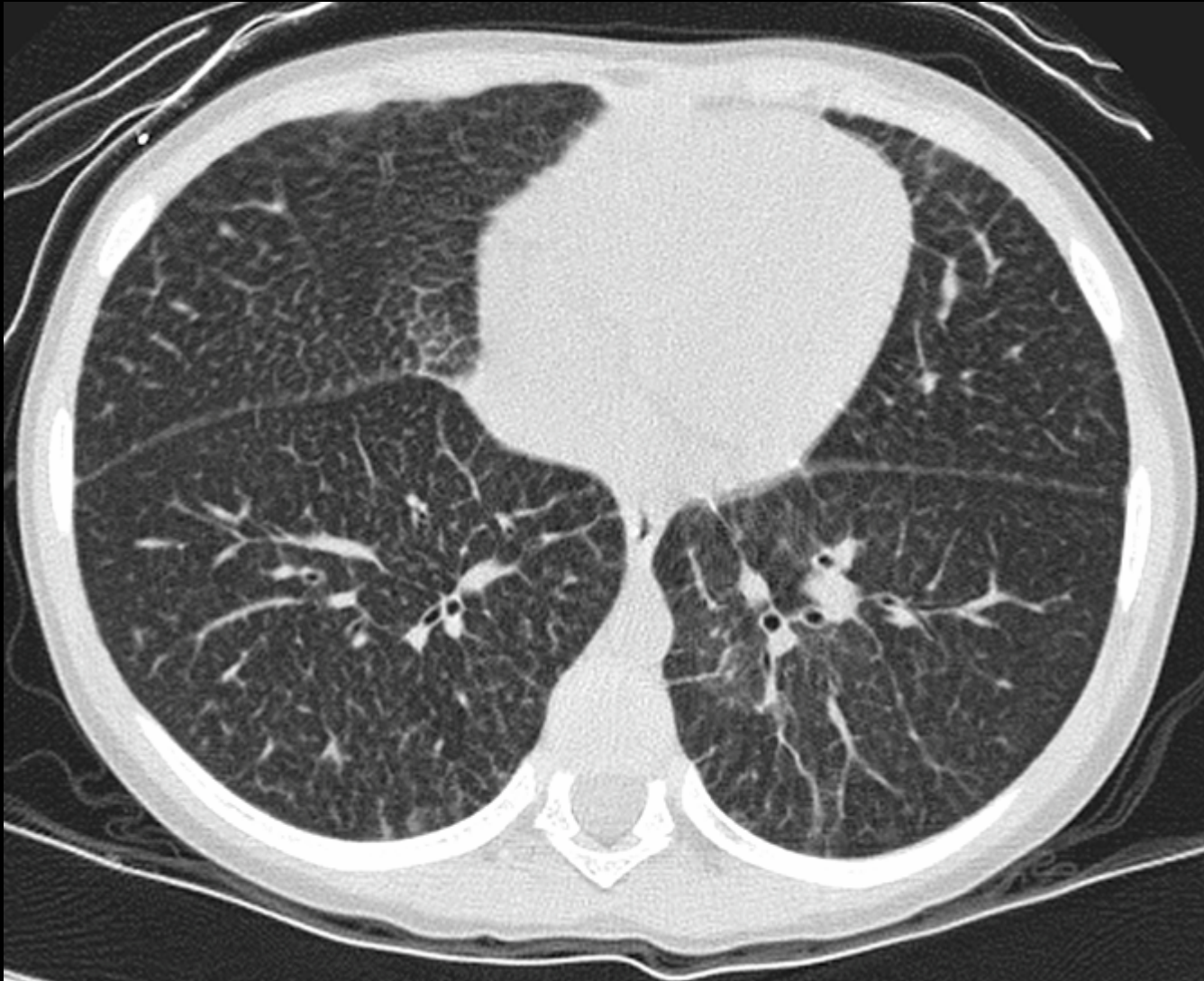


5 year old



13 year old

Niemann-Pick Type B



Niemann-Pick Type B

- ◆ Enzyme defect leads to buildup of sphingomyelin
- ◆ Type B does not involve the CNS, symptoms are abdominal distension and respiratory
- ◆ Abnormal macrophages (“foam cells”) accumulate in the lungs producing nodular and ground glass opacities

Niemann-Pick Type B

- ◆ Pathophysiology of lung disease and imaging appearance is well understood
- ◆ There is no significant relationship between the severity of radiographic abnormality and the severity of respiratory symptoms

Conclusion

- ◆ New techniques allow high quality images in patients of all ages
- ◆ Identifying the presence and location of disease is an important contribution
- ◆ HRCT findings are rarely specific, and lung biopsy will often be needed

Thank You for Your Attention

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