# Nodular Lung Disease

American College of Radiology™

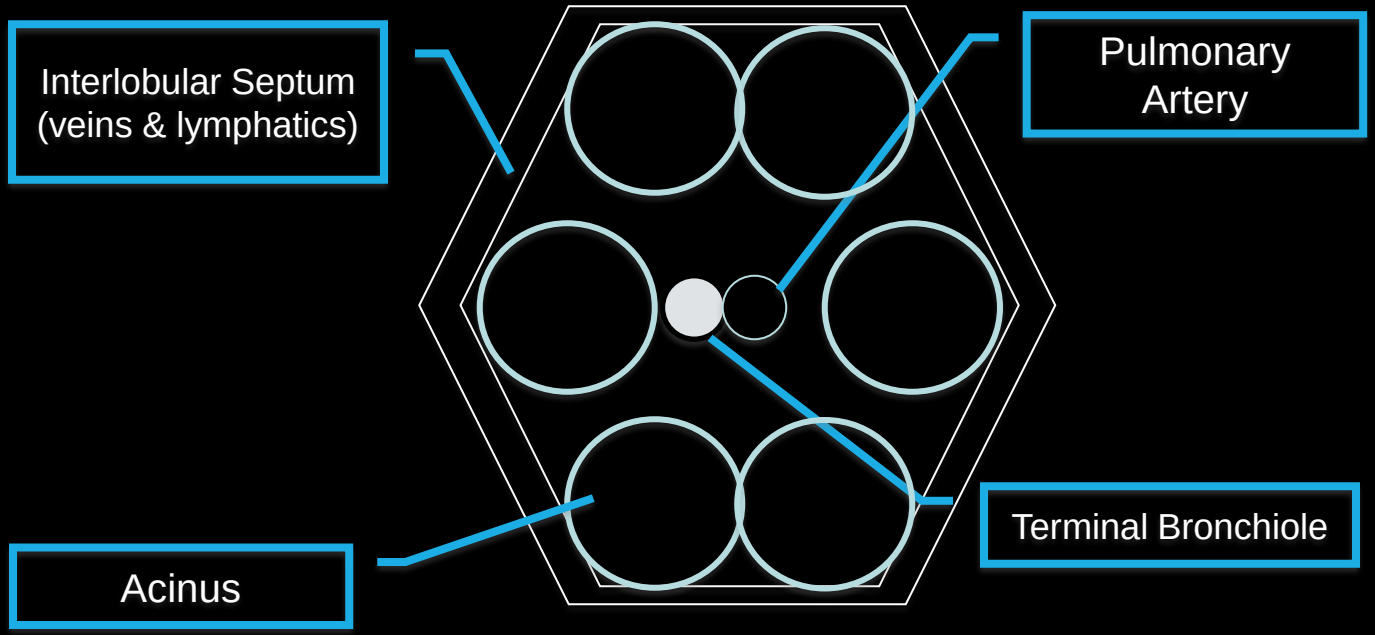
*We Have No Relevant Disclosures*

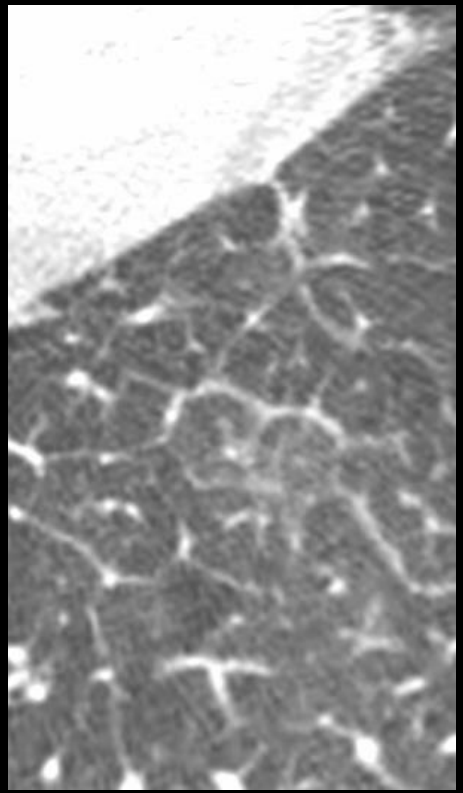
# Content

- Random nodules
- Perilymphatic nodules
- Centrilobular nodules AND Small airway disease

# Approach to Diffuse Nodules

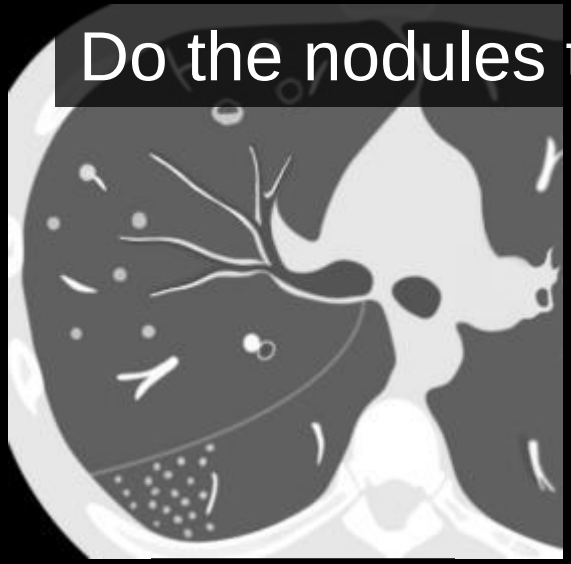
# Pulmonary Lobule



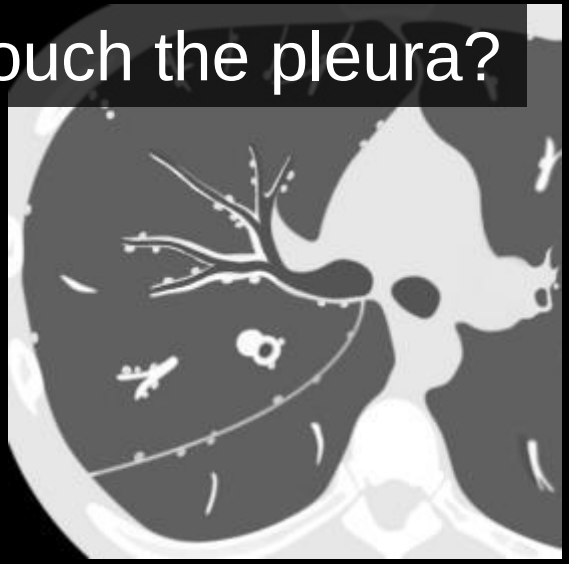
# Nodules: Distribution → Differential

Do the nodules touch the pleura?



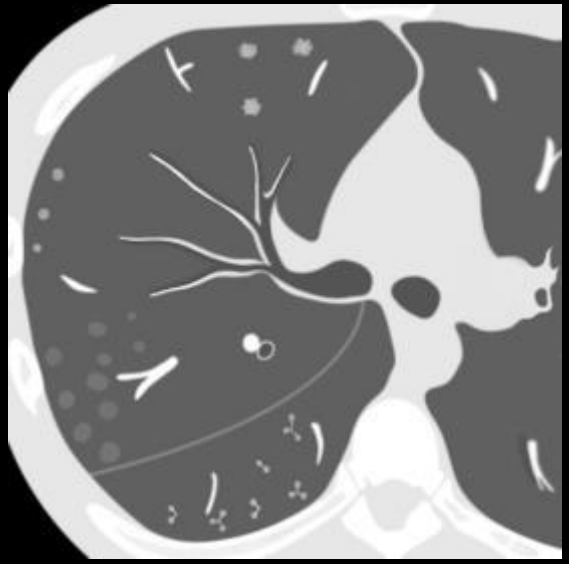
Random

Hematogenous disease



Perilymphatic

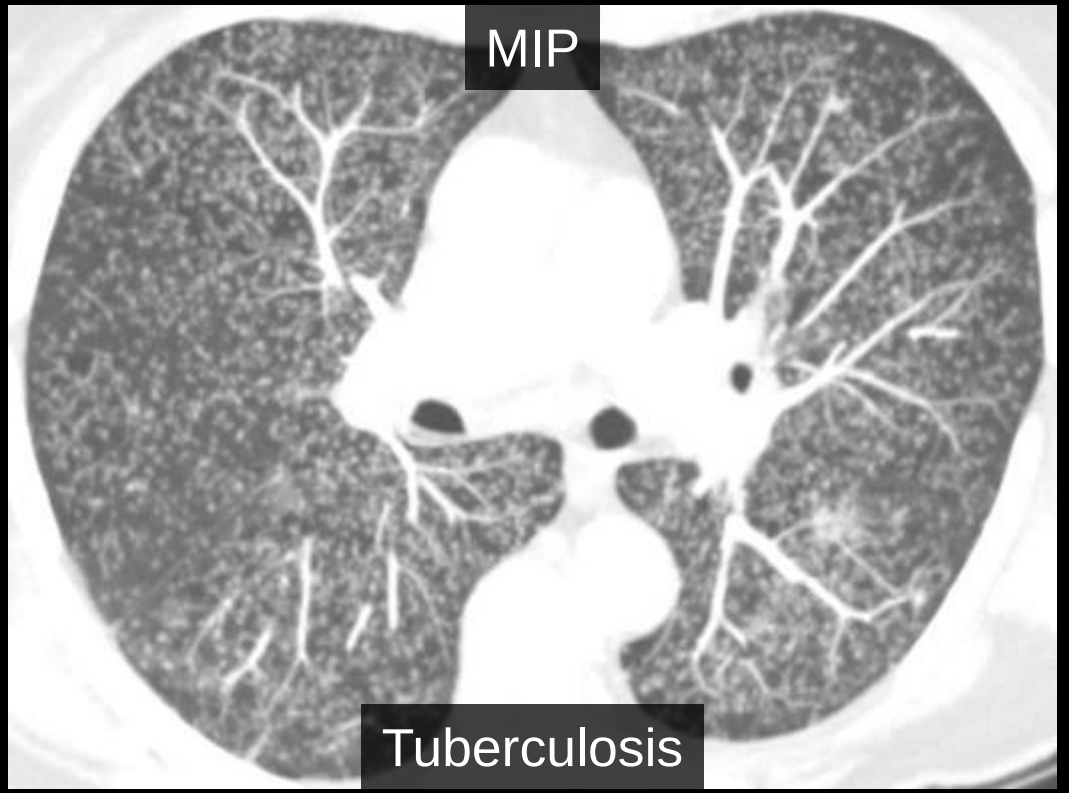
Perilymphatic disease



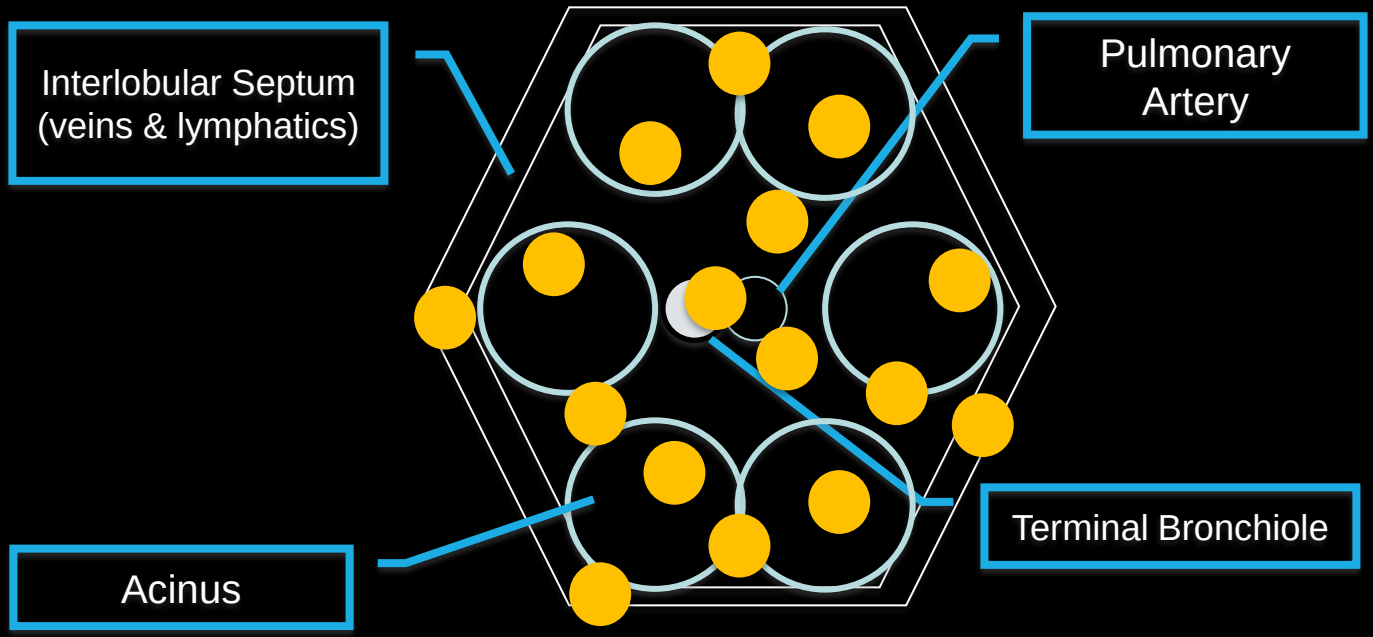
Centrilobular

Small airway disease

# Random Pattern



# Random Pattern



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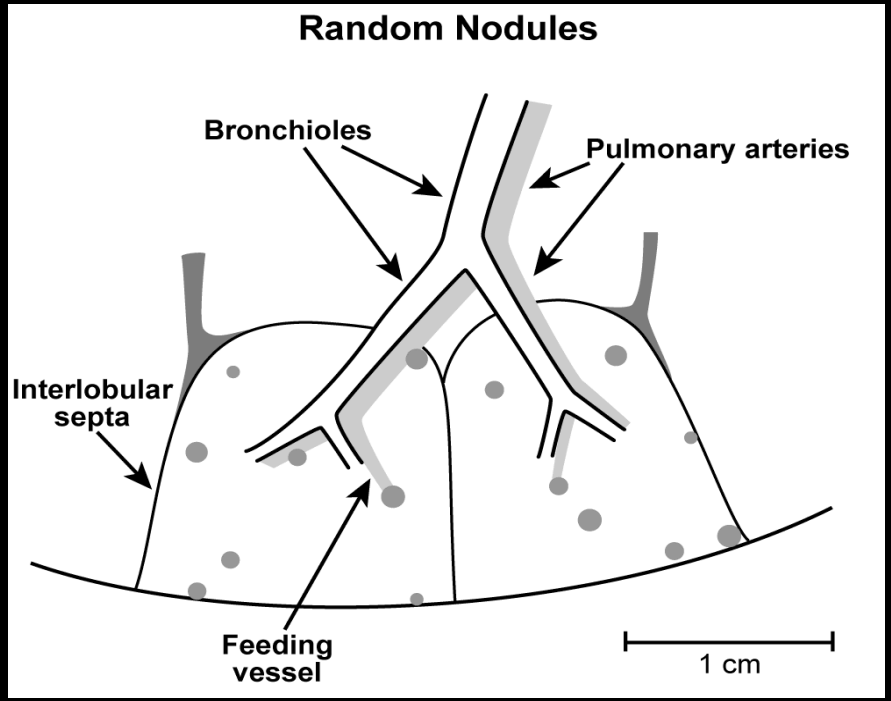
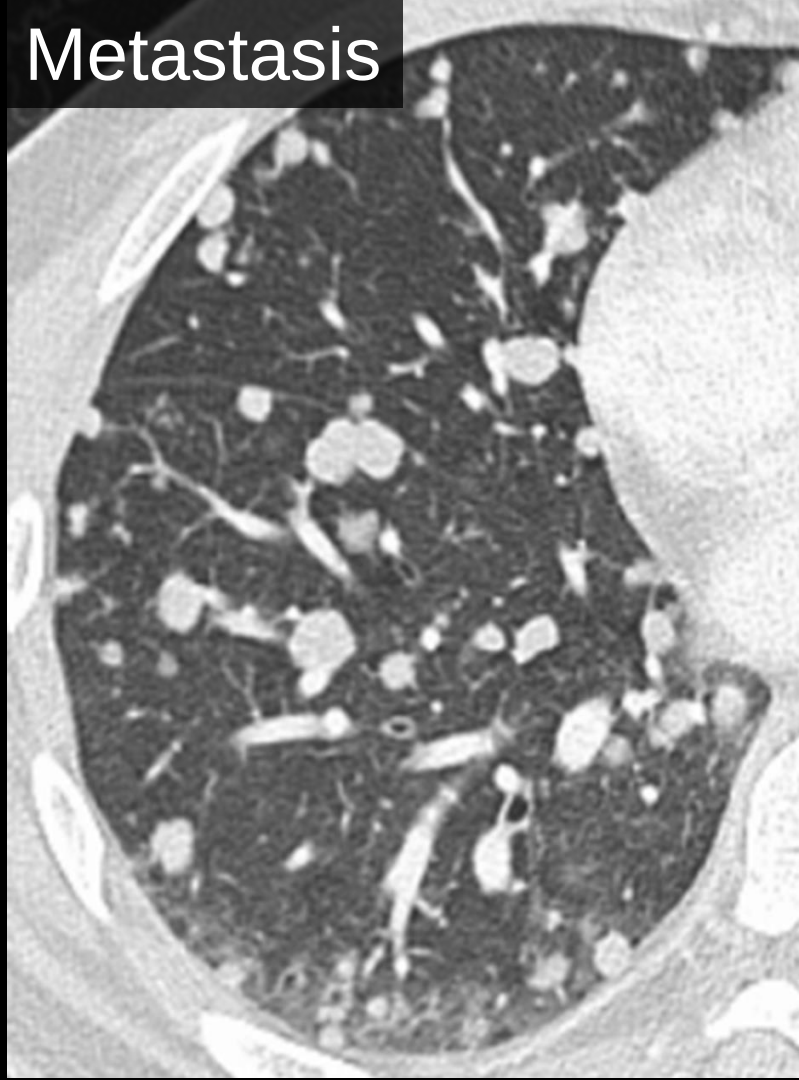



- Equally abut structures = do not coalesce
- Hematogenous spread

# Random Pattern

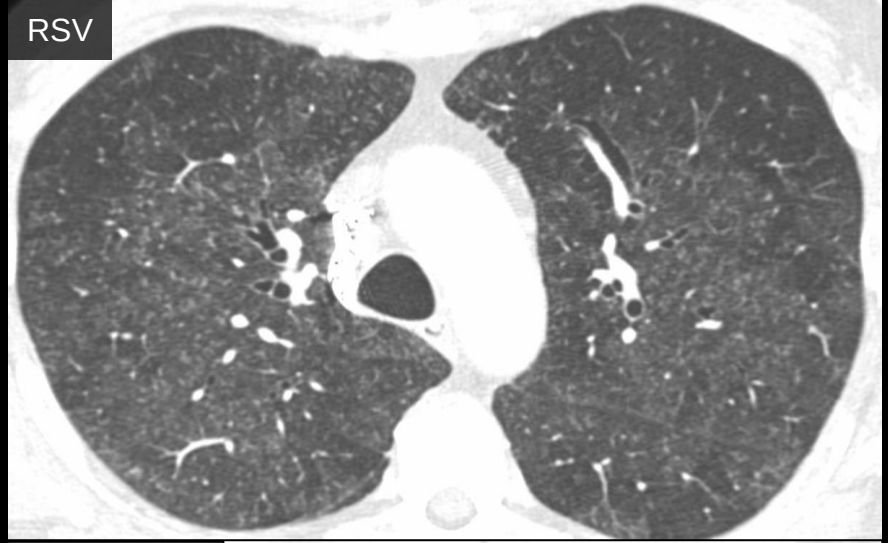
- Variable size
- Typically sharply defined
- +/- cavitary
- Can abut pleura (do not coalesce)
- Main DDx:
  - Infection
  - Metastasis

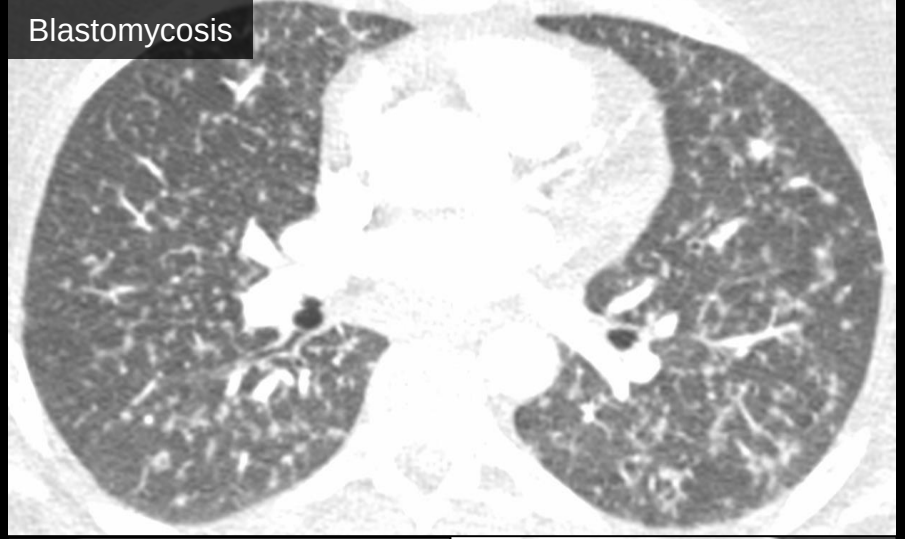


# Random Pattern: Miliary

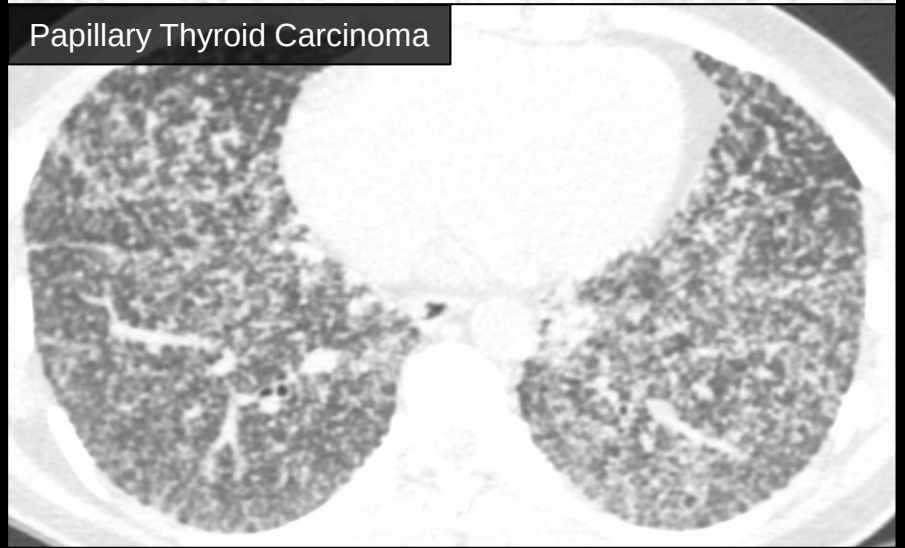
- Profuse, diffuse, random micronodules (1-2 mm)
- Usually insidious presentation
- Same differential:
  - Infection (TB, fungal, viral)
  - Malignancy (thyroid, renal, melanoma, head & neck)

MIP: Increases conspicuity


RSV


Blastomycosis

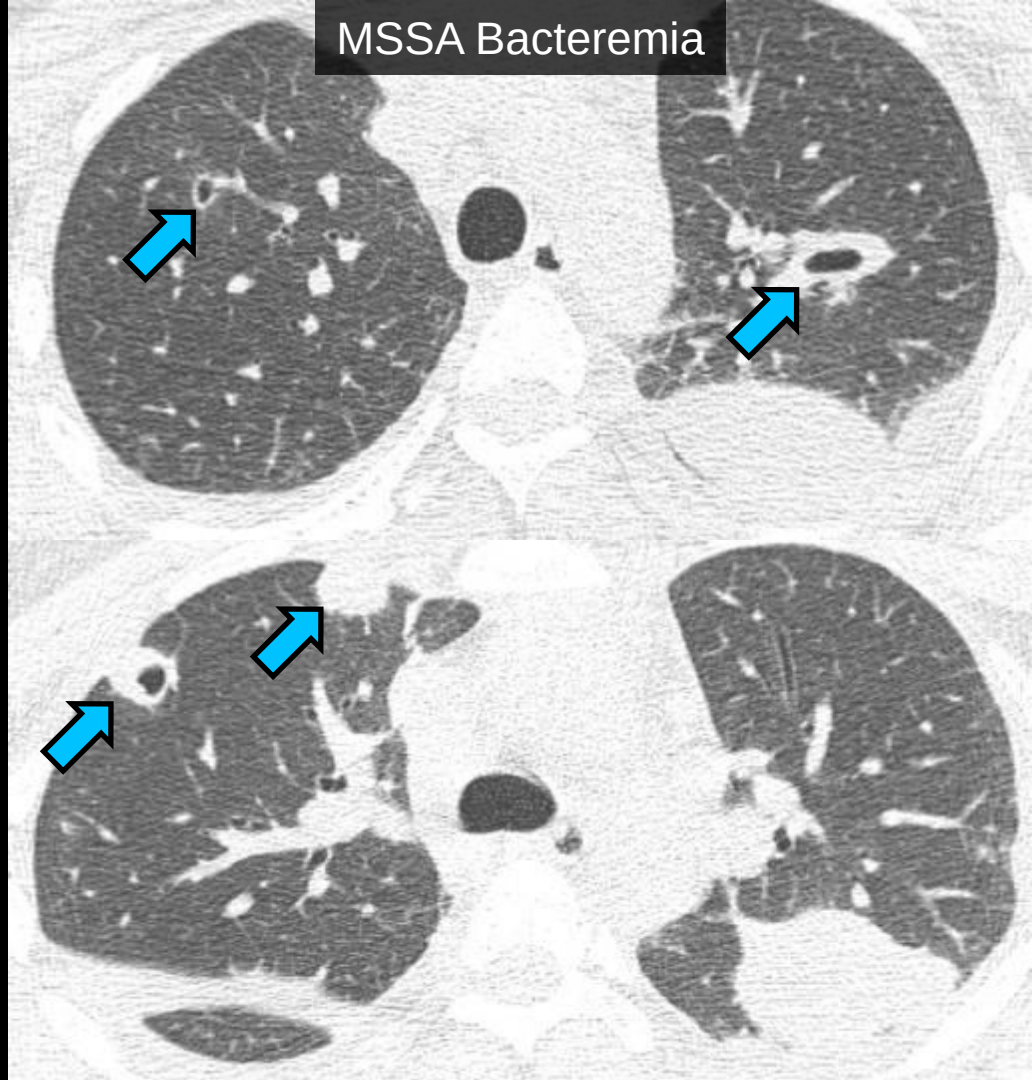

Tuberculosis


Papillary Thyroid Carcinoma

# Random Pattern (Rarely): Sarcoid

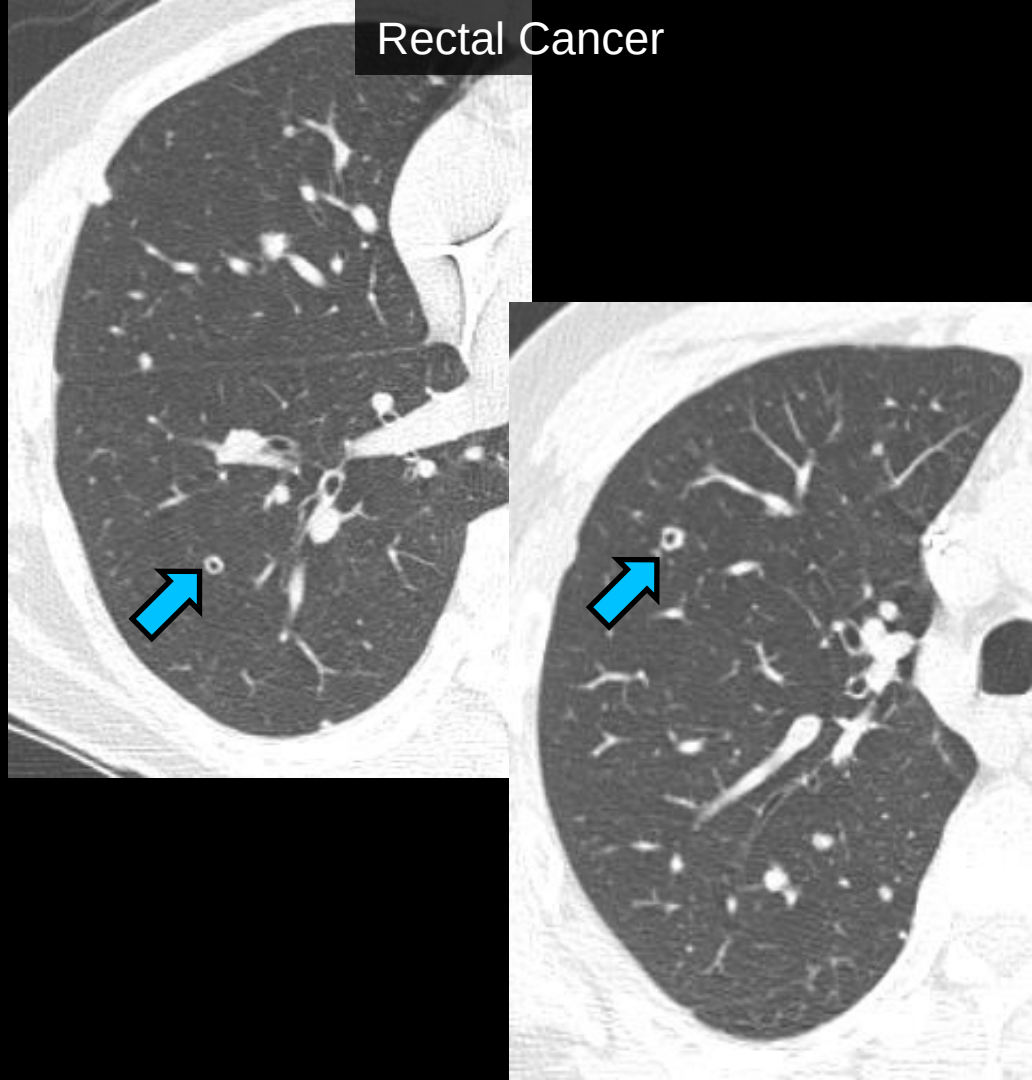
# Random Pattern: Cavitary

- Septic emboli
- Mycobacterial/fungal infection
- Metastases



# Random Pattern: Cavitary

- Septic emboli
- Mycobacterial/fungal infection
- Metastases (e.g. SCC, colorectal, lung)



# Random Pattern: Cavitary

- Less common
  - Vasculitis
  - Recurrent respiratory papillomatosis
  - Meningothelial-like nodules

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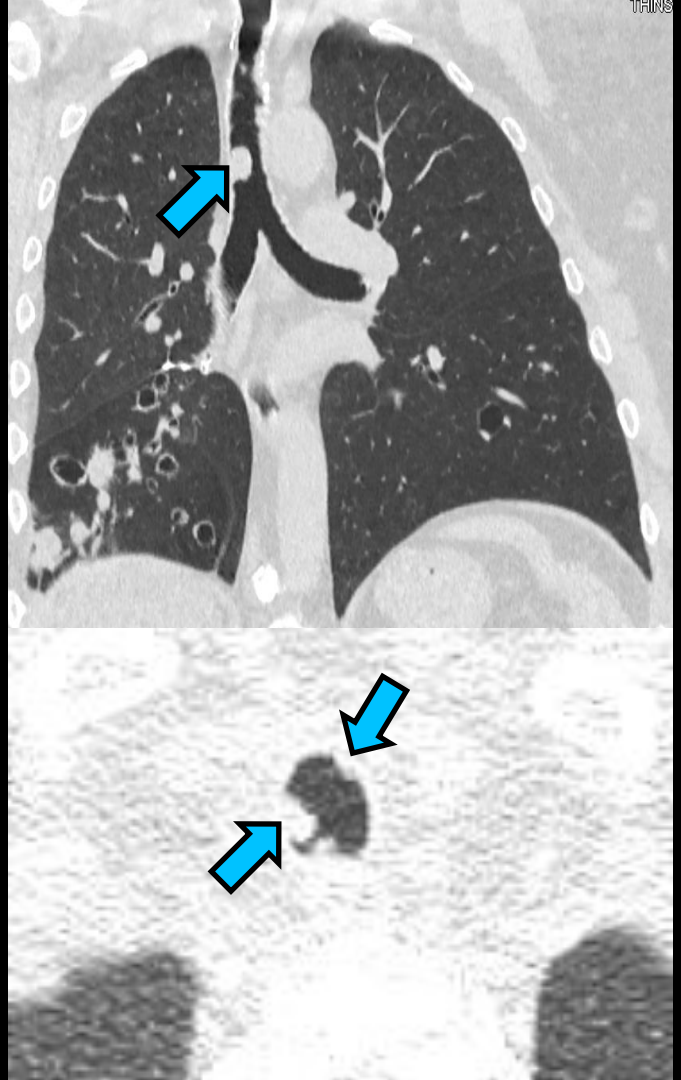

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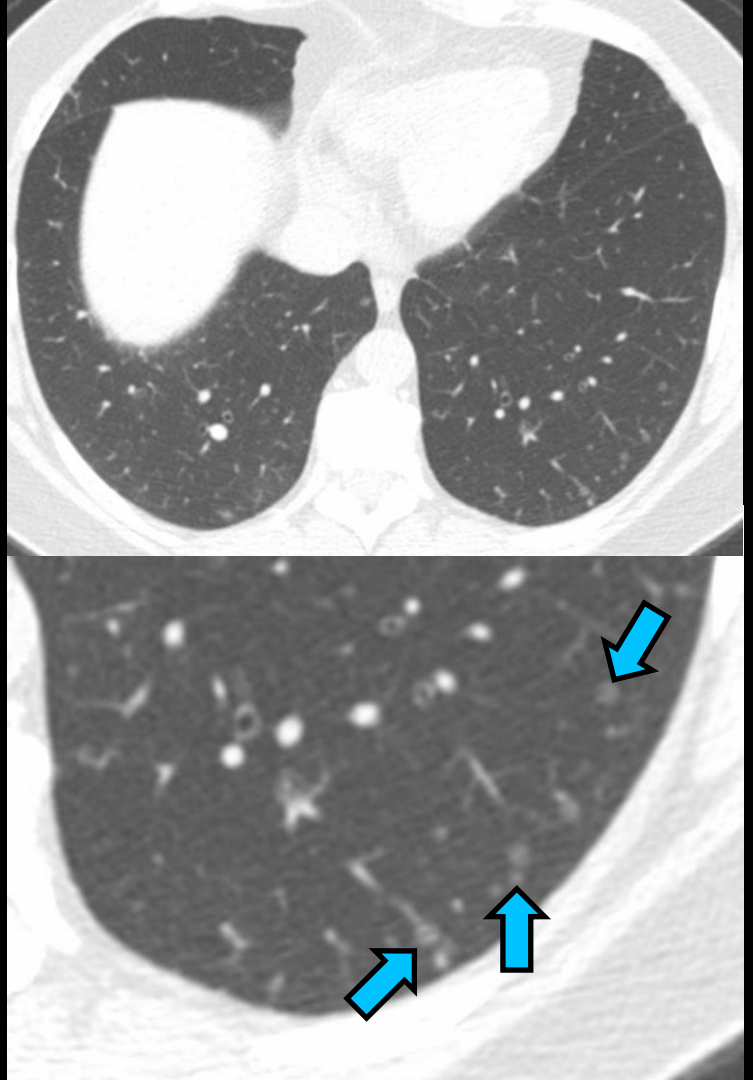
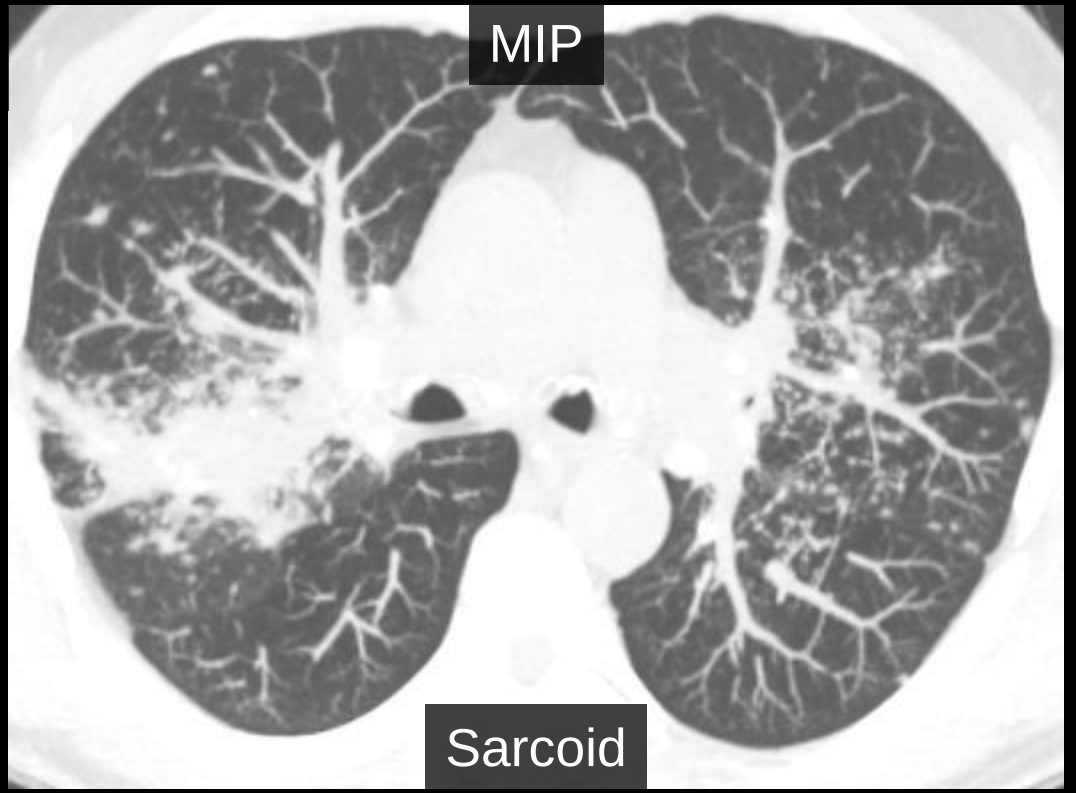


# Perilymphatic Pattern

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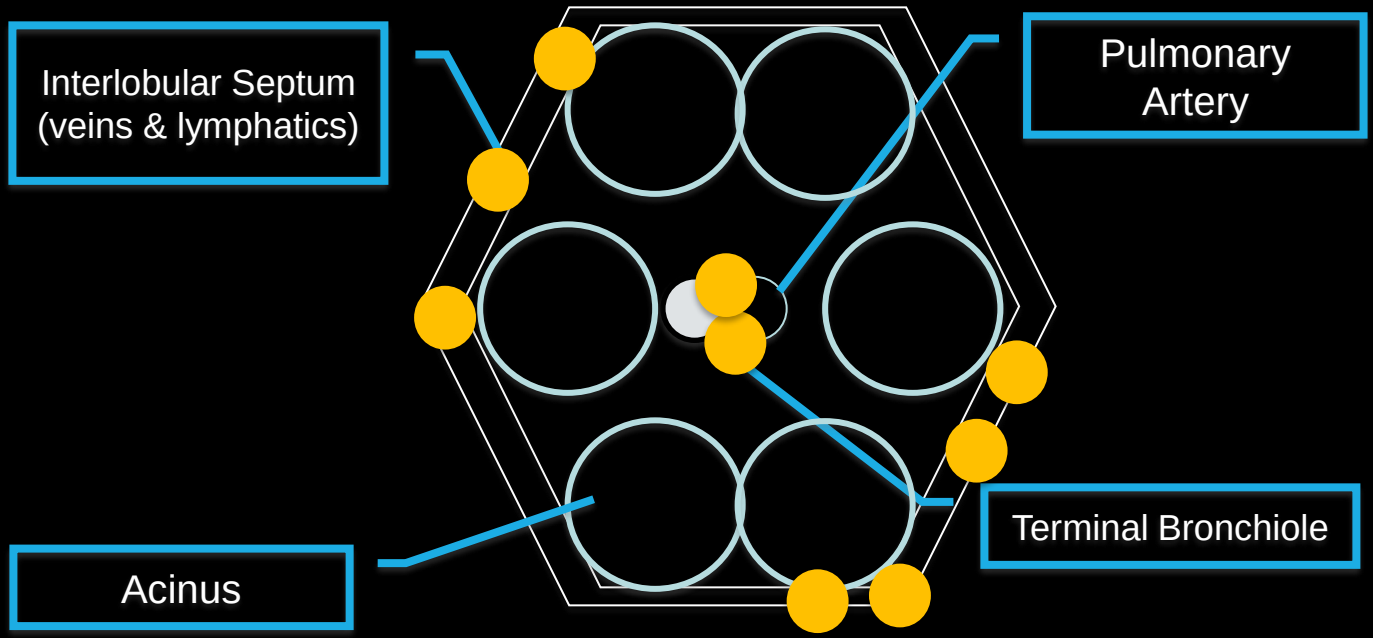
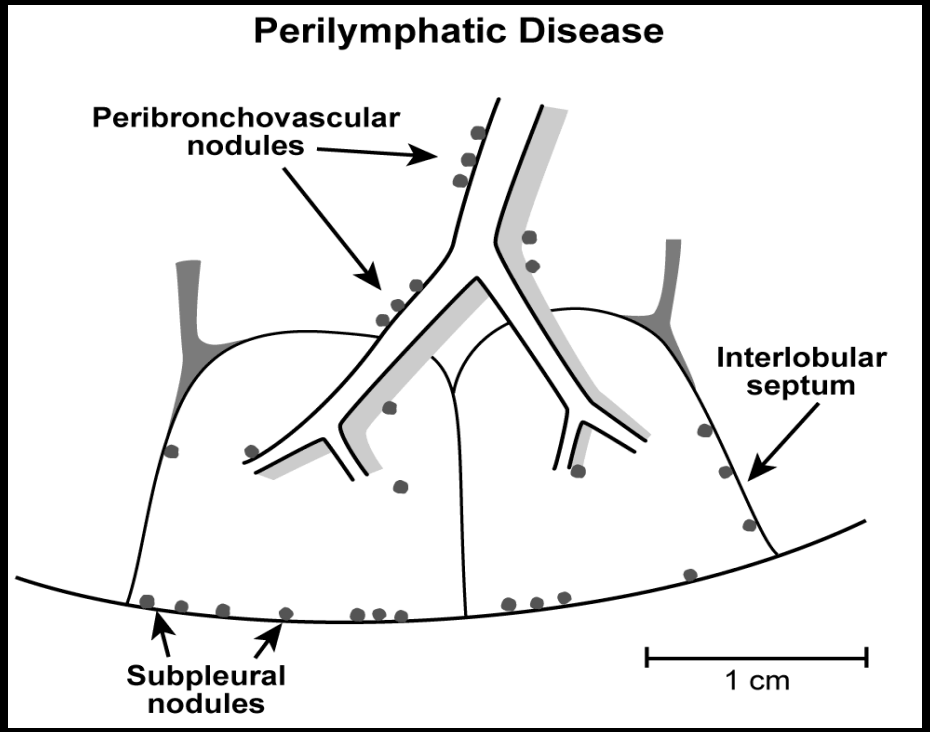
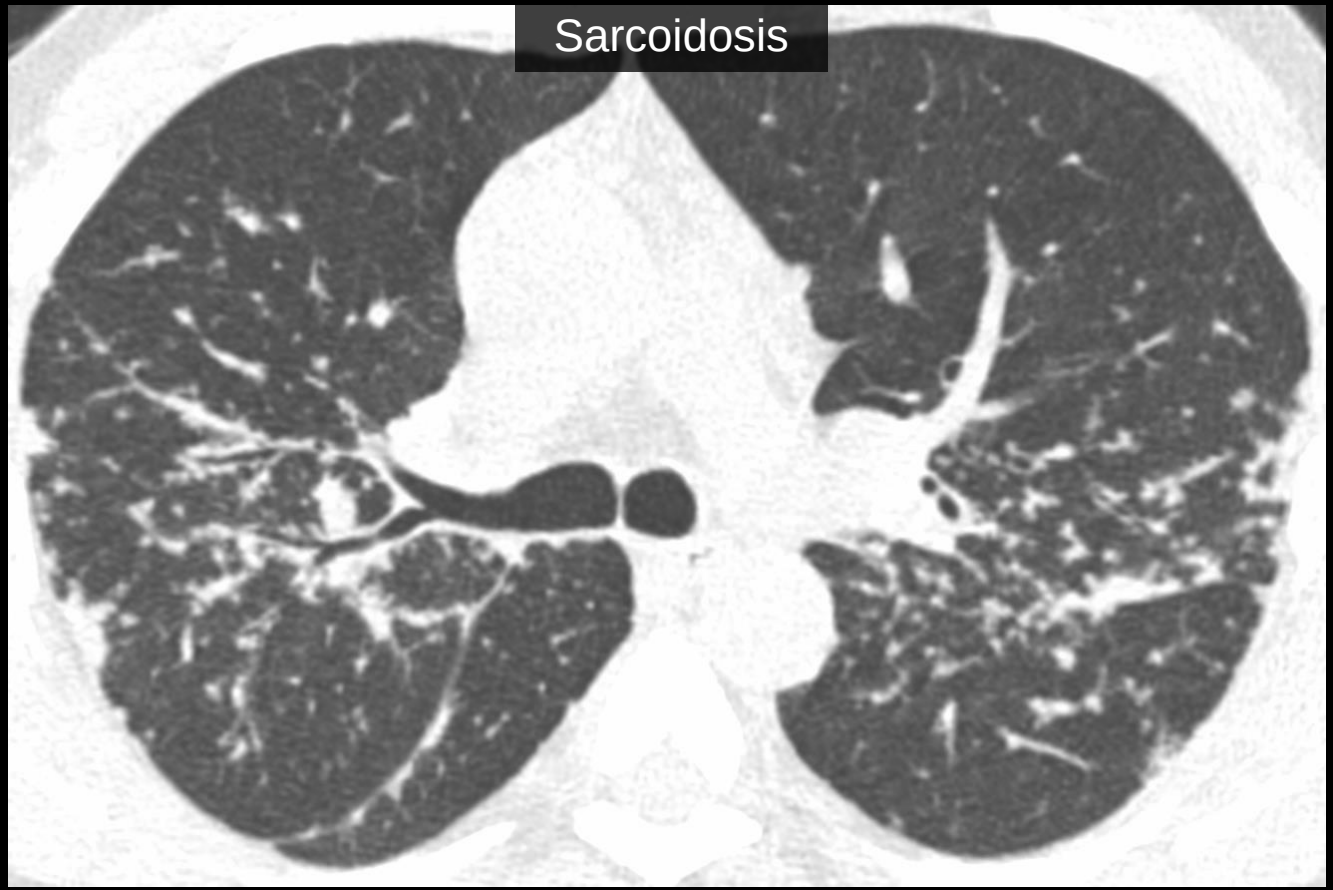


# Perilymphatic nodules go along interstitium

- Along fissures
- Costal pleura
- Pulmonary veins (interlobular septa)
- Bronchovascular bundles

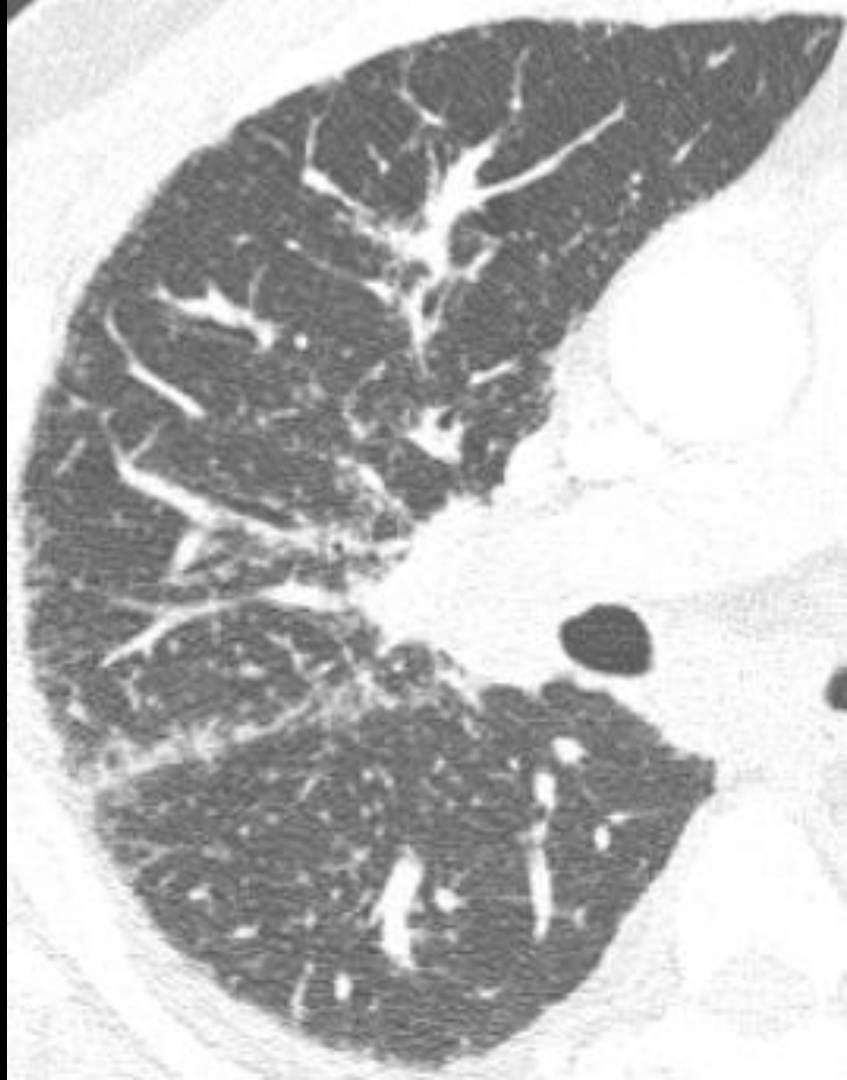


# Perilymphatic nodules = Clustering is key



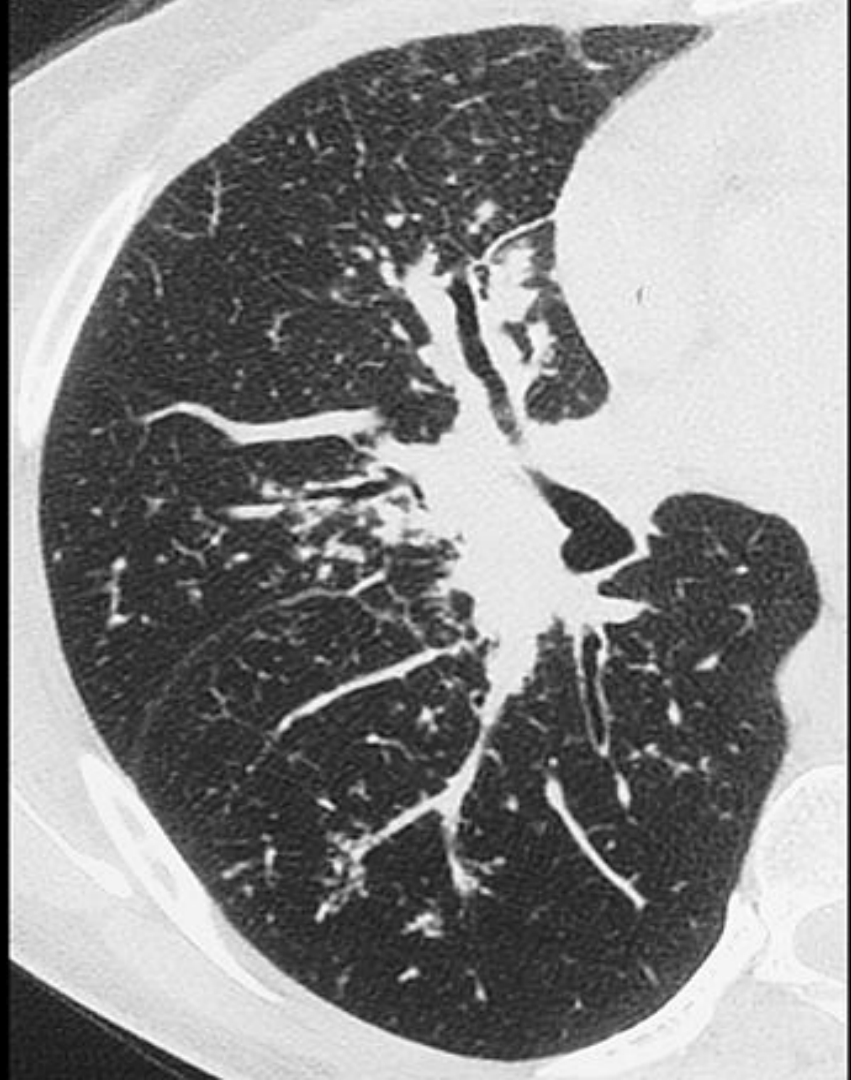
# Perilymphatic Pattern

- Irregular margins
- DDx
  - Sarcoidosis
  - Lymphangitic carcinomatosis

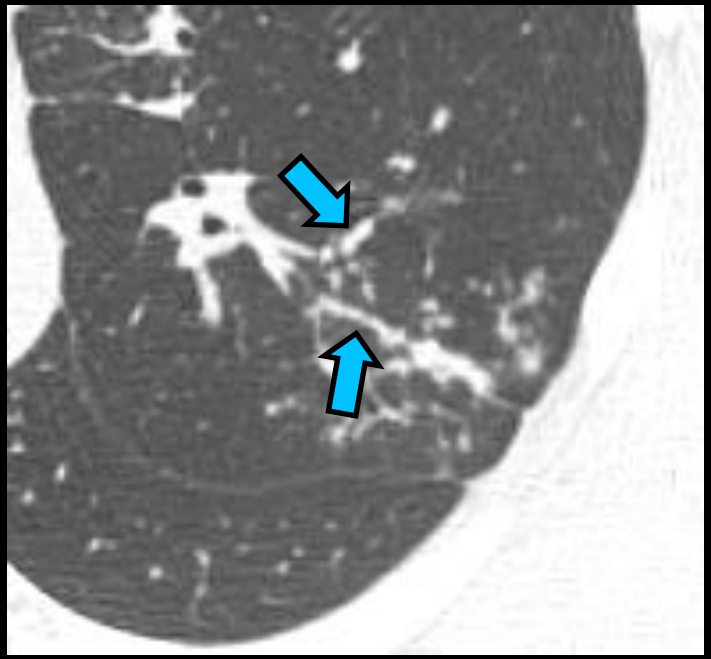


# Perilymphatic Pattern

- Sarcoidosis:
  - Upper to mid zone
  - “Symmetric”
  - Clustered
  - Beaded veins



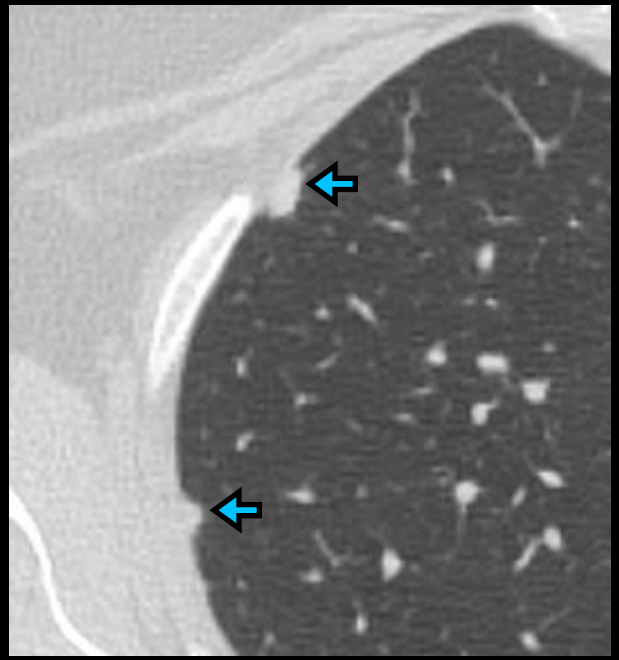
# Perilymphatic Pattern: Sarcoidosis



“Beaded” veins

Clustering around bronchovascular structures

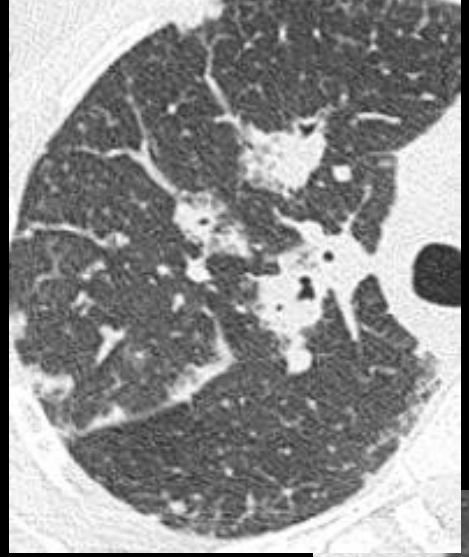
# Perilymphatic Pattern: Sarcoidosis

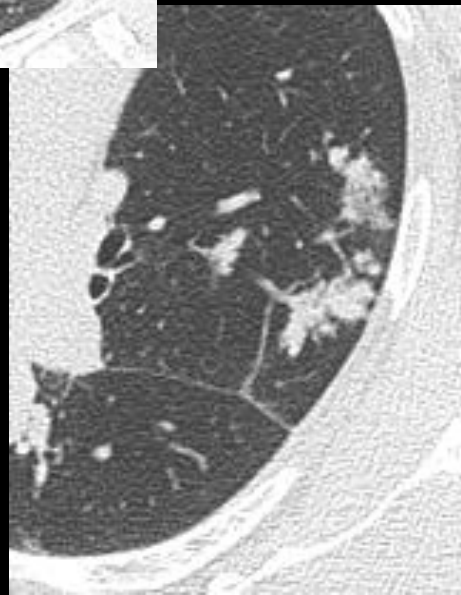


Pseudoplaques = coalescent small nodules

# Perilymphatic Pattern

- Sarcoidosis (less common):
  - Well-defined and/or cavitary nodules
  - “Ground-glass attenuation”
  - Diffuse





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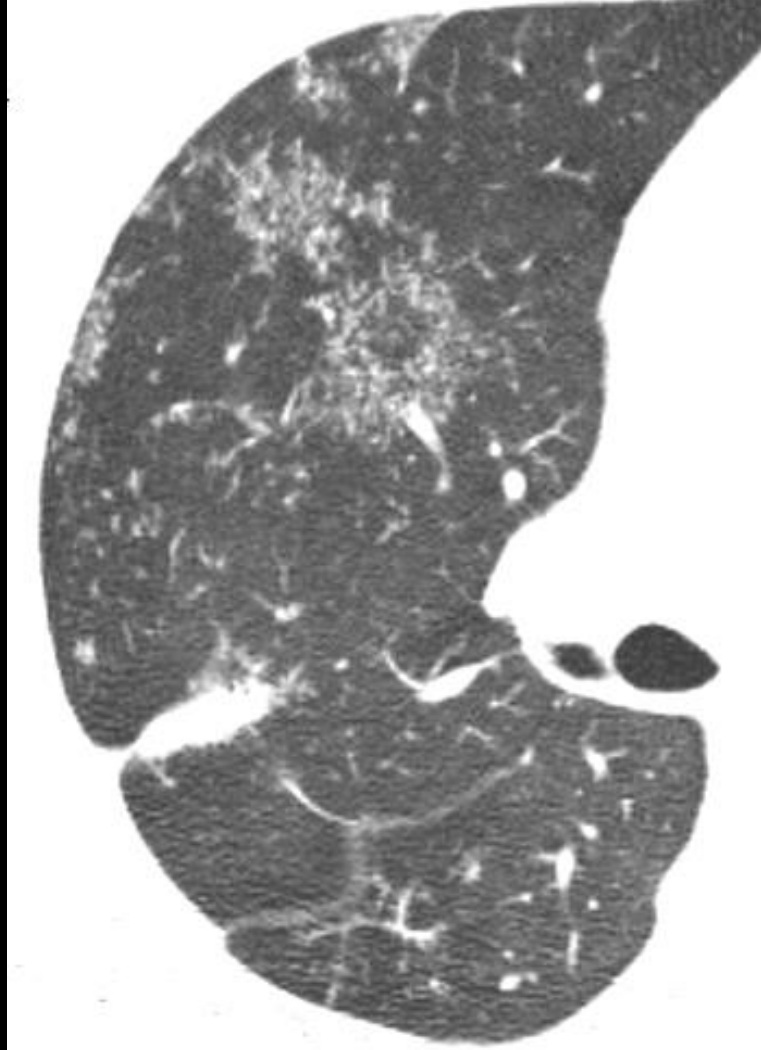
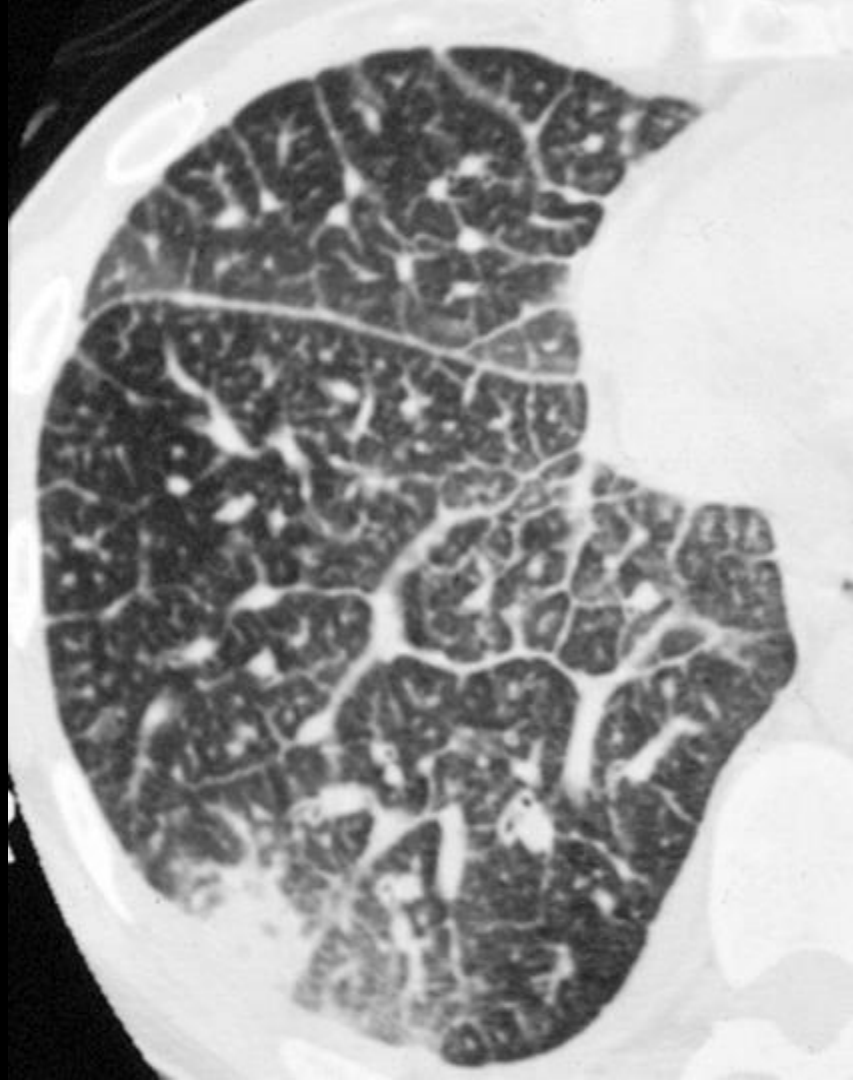




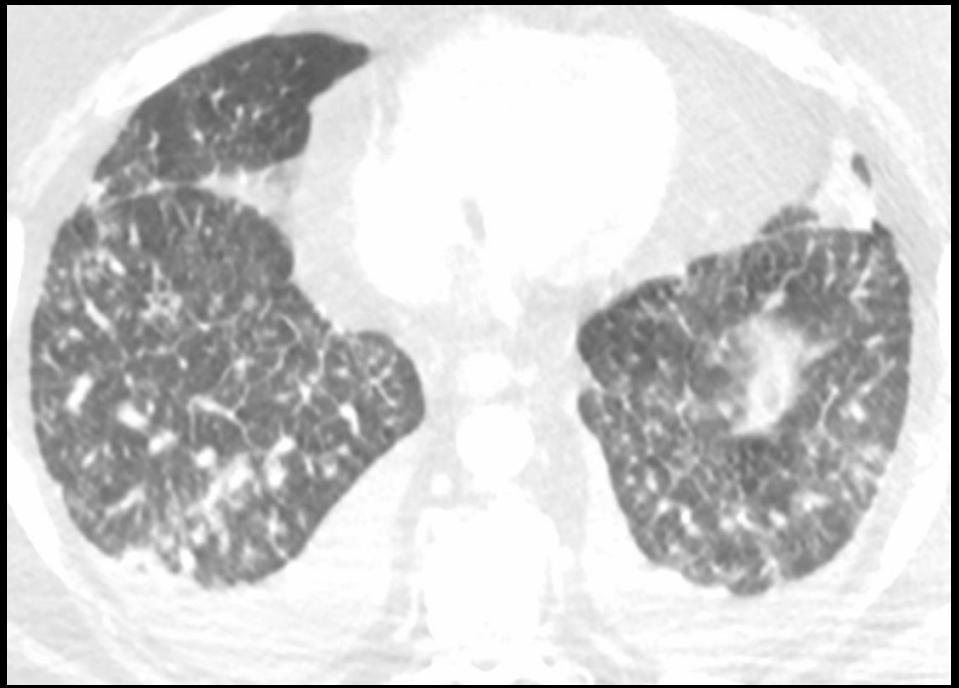
“Subtle” = often confused with ground-glass

# Perilymphatic Pattern

- Lymphangitic carcinomatosis
  - Thickened septa/ fissures
  - Smooth or nodular
  - Asymmetry is a concern
  - +/- lymphadenopathy, effusions

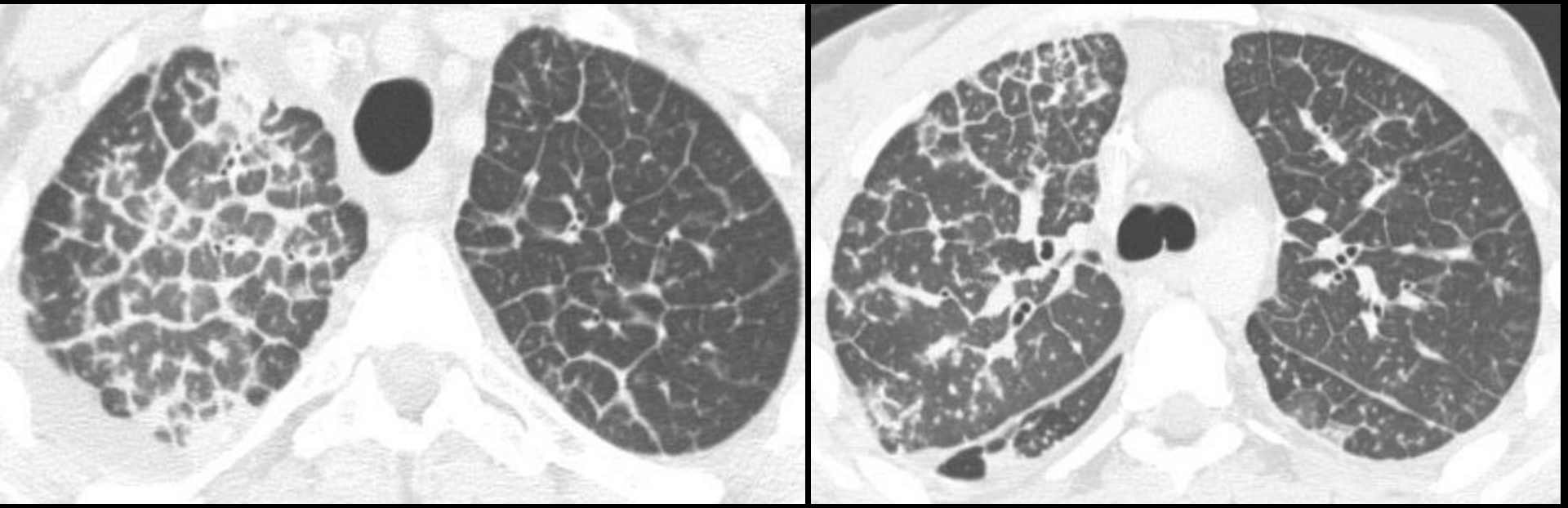


# Perilymphatic Pattern: Lymphangitic Carcinomatosis



Usually more lines than sarcoid

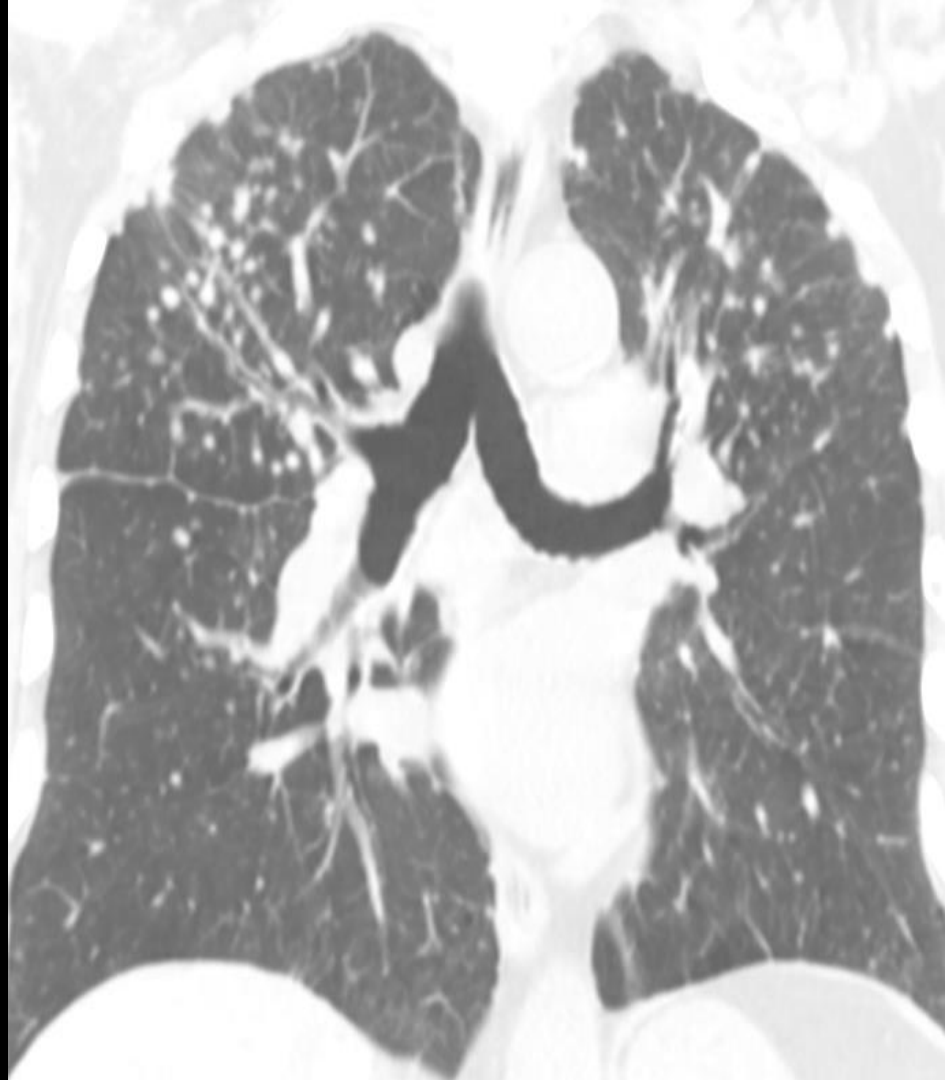
# Perilymphatic Pattern: Lymphangitic Carcinomatosis



Asymmetry is suspicious

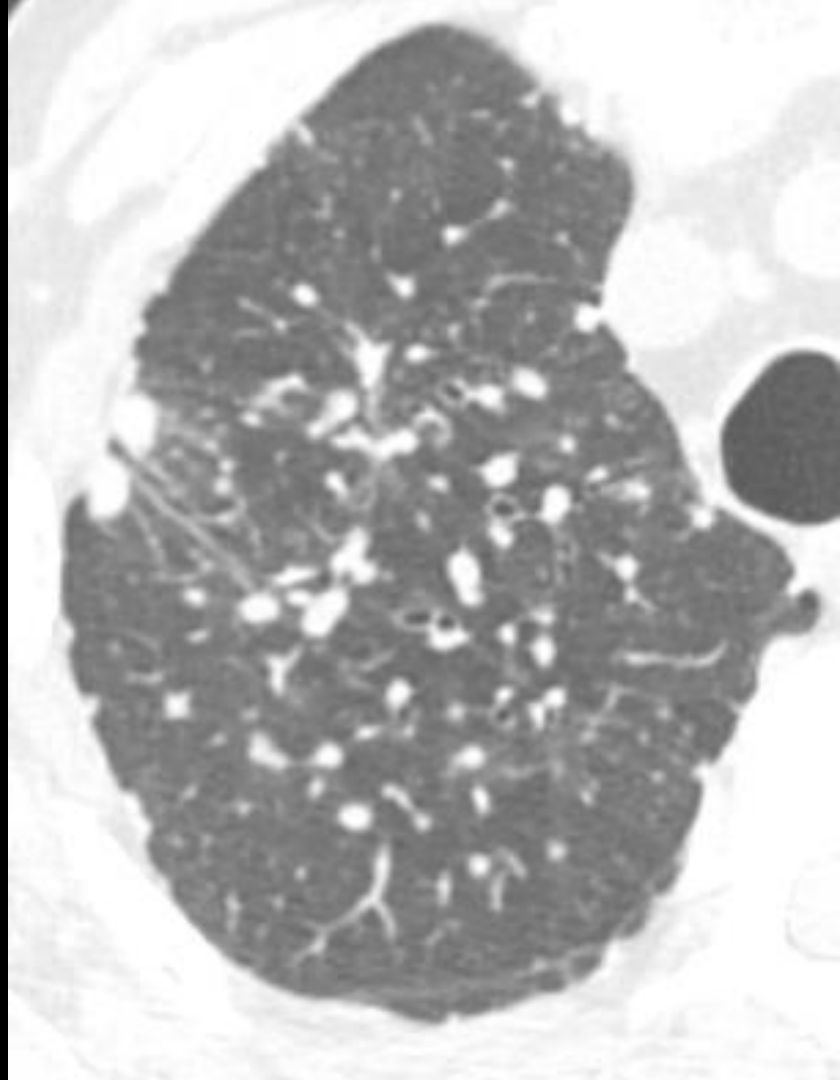
# Perilymphatic Pattern

- Smooth margins
- DDx
  - Silicosis
  - Coal worker's pneumoconiosis

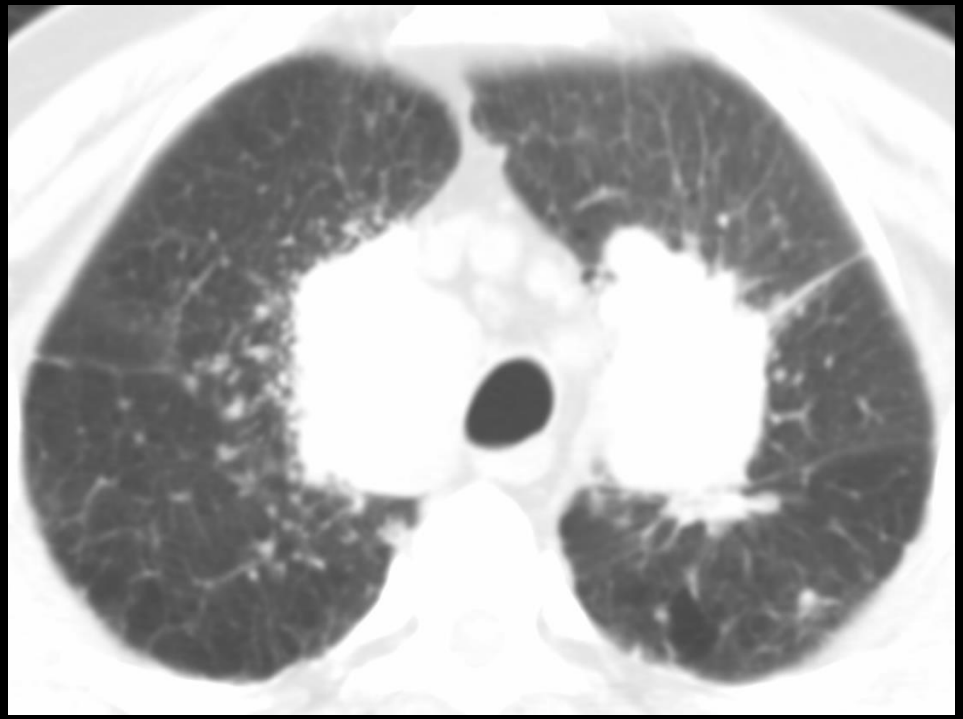


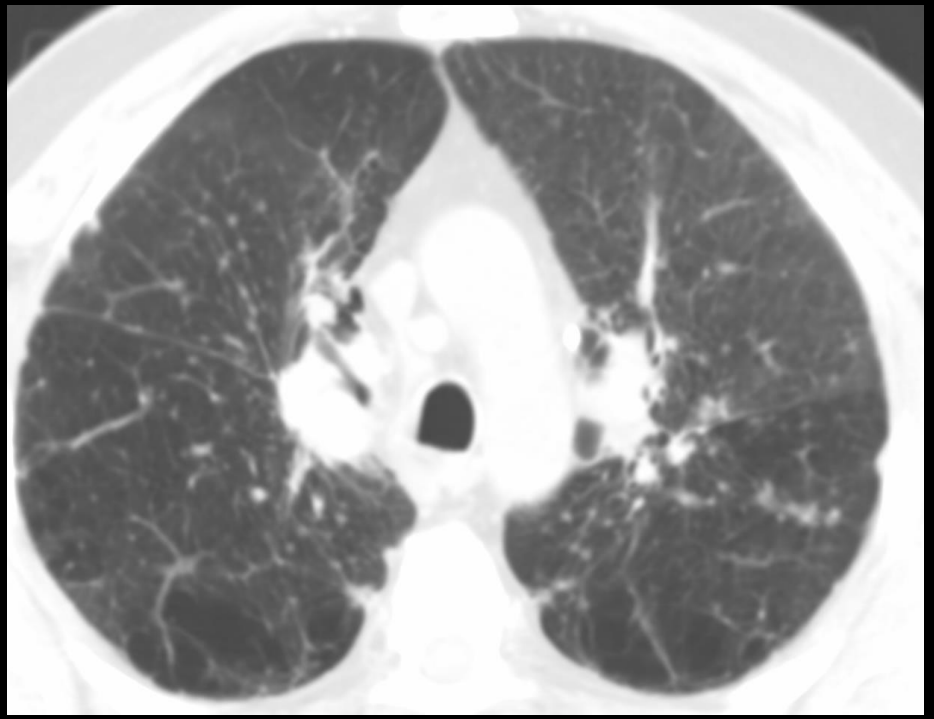
# Perilymphatic Pattern

- Silicosis
  - Small nodules
  - Usually more round than sarcoid
  - Upper lobe
  - Occupational exposure history is key



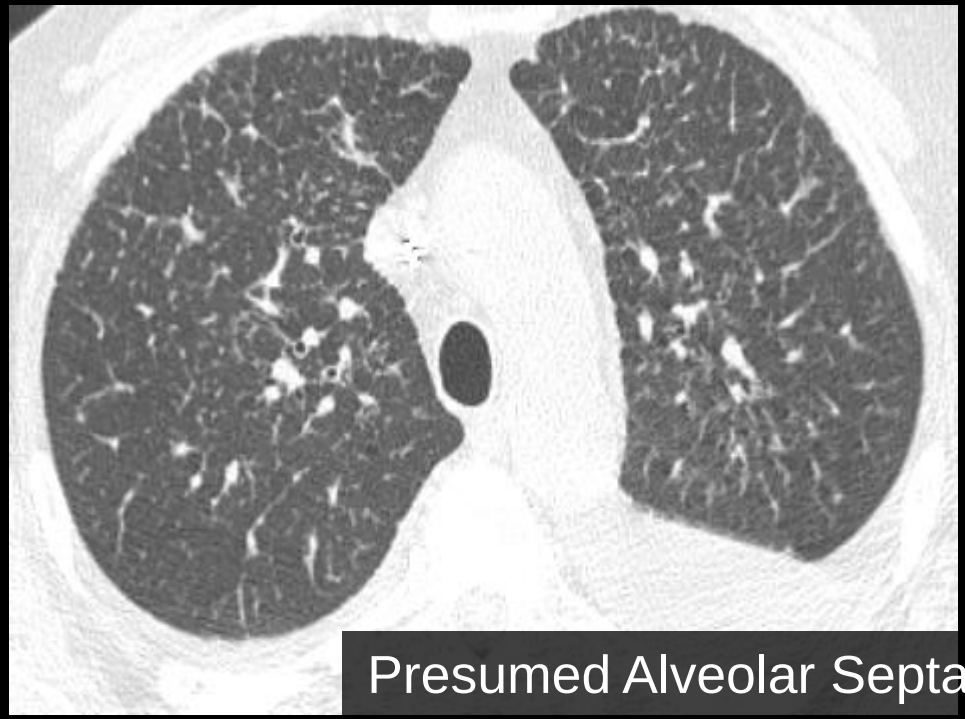
# Coal Worker's Pneumoconiosis

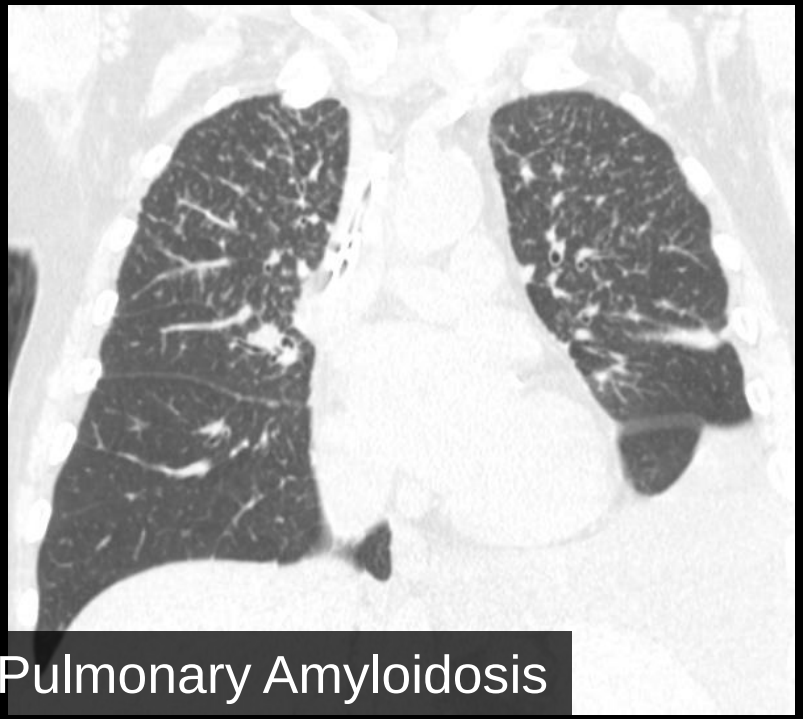




Coalescence into large opacities
(progressive massive fibrosis)

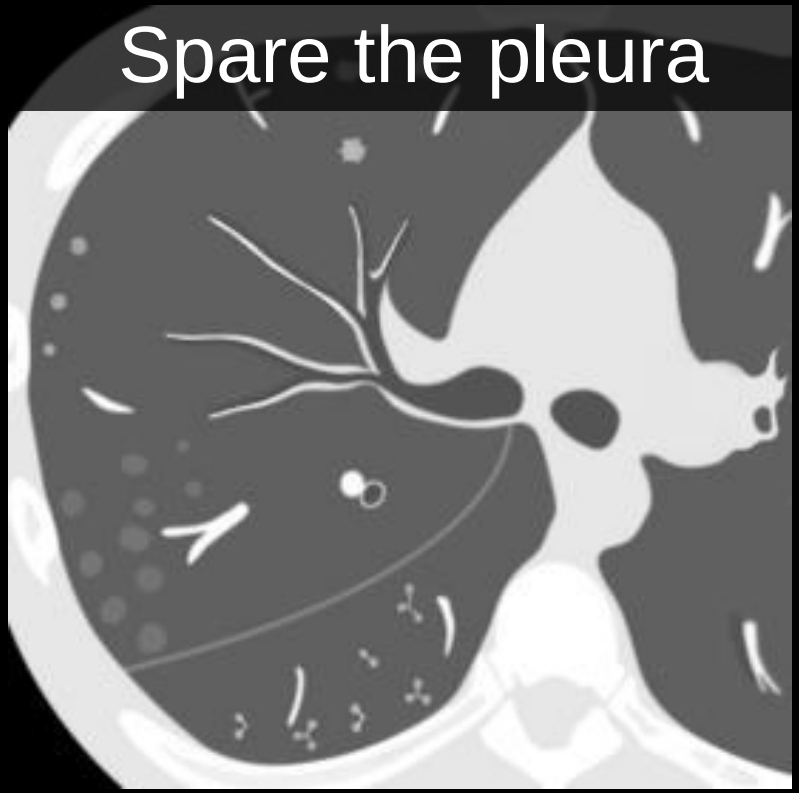
# Very rare: Amyloidosis

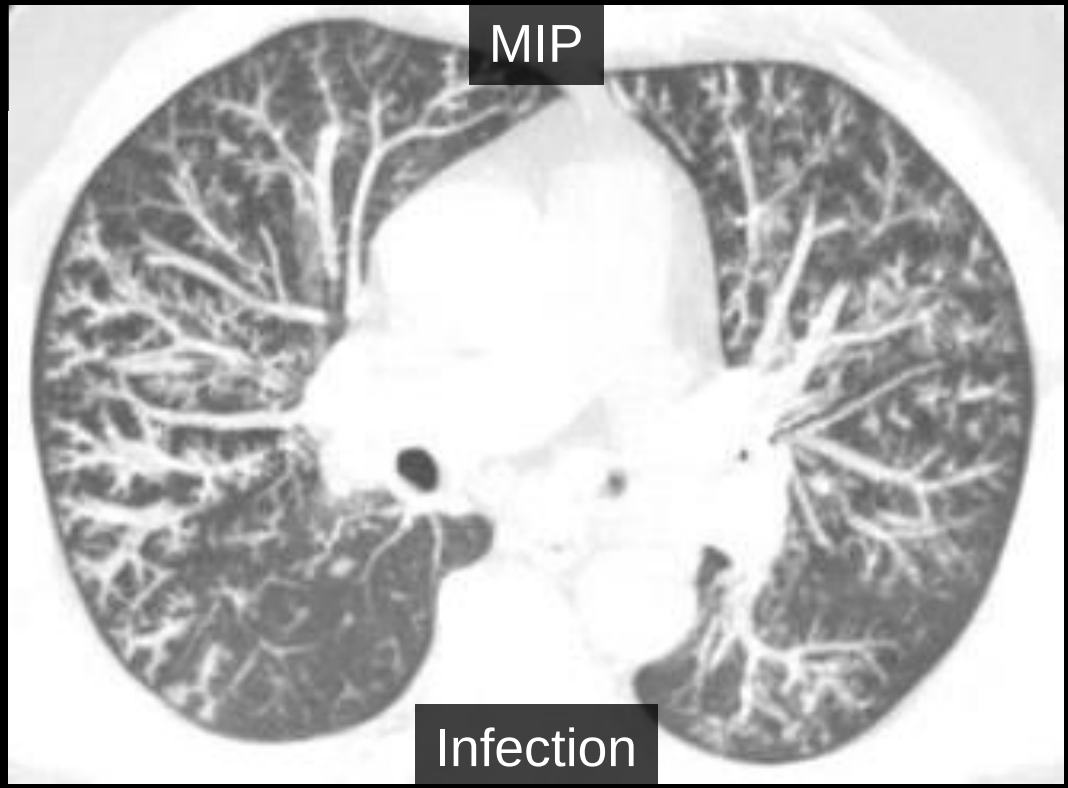




Presumed Alveolar Septal Pulmonary Amyloidosis

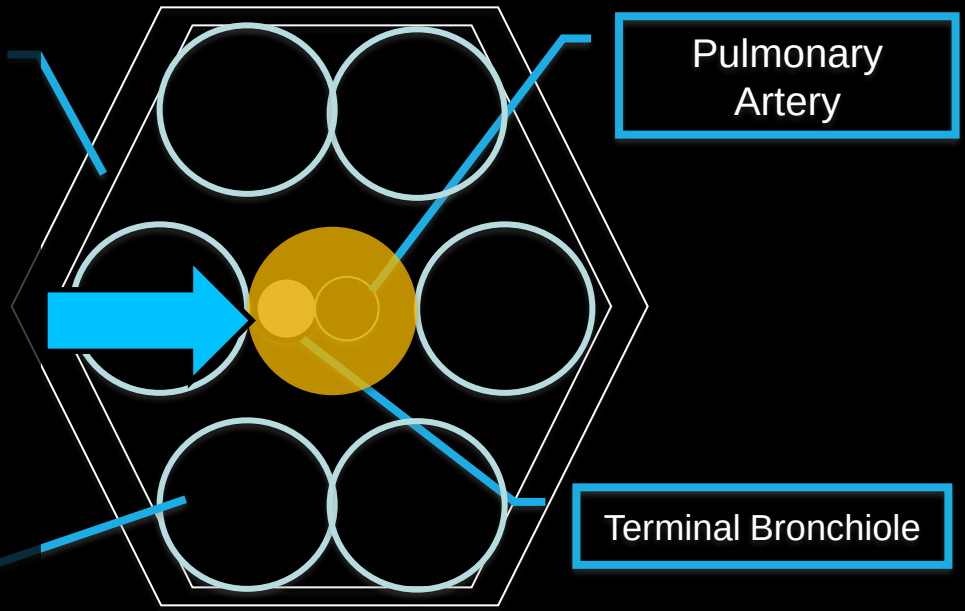
# Centrilobular Pattern



# Centrilobular Pattern

Almost always small airway disease*

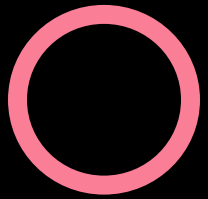



*99% of the time

# Small airway disease = Bronchiolitis

Pathology involving primarily the bronchioles and small conductive airways

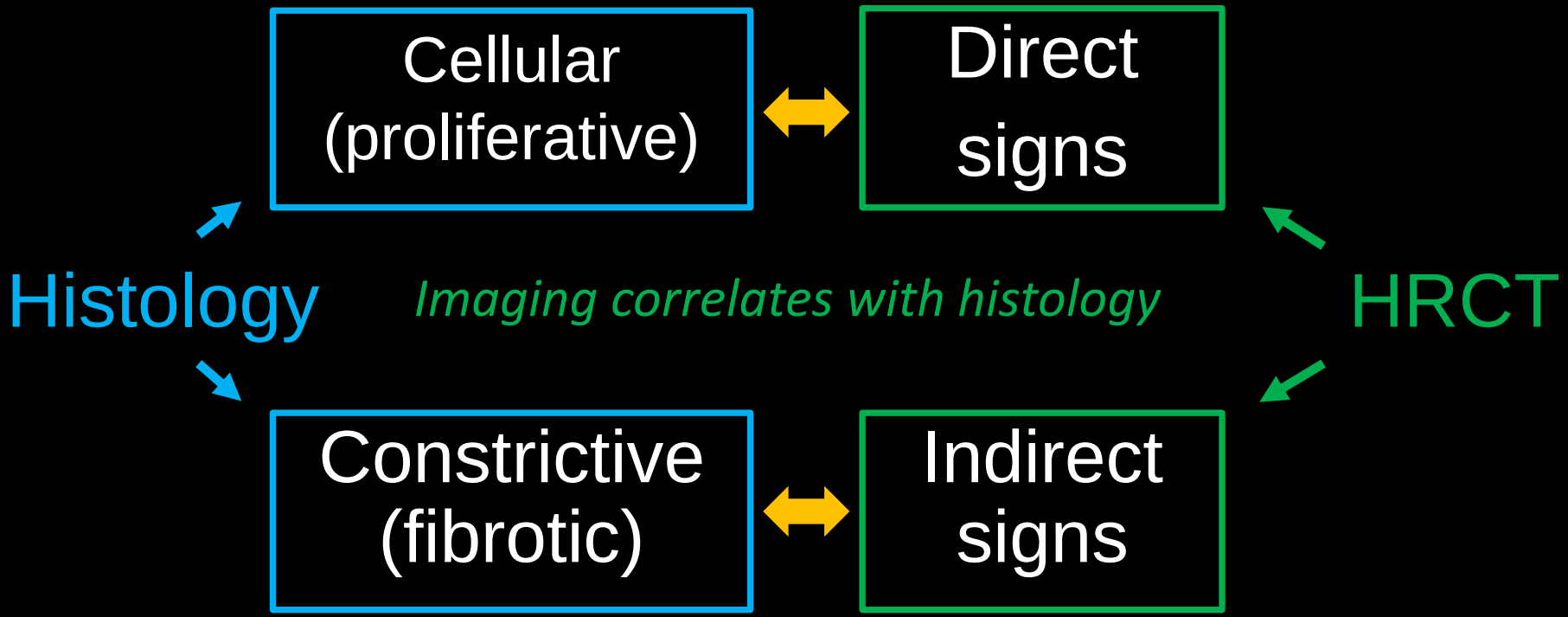
Normal bronchiole



≤ 2 mm

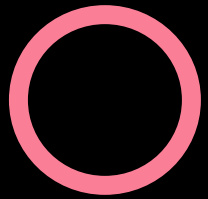
No cartilage

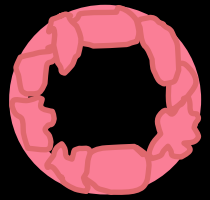
# Bronchiolitis: Classification



# Cellular bronchiolitis: Direct Signs

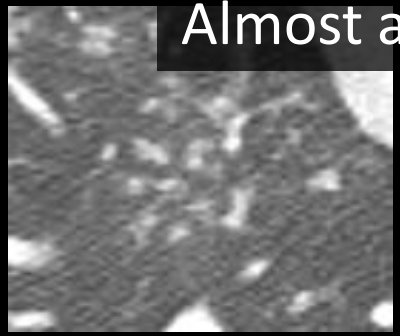
Normal bronchiole
Too small to see





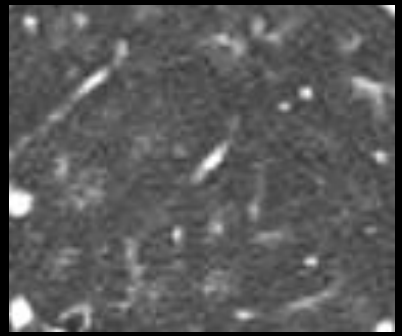
Inflammatory cells

Almost always infection or aspiration



Centrilobular nodules

Tree-in-bud (V-Y shaped) nodules



Centrilobular ground-glass

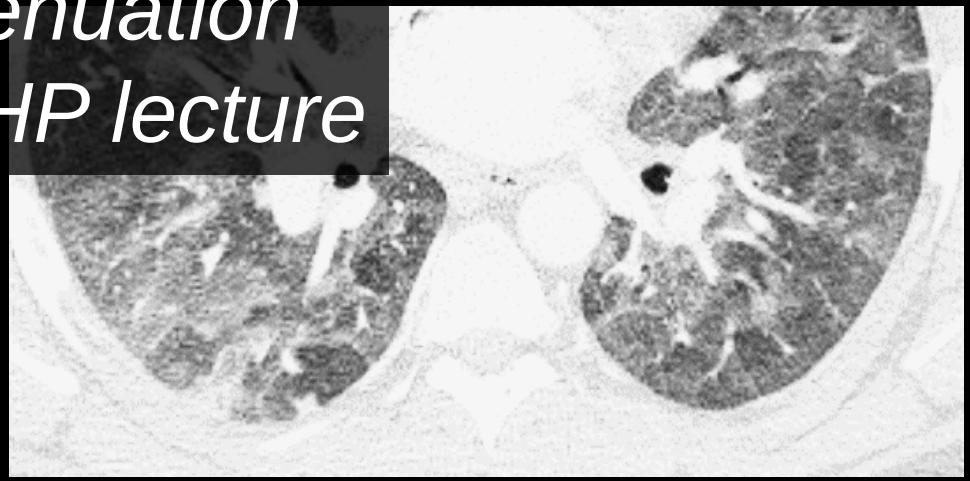
# Constrictive bronchiolitis: indirect signs

Normal Bronchiole

*Discussed in Mosaic Attenuation and HP lecture*

Peribronchiolar fibrosis and scar with little/no active inflammation

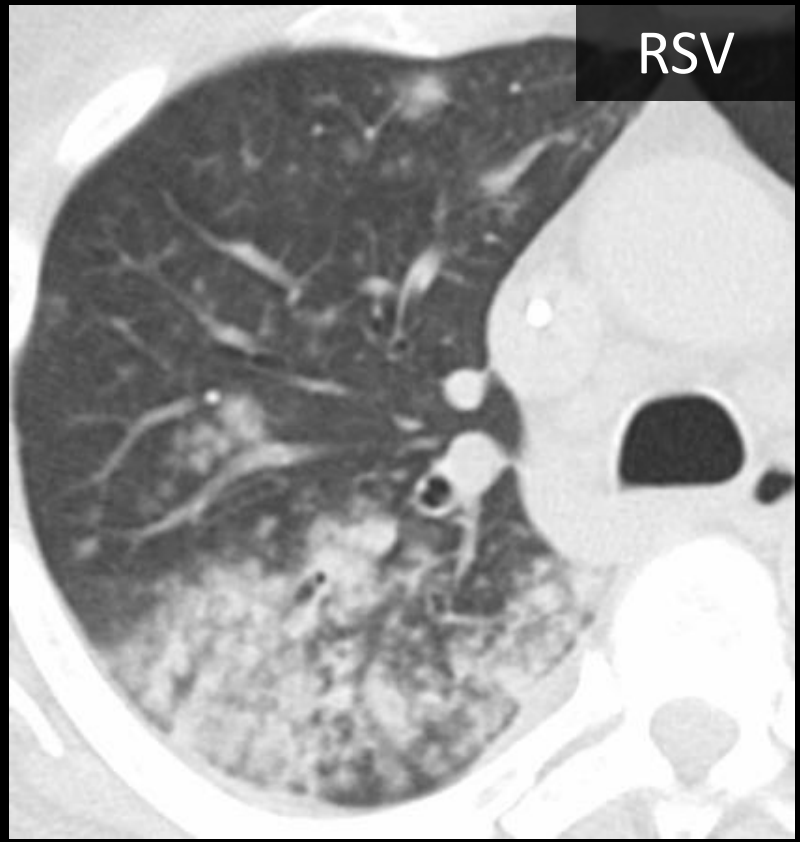
Mosaic Attenuation



Air Trapping

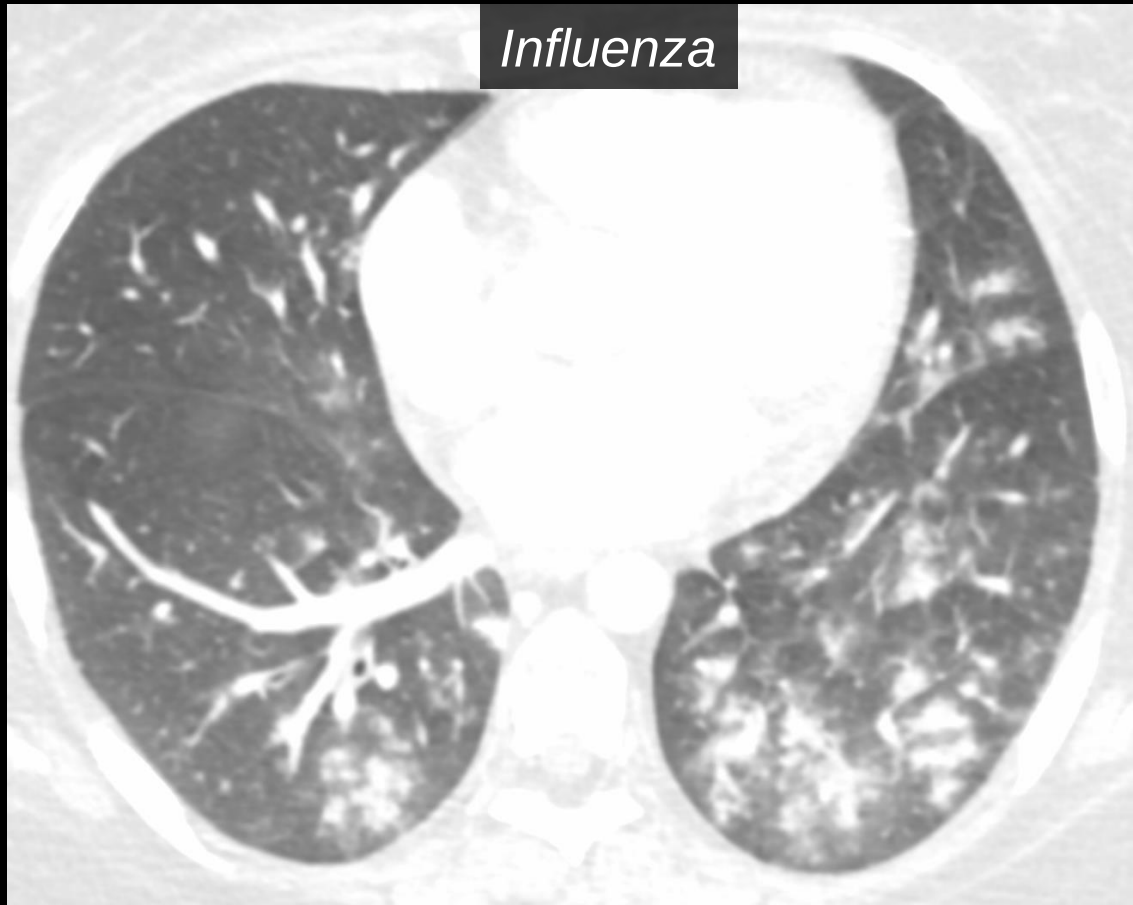
# Focus: Centrilobular Nodules

- Acute
  - Infection
  - Infection
  - Infection
  - Infection
  - Aspiration



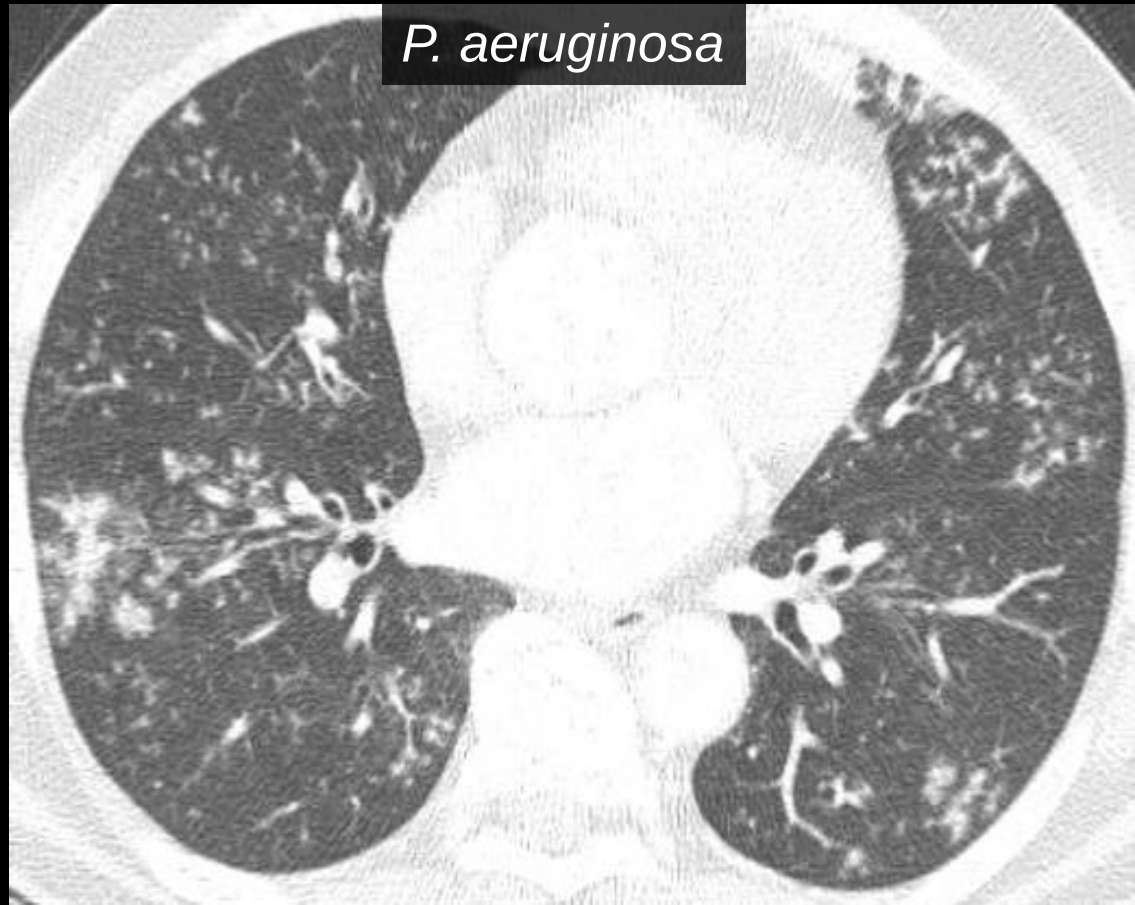
# Centrilobular Nodules

- Acute: Infection
  - Most common type of cellular bronchiolitis
  - Many pathogens: virus, bacteria, fungi
  - Varying sizes



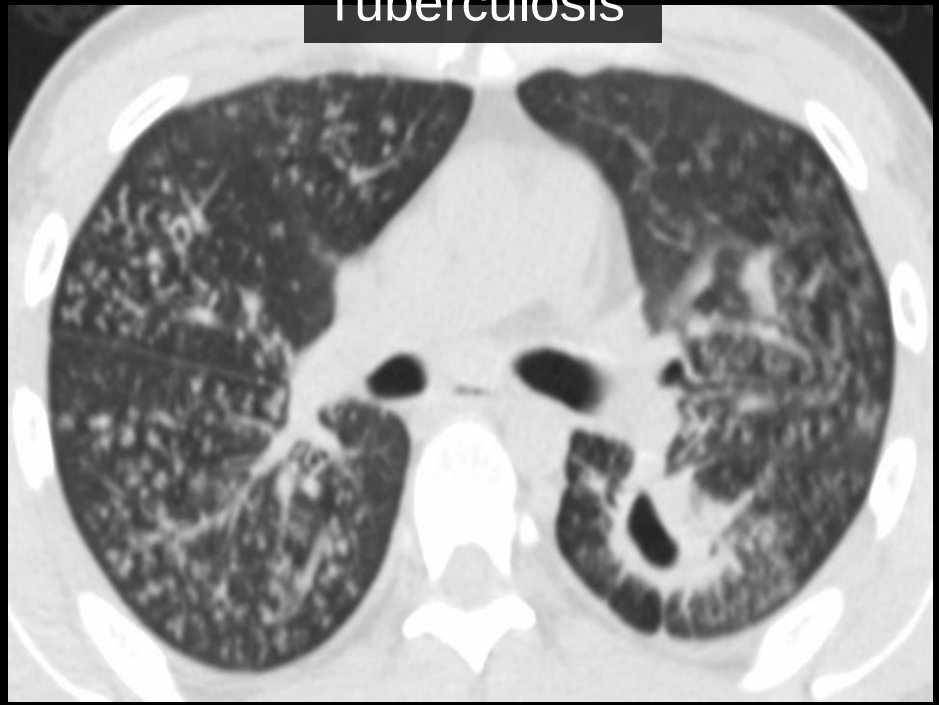
# Centrilobular Nodules

- Acute: Infection
  - Spare the pleura
  - Evenly spaced (within zone)
  - Asymmetric
- +/-
  - Different attenuation

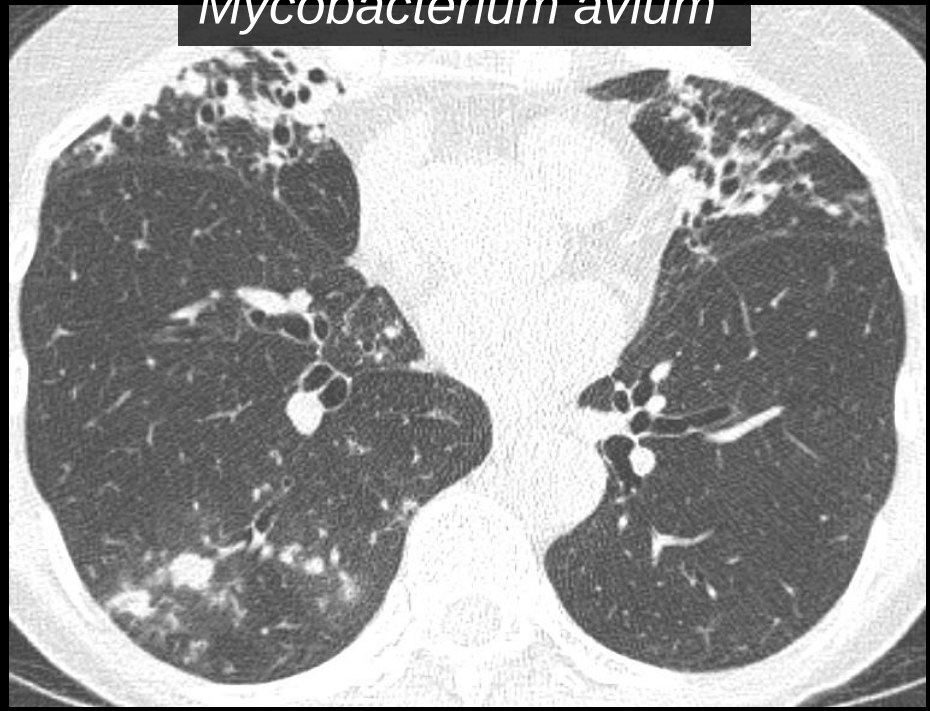


# Educated guesses

Tuberculosis

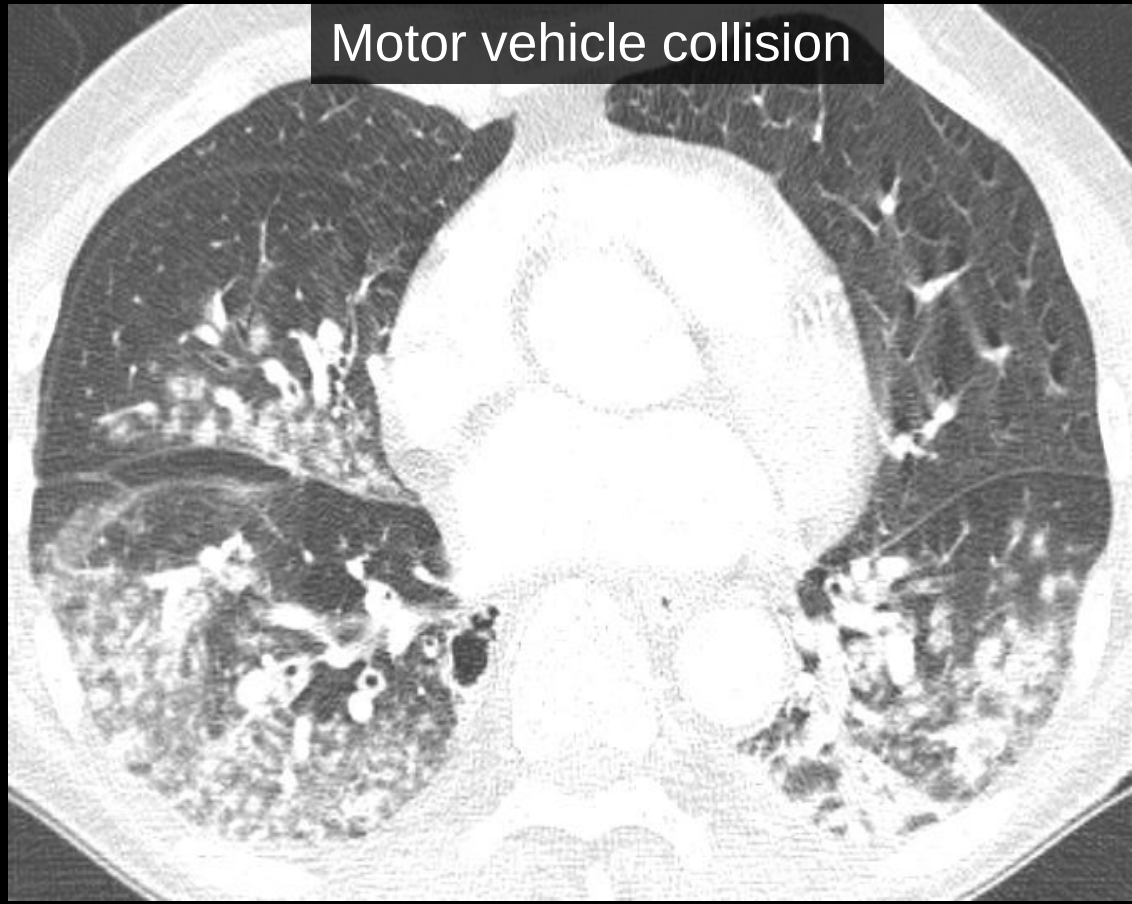


*Mycobacterium avium*



# Centrilobular Nodules

- Acute: Aspiration
- Second most common type of cellular bronchiolitis
- Under-recognized and misdiagnosed

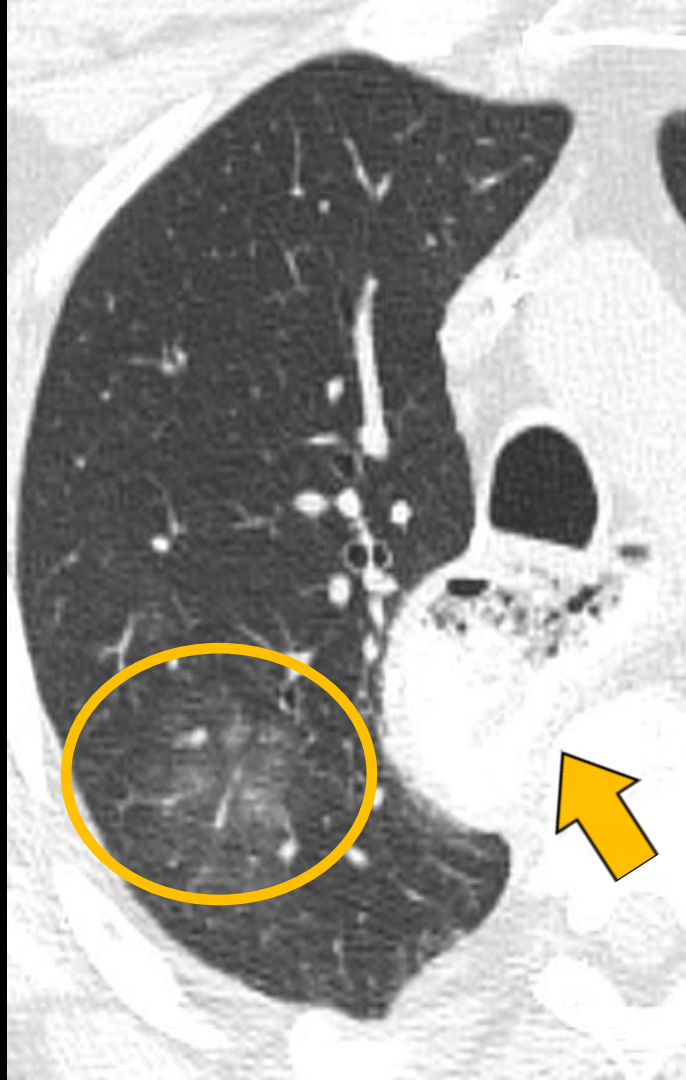


# Centrilobular Nodules

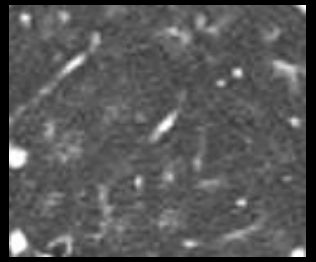
- Acute: Aspiration
- Distribution based on body position at time of aspiration
- Bronchiolar inflammation and foreign body reaction

# Centrilobular Nodules

- Acute: Aspiration
  - Clues
    - Clinical: AMS, neurological disorders
    - Image: Ancillary findings, distribution, waxes & wanes



# Centrilobular Nodules



## Tree-in-bud (focal/multifocal)

Infection

Aspiration

## Ill-defined (diffuse)

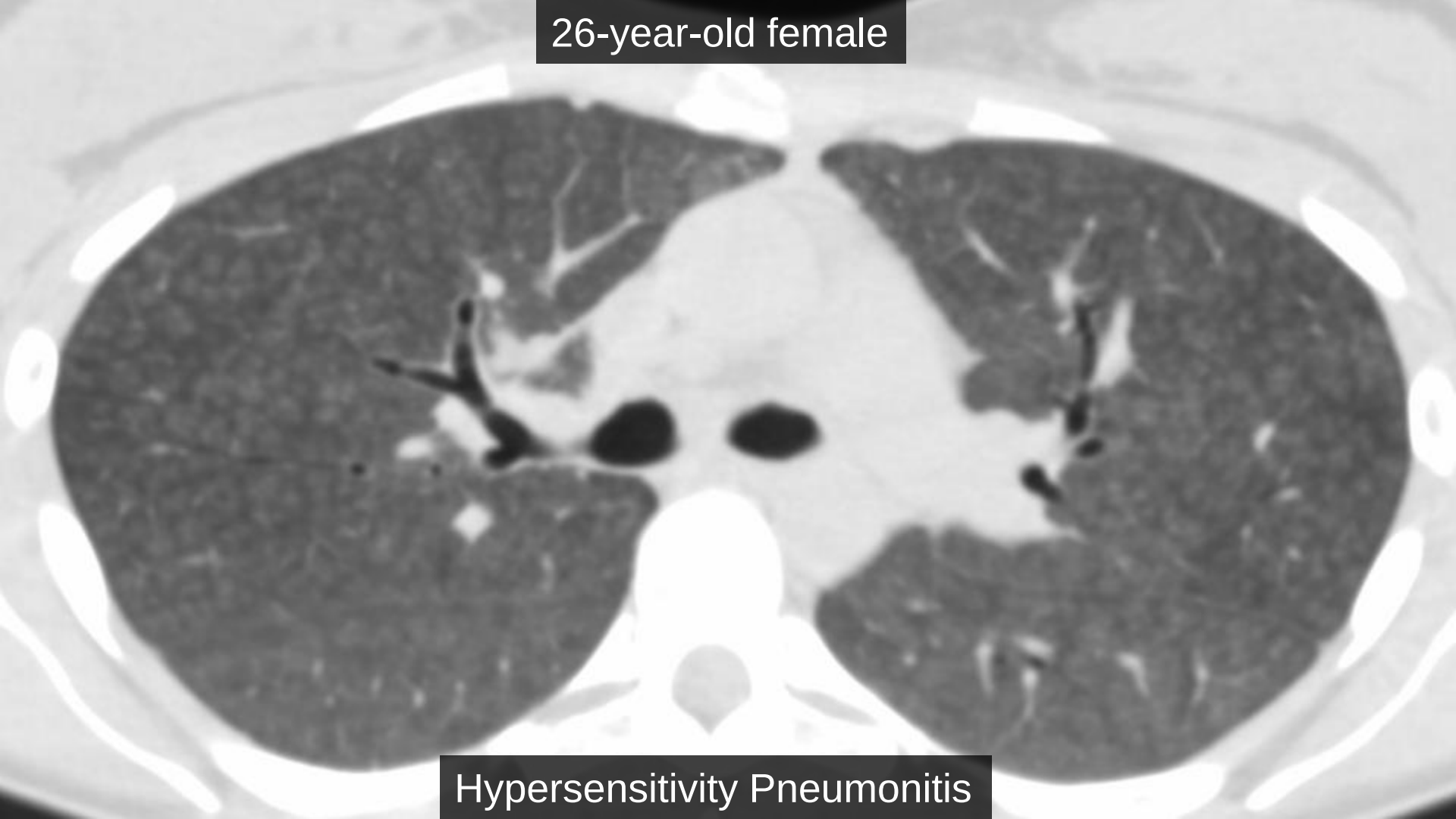
Hypersensitivity

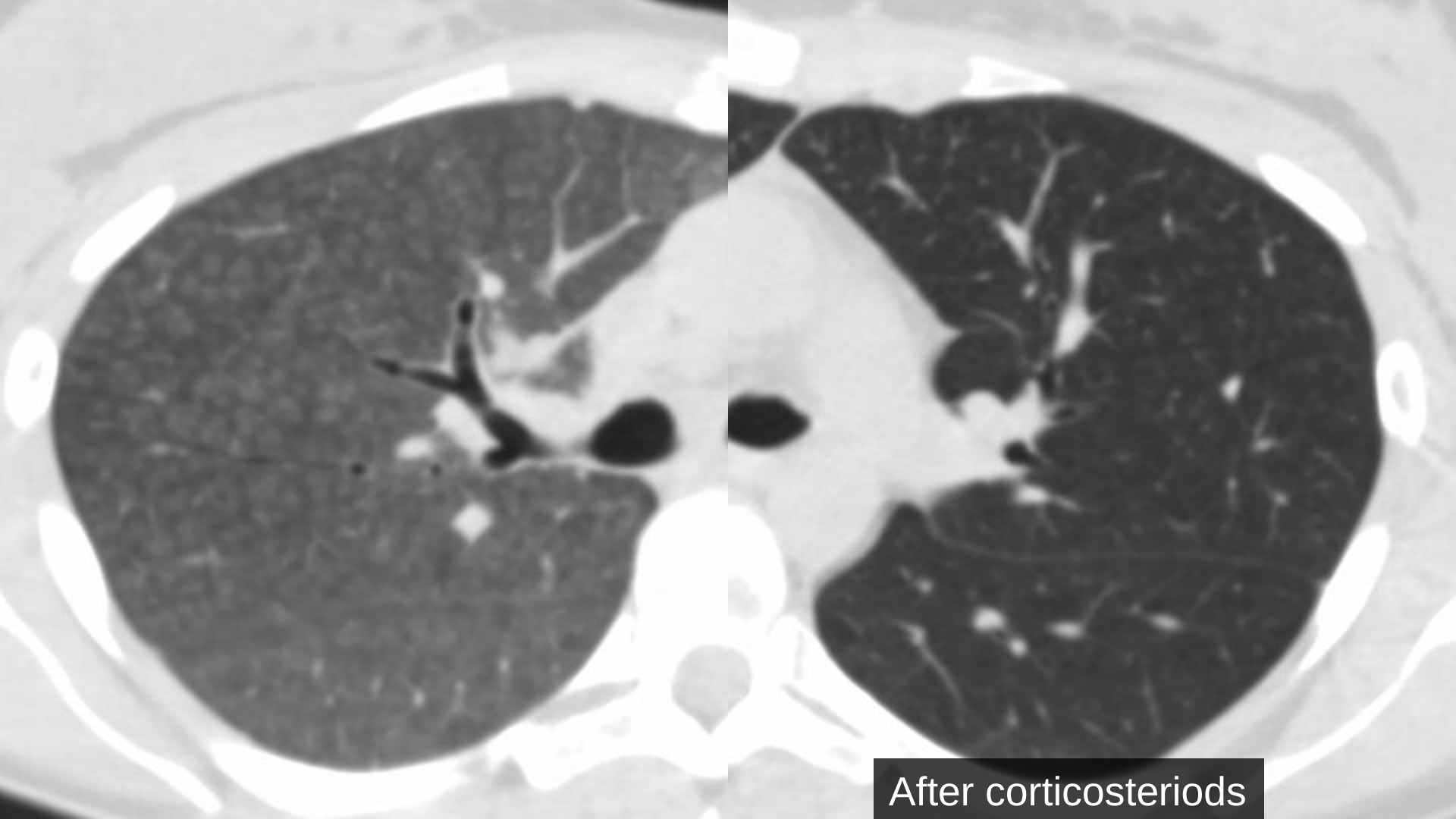
Respiratory bronchiolitis

Follicular bronchiolitis

Diffuse panbronchiolitis

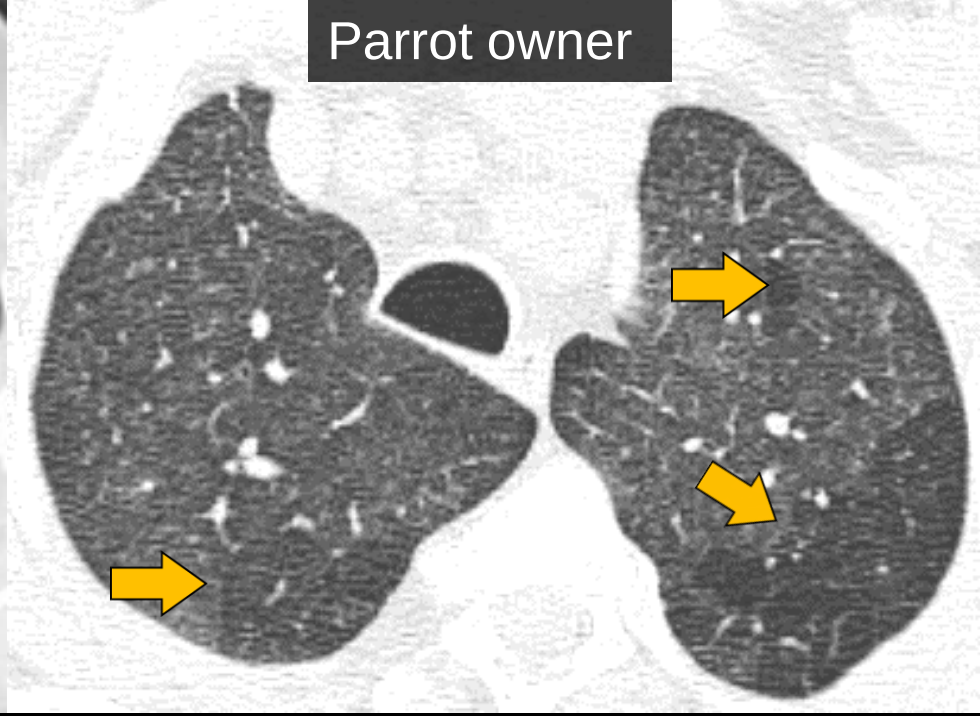
Exposures


26-year-old female
Hypersensitivity Pneumonitis


After corticosteriods

# Hypersensitivity Pneumonitis

- Centrilobular GG nodules
- Diffuse
- +/- air trapping (plugging of airways)
- Very symptomatic
- Exposures

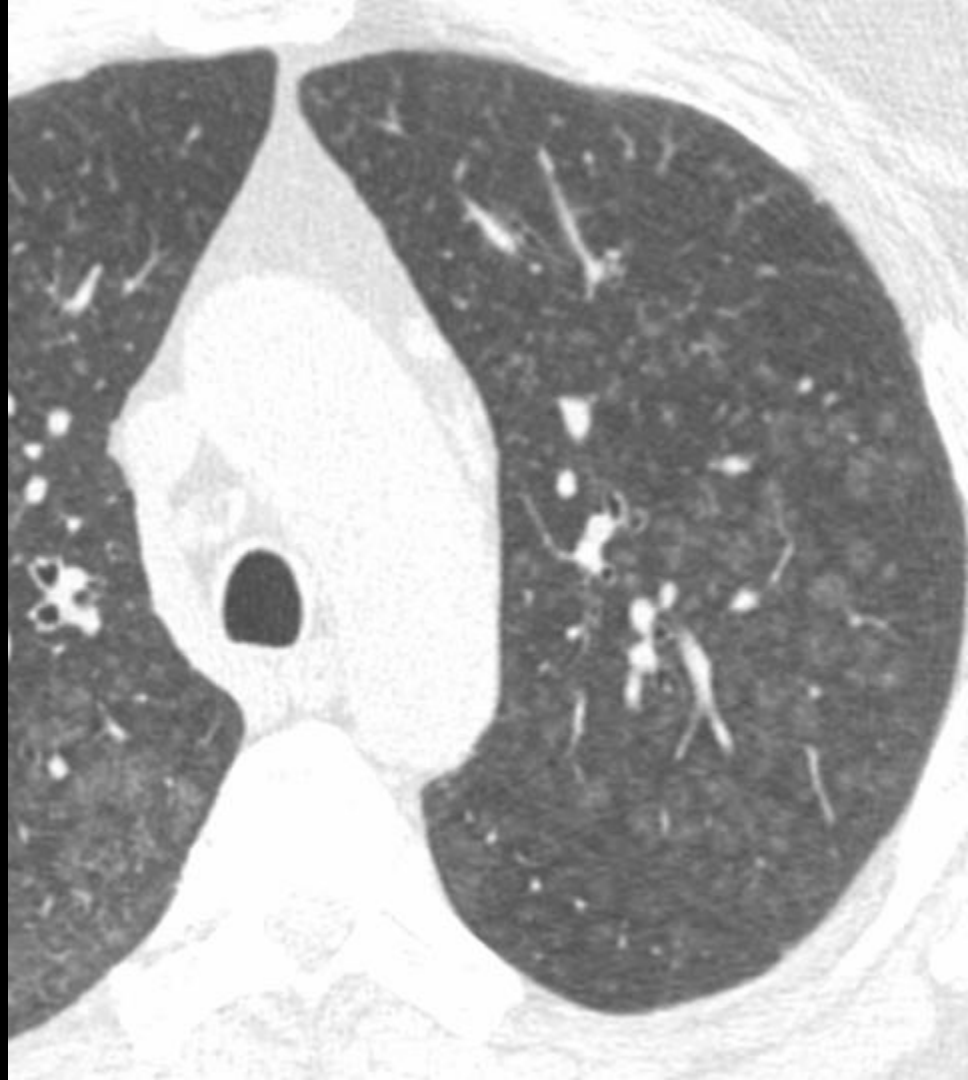



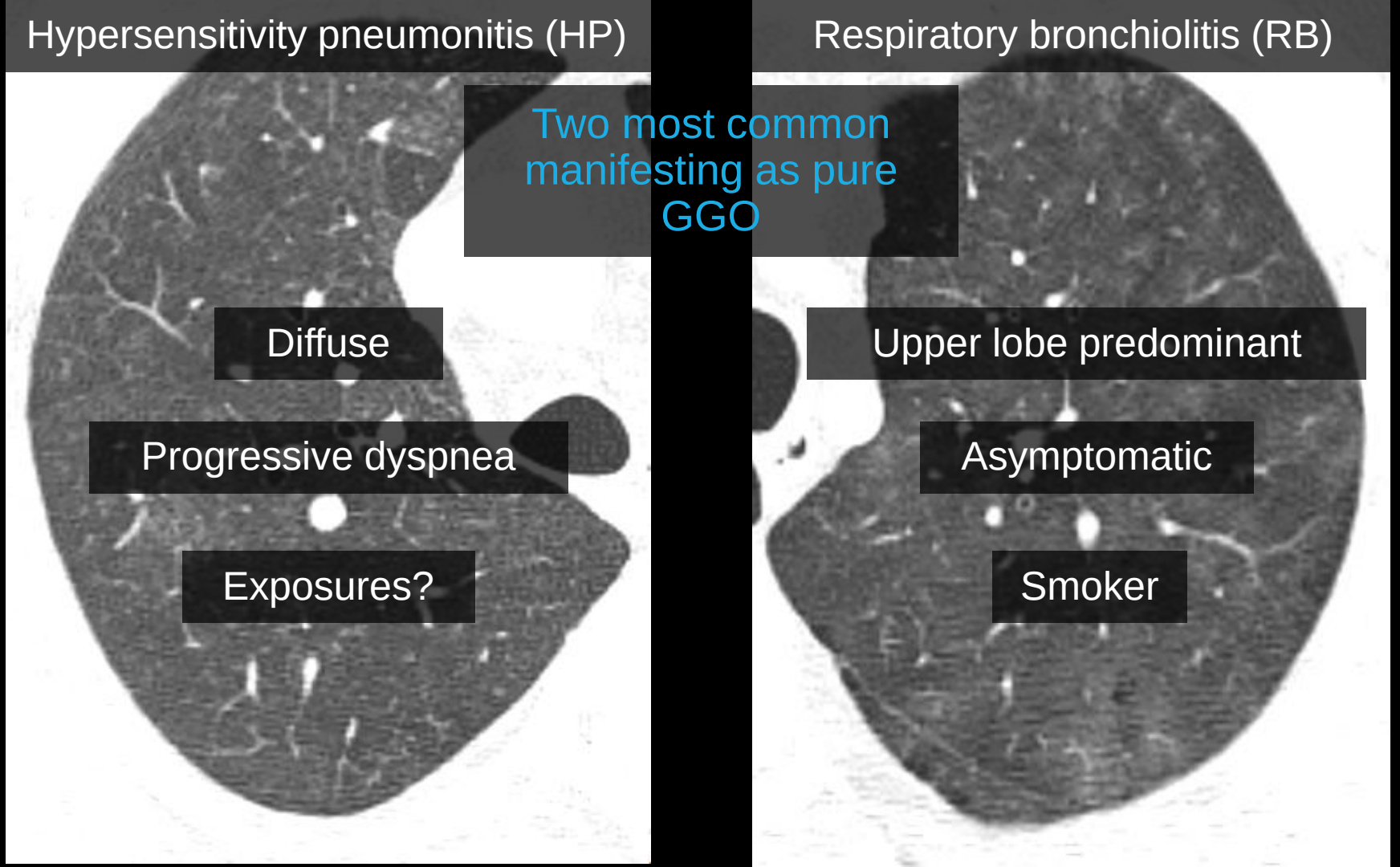

Diffuse centrilobular GG nodules: rarely acute infection


62-year-old smoker with cough

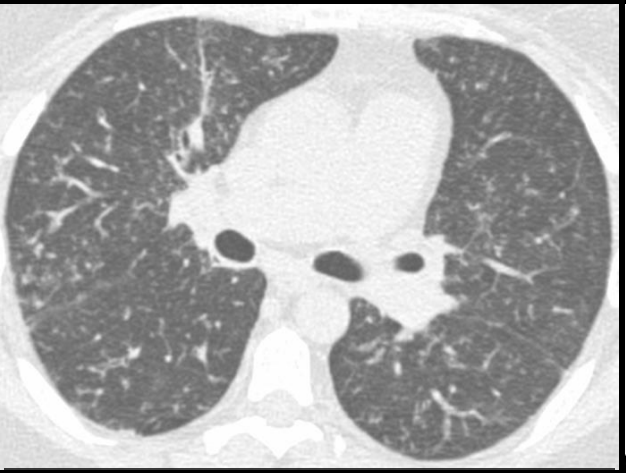
# Respiratory Bronchiolitis

- Centrilobular GG nodules
- Smoker’s macrophages
- Upper lobe predominant
- Current or former smokers
- */- other smoking-related diseases

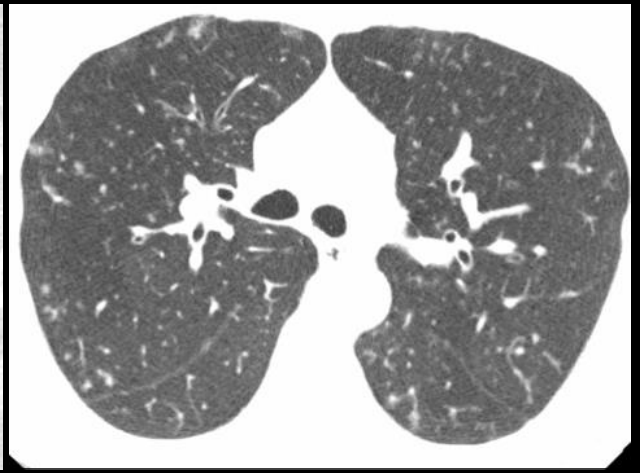



Hypersensitivity pneumonitis (HP)
Respiratory bronchiolitis (RB)
Two most common manifesting as pure GGO
Diffuse
Progressive dyspnea
Exposures?
Upper lobe predominant
Asymptomatic
Smoker

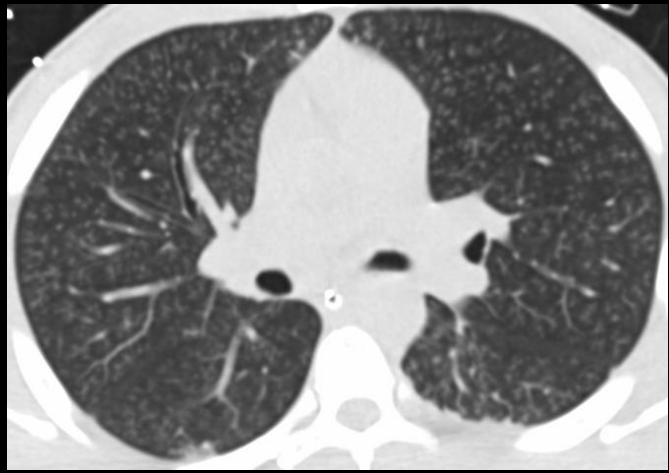
# Less Frequent Causes of *Diffuse* Centrilobular Nodules



45-year-old female with rheumatoid arthritis



45-year-old woman with dyspnea and sinusitis



20-year-old male with acute respiratory failure

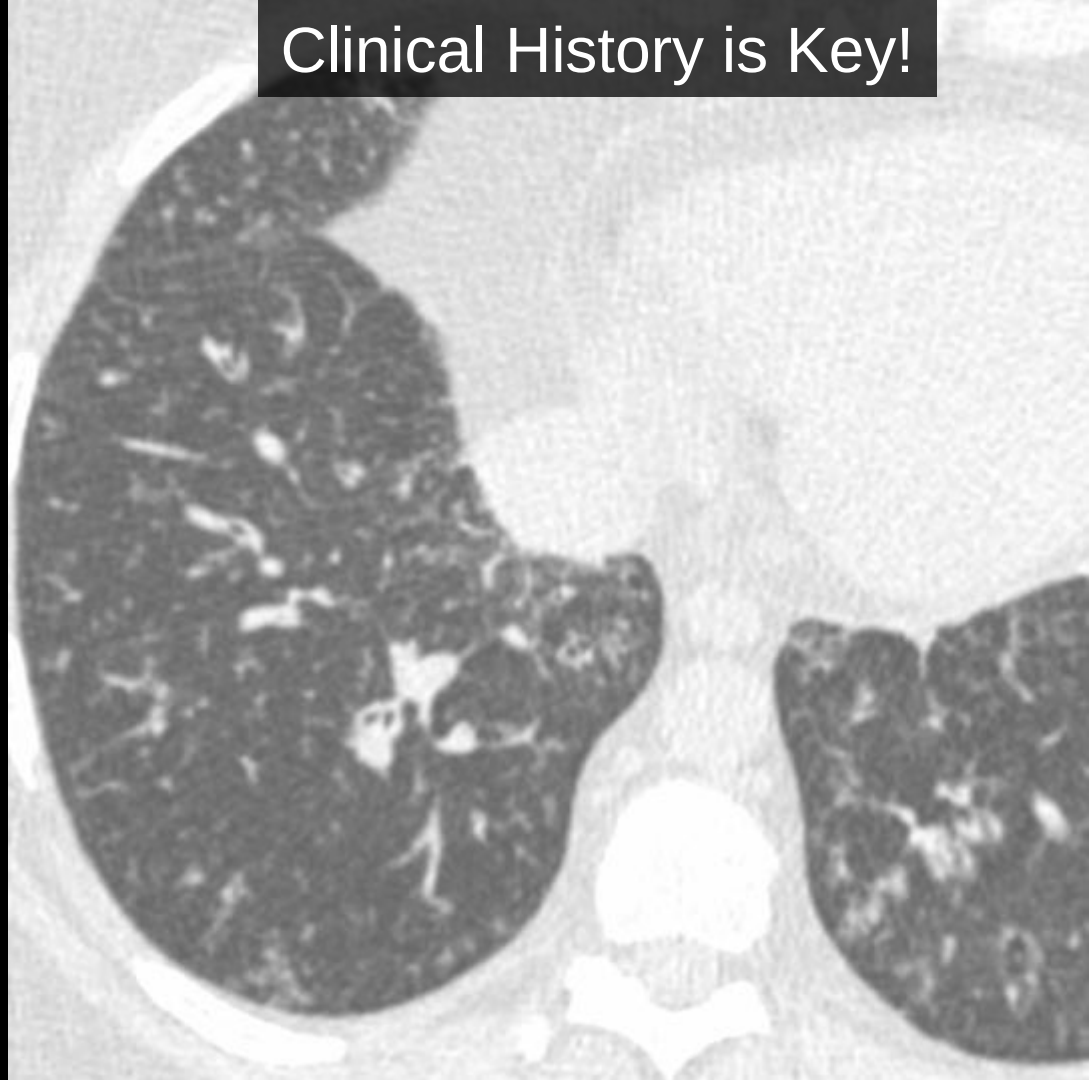
# Follicular Bronchiolitis

- Lymphoid hyperplasia along small airways (BALT)
- Centrilobular or peribronchial nodules (may be small or large)
- +/- airway thickening, air trapping
- +/- cysts

45-year-old female with rheumatoid arthritis

# Follicular Bronchiolitis

- Collagen vascular disease
  - RA and Sjogren's
- Immunodeficiency

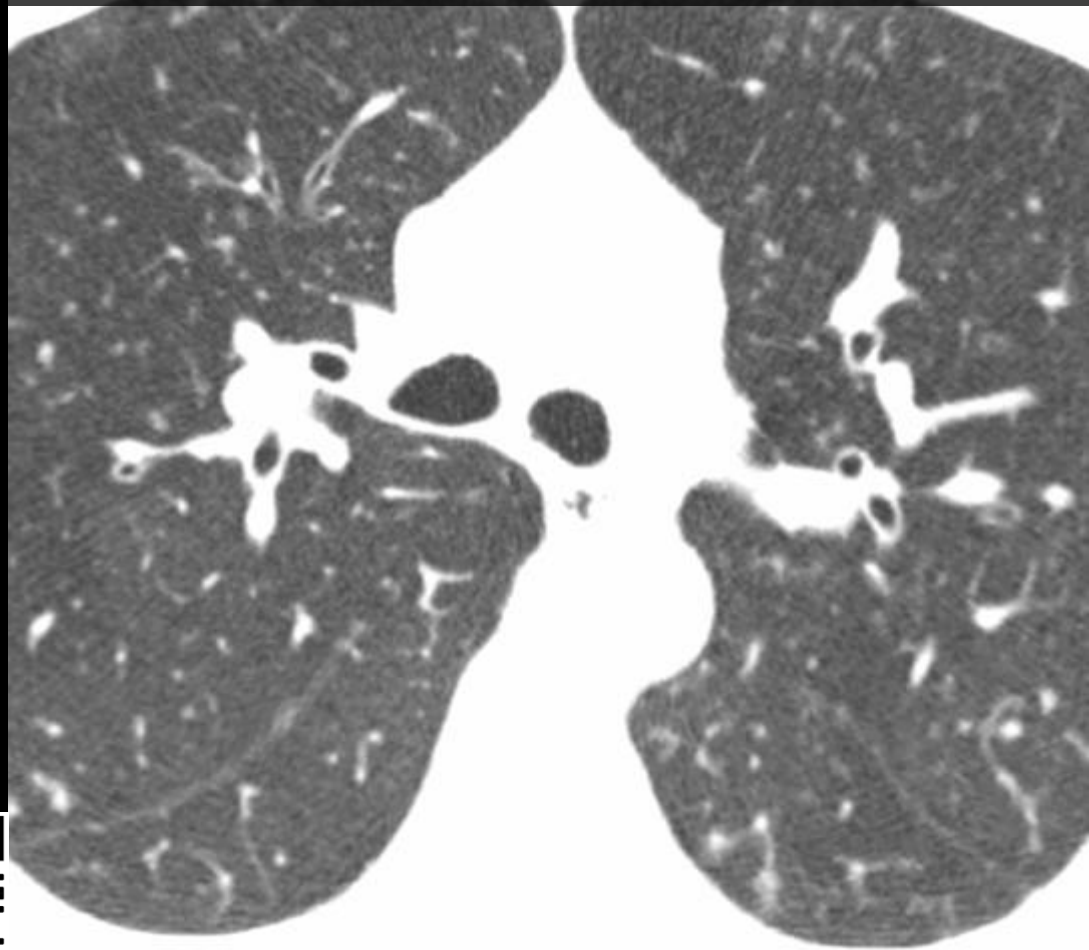


# Diffuse Panbronchiolitis

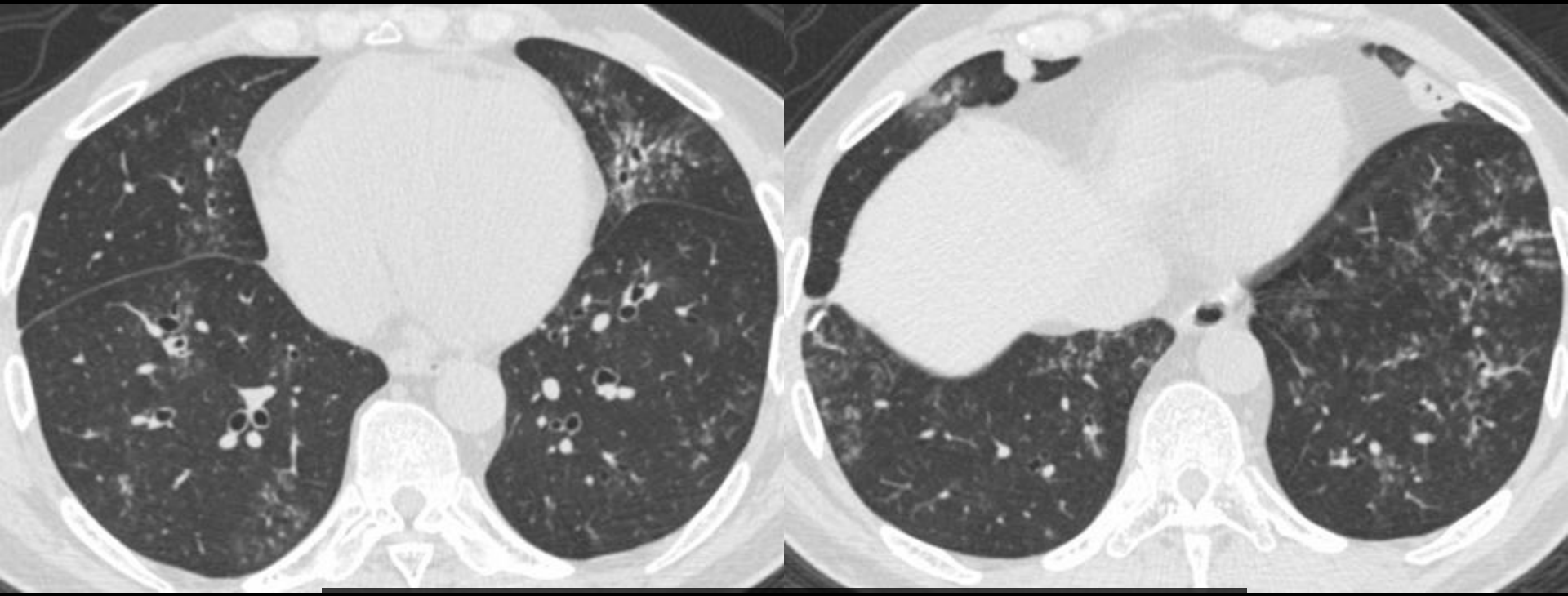
- Increasingly recognized outside of Asia
- ‘Diffuse’ – everywhere
- ‘Pan’ – transmural infiltration of bronchioles
- Sinusitis + bronchiolitis (*P aeruginosa or H influenzae*)

Poletti *ERJ* 2006

45-year-old woman with dyspnea and sinusitis

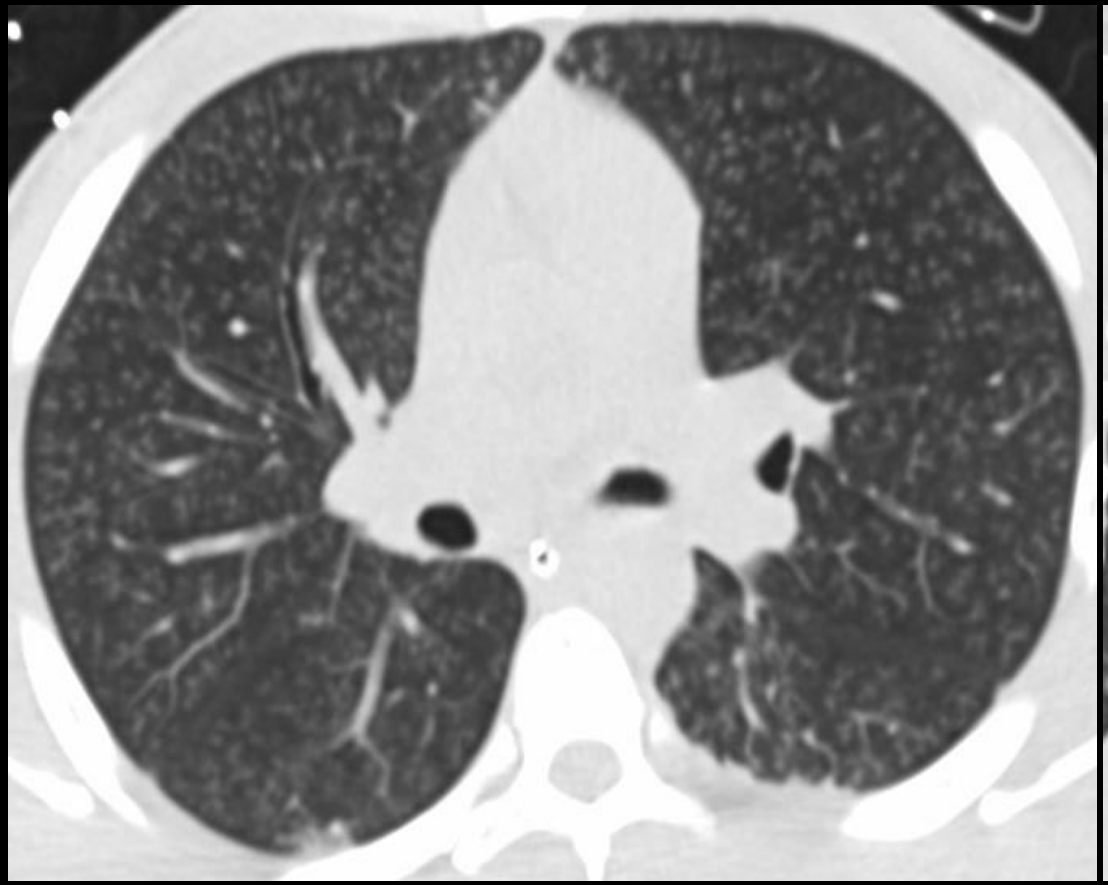


# Diffuse Panbronchiolitis

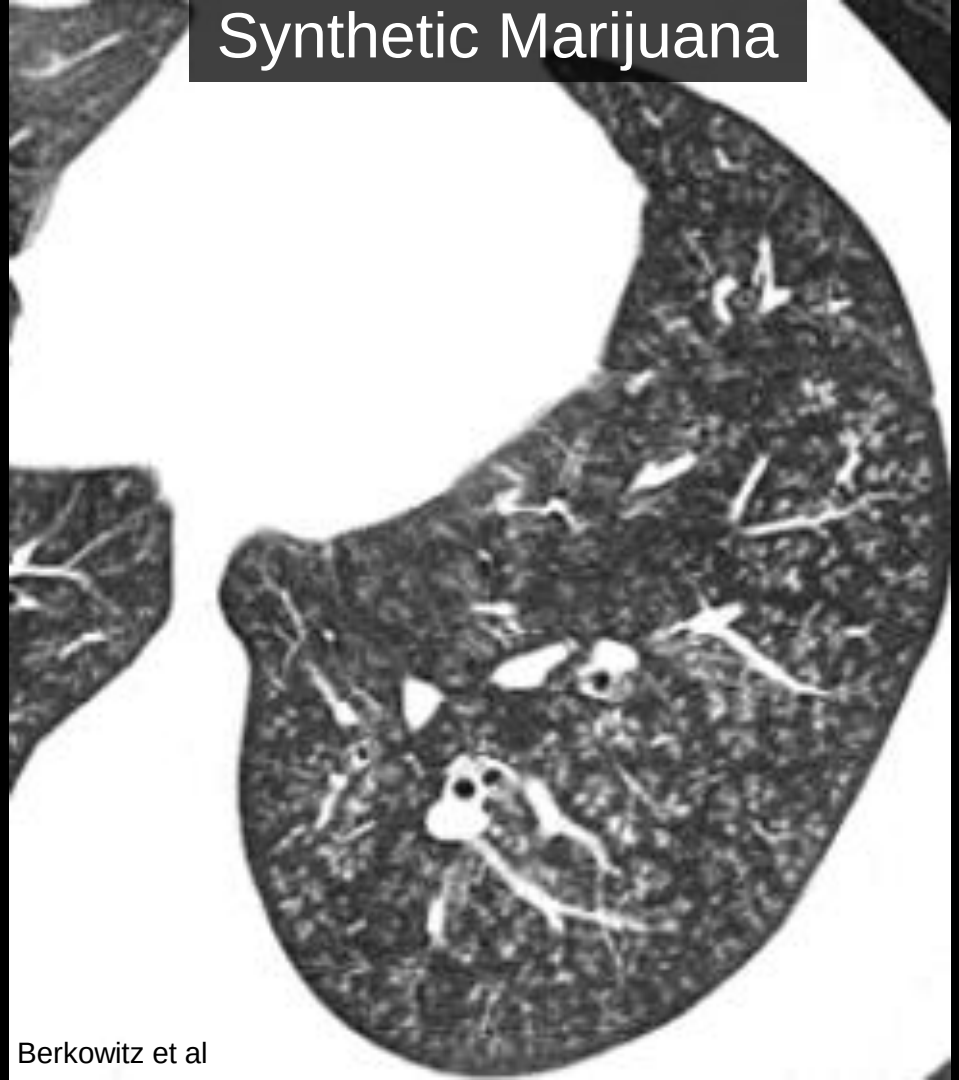


42-year-old male with chronic sinusitis

# 20-year-old male with acute respiratory failure



# Synthetic Marijuana



Berkowitz et al

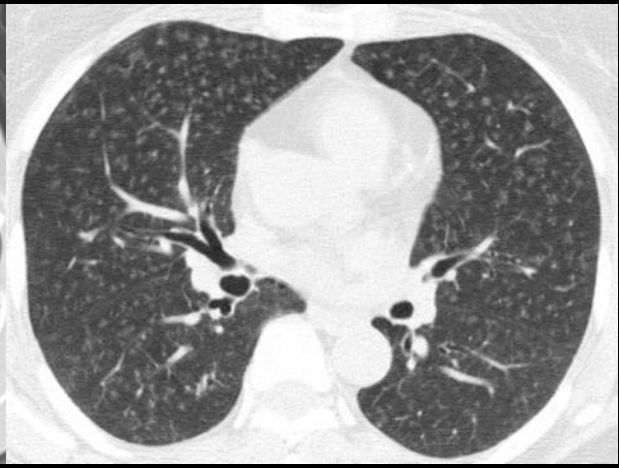
**Pulmonary Effects of Synthetic Marijuana: Chest Radiography and CT Findings**

- Acute respiratory symptoms and hypoxemia
- Diffuse centrilobular nodules
- Tree-in-bud
- Path: Airway-centered organizing pneumonia +/- lung injury

# Exposures?

Another synthetic marijuana

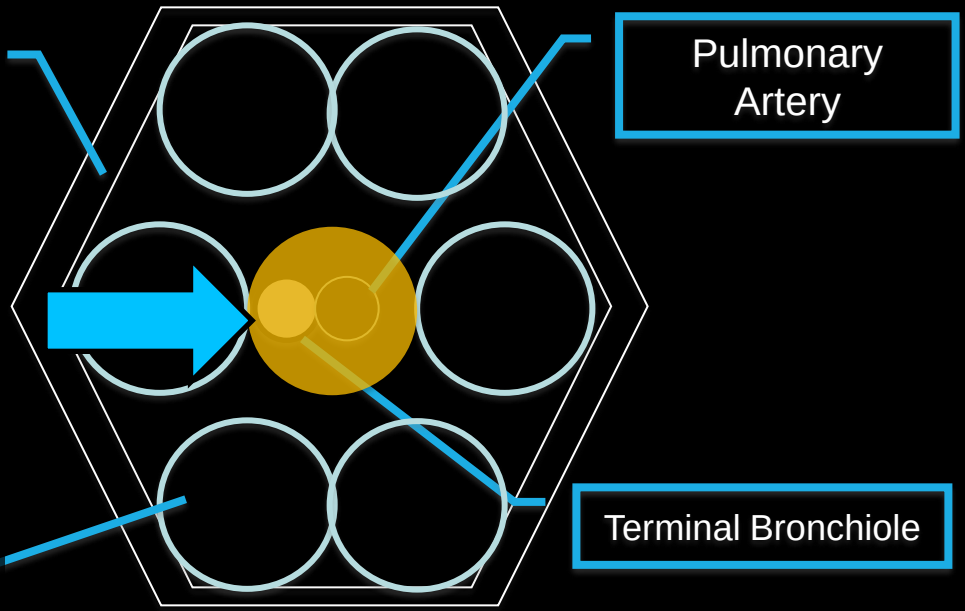
Hot yoga instructor



Hookah user

# Centrilobular Pattern

*Almost*
always
small
airway
disease*



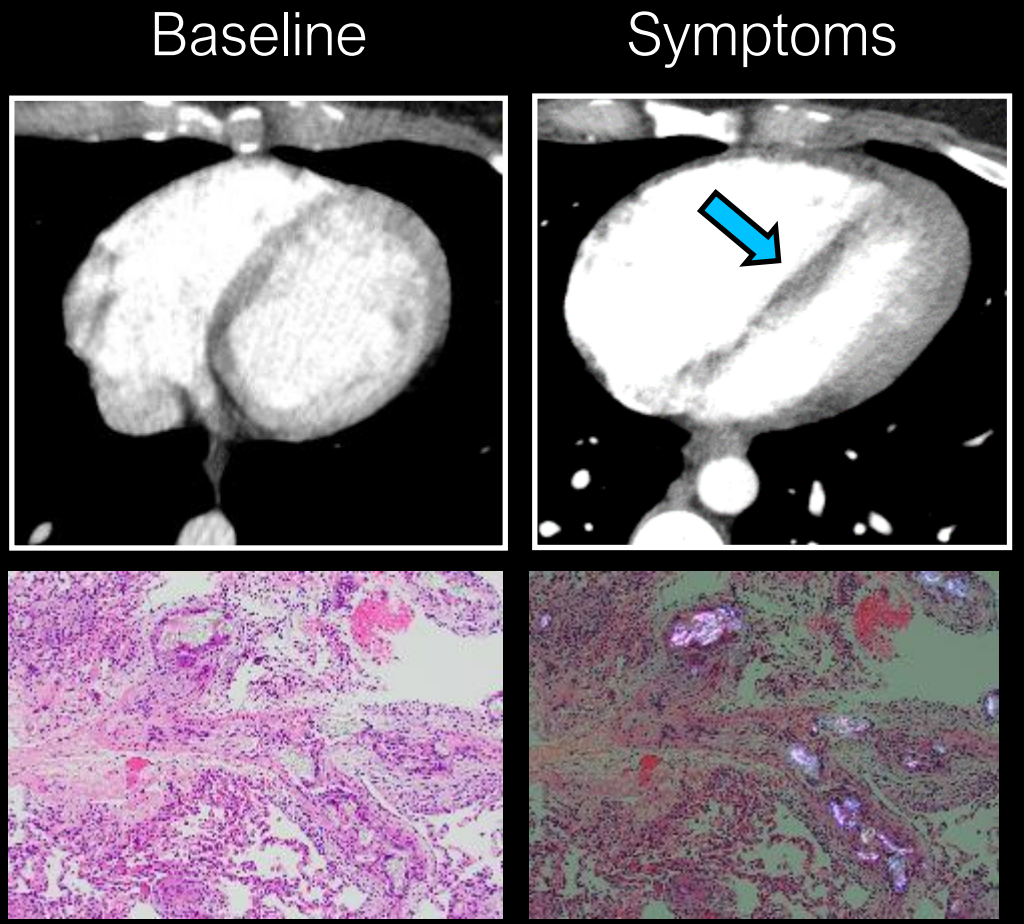

*99% of the time

# Vascular causes: centrilobular GGO

Resected hand sarcoma on surveillance.  3 months of dyspnea on exertion and newly diagnosed pulmonary hypertension

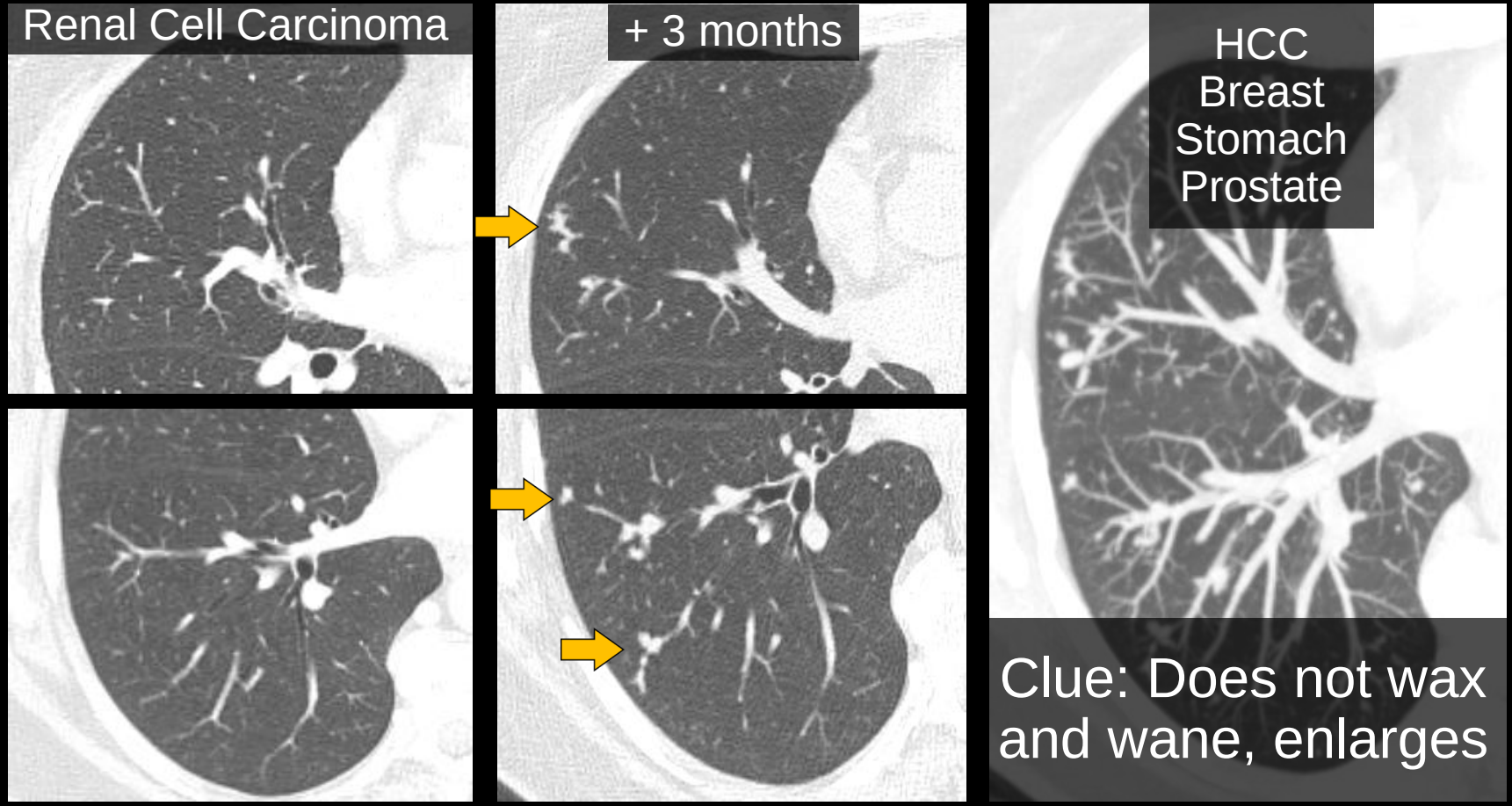
# Excipient lung

- Diffuse
- Granulomatous reaction to foreign material in vessel wall (talc, cellulose, starch)
- Delayed diagnosis

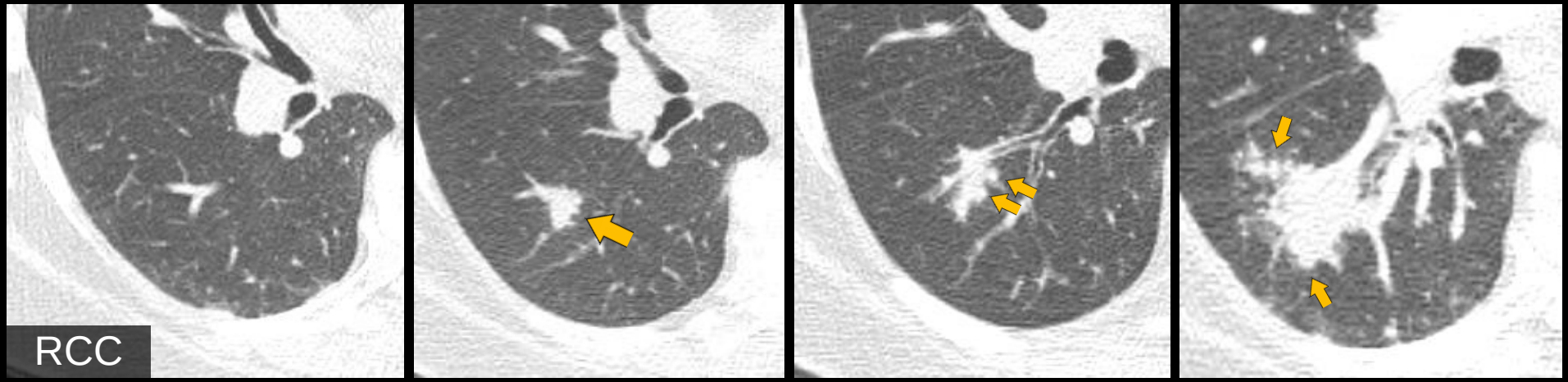



Intravascular foreign body-type granulomas and birefringent crystals suggestive of talc emboli from injection

# Vascular causes: tree-in-bud



# Intravascular Metastases

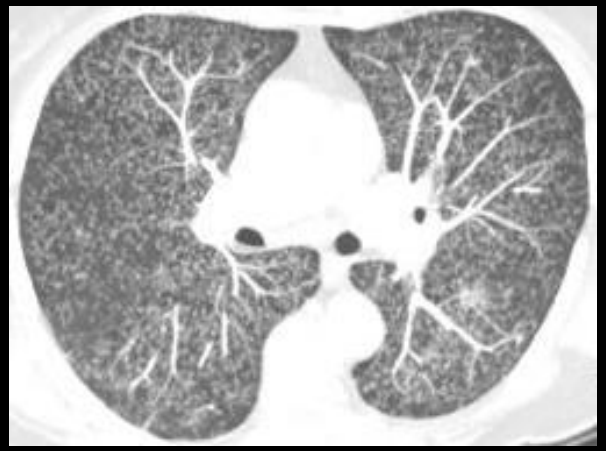



Dilated, beaded, branching

Persist and grows

# Summary

# DDx for Hinges on Distribution



- Do nodules touch the pleura? = perilymphatic or random
- Clustering = key feature of perilymphatic nodules
- Evenly spaced = centrilobular

# Summary

- Random nodules: infection or metastasis
- Perilymphatic nodules: sarcoidosis or carcinomatosis
- Centrilobular: direct sign of small airway disease (99%)
  - Tree-in-bud: variant of centrilobular nodules, almost always infection or aspiration
  - Diffuse centrilobular GGNs:
    - Rarely acute infection → exposures
    - HP or RB most common
    - Don’t forget vascular (likely <1%)

# Nodular Lung and Small Airway Disease

Questions?