

115年胸部影像判讀繼續教育課程

肺部感染症及呼吸道疾病之影像判讀

高雄市立大同醫院胸腔內科

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感謝唐士恩主任, 張山岳主任slide的傳承

近年胸腔影像考試在感染症方面的趨勢

肺結核 (Pulmonary Tuberculosis) 是最頻繁出現的感染症診斷，幾乎在每個年份的考題中都有出現。這包含了活動性肺結核、粟粒性肺結核，以及與其相關的併發症或後遺症（如脊椎旁膿瘍、結核後氣管狹窄、結核後續發黴菌感染），顯示其重要性及多樣化的影像表現。

支氣管擴張症 (Bronchiectasis) 是另一個非常頻繁出現的主題。且伴隨的影像表現（如樹芽徵 tree-in-buds pattern）常提示活動性感染。它也與一些先天性疾病（如 Kartagener syndrome）相關，這些疾病常伴有慢性呼吸道感染。

瀰漫性泛細支氣管炎 (DPB) 也是一個出現頻率較高的診斷，在影像上常伴有支氣管擴張。

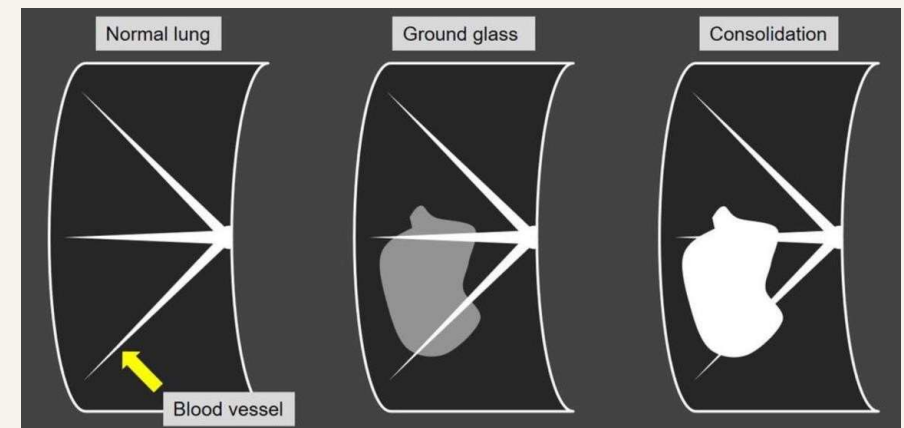
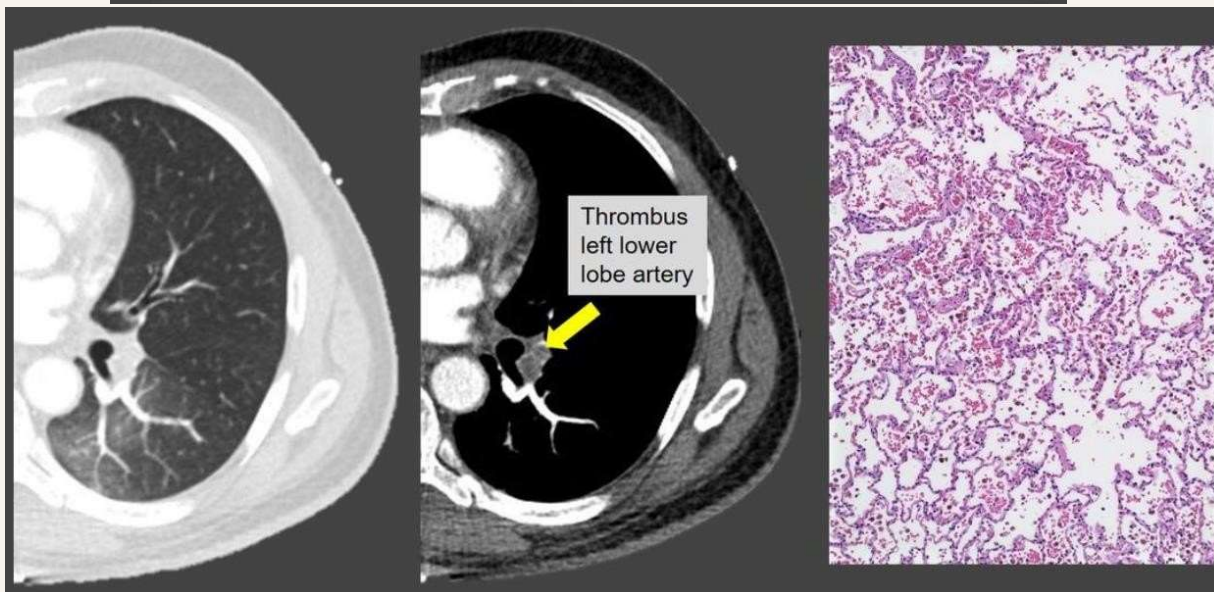
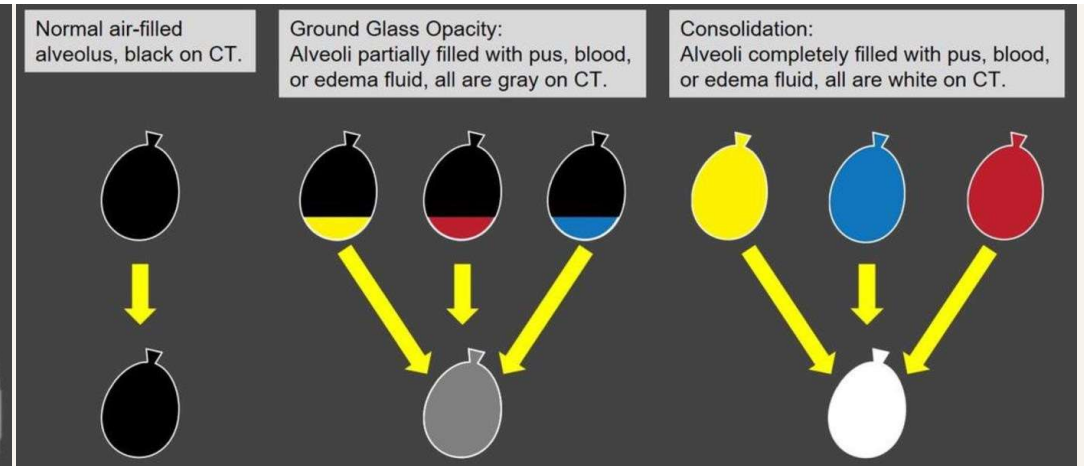
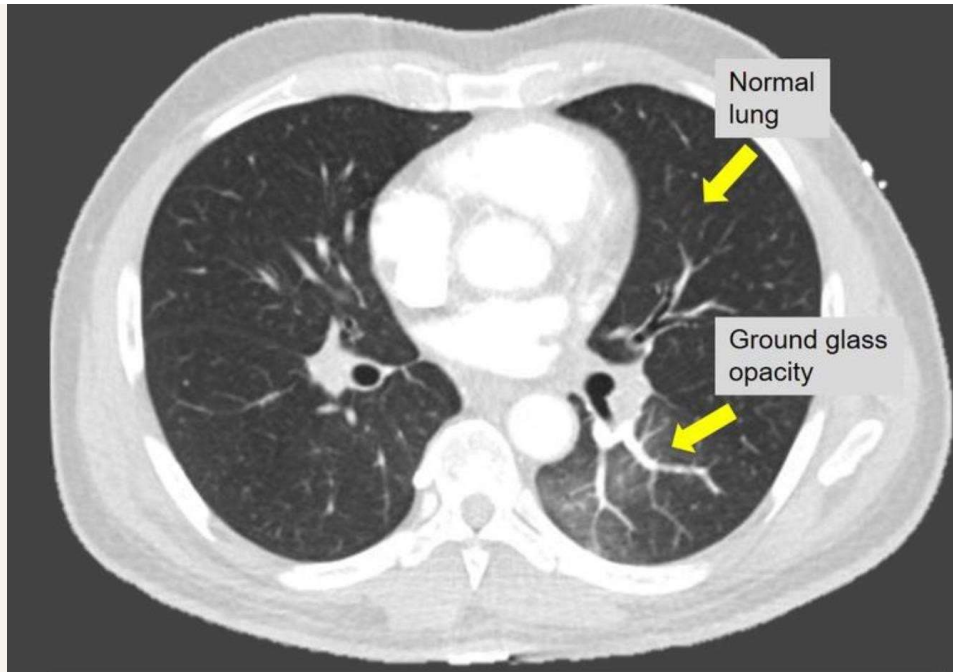
肺隱球菌病 (Pulmonary Cryptococcosis) 和麴菌瘤/肺部黴菌感染 (Aspergilloma/Mycetoma/Fungal infection) 也在多個年份出現。這顯示真菌感染在胸腔影像學中的重要性，特別是麴菌瘤常表現為空腔病灶內的球形團塊 (ball in hole)。

肺囊蟲肺炎 (PJP) 近年來也有穩定出現，雖然總次數較少，但可能與特定族群的影像鑑別有關。

其他較零星出現但重要的感染症相關診斷包括：敗血性栓塞、肝膿瘍、非結核分枝桿菌感染 (NTM)、肺膿瘍、膿胸以及 descending mediastinitis。這些顯示考試會涵蓋不同類型的感染及其在胸部的表現或併發症。

Common patterns of infection

1. 肺泡性實質化 (Alveolar process / Consolidation)
2. 毛玻璃狀病變 (Ground Glass Opacity, GGO)
3. 結節 (Nodules)
4. 空腔 (Cavities)
5. 間質性病變 (Interstitial pattern) (常與GGO 重疊)
6. 支氣管擴張 (Bronchiectasis) (常與感染相關)
7. 樹芽徵 (Tree-in-bud) (提示細支氣管內感染/發炎)
8. 粟粒狀病變 (Miliary pattern) (瀰漫性小結節)



<https://www.grepmed.com/images/13949/glass-pulmonary-lung-chestct-pathophysiology>

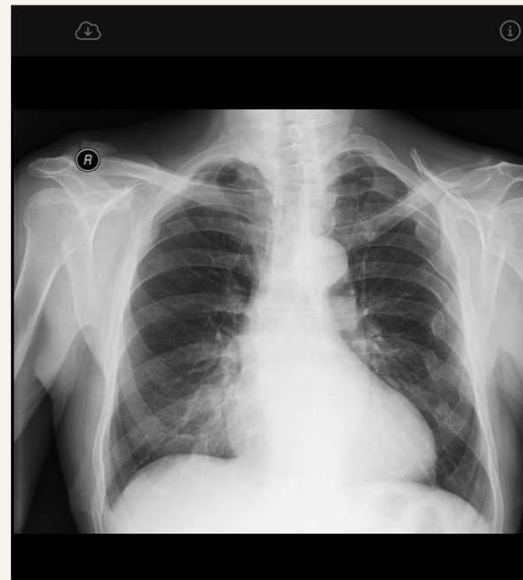
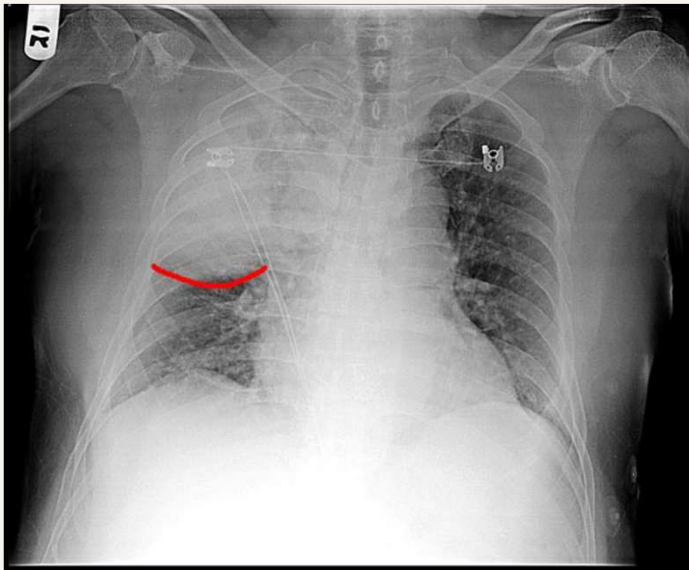
Bacterial Infection

Typical pattern: 肺泡性實質化(Consolidation) 是細菌性肺炎的經典表現。

Distribution: 常呈現大葉性(Lobar) 或支氣管性(Bronchopneumonia/Lobular) 分佈。大葉性肺炎通常由Streptococcus pneumoniae 或Klebsiella pneumoniae 引起。

Klebsiella 肺炎有時會導致Volume expansion, 在影像上表現Bulging fissure sign。

支氣管肺炎常呈現多發性、分葉狀的實質化。



<https://radiopaedia.org/>

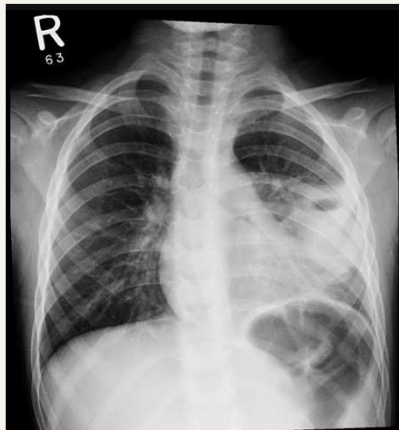
Bacterial Infection

單側 vs. 雙側：細菌性肺炎較為單側。

併發症：Lung abscess，影像上呈現thick wall cavity，常伴有air fluid level。膿胸（Empyema）也是常見併發症，表現為loculated pleural effusion。敗血性栓塞（Septic emboli）通常表現為bilateral, multiple nodules w or w/o cavities，需要與惡性轉移鑑別。

其他細菌：Nocardia 和Actinomycosis 也可引起肺部感染，並可能形成空腔。

Contrast-enhanced CT 通常用於評估併發症（如empyema, abscess）、區分 consolidation or atelectasis，以及在對初始治療反應不佳時提供更多資訊。



<https://radiopaedia.org/>

Viral Infection

典型影像模式： 毛玻璃狀病變（GGO）是病毒性肺炎的常見表現，尤其在免疫功能正常者。病毒性肺炎也可表現為interstitial pattern or consolidation。

分佈： Often bilateral，可以是diffuse G G O 或patch。COVID-19 在CXR 上表現多樣且非特異性，常為周邊、雙側、下肺區的陰影。HRCT 上COVID-19 可見G G O 和實質化。

Viral Infection

特定表現：流感(Influenza) 可見GGO with patch consolidations及邊界不清的小結節。RSV 在兒童多見，常為氣道中心分佈，可見tree-in-bud pattern。CMV 在免疫不全者多見，常為雙側不對稱的 GGO，可能伴有肋膜積液。

瀰漫性小結節：病毒感染也可能呈現粟粒狀病變(miliary pattern)。

CT: ground glass opacities

Fungal infection

真菌感染影像表現多樣，取決於病原體種類及宿主免疫狀態。

Pneumocystis jirovecii Pneumonia (PJP)：好發於免疫不全者(如 AIDS)。經典影像表現為雙側瀰漫性GGO，偶爾可見 Crazy-paving pattern。隱球菌病(Cryptococcosis)：可表現為結節或瀰漫性小結節(miliary pattern)。好發於免疫不全者(如腎移植後)。

Fungal infection

Aspergillosis:

麴菌瘤 (Aspergilloma/Mycetoma): 好發於既存空腔 (如old TB的空腔) 內, 影像呈現球形團塊, 經典徵象為 "Ball-in-Hole" sign。常見於免疫功能正常者。

侵襲性肺麴菌病 (Invasive Pulmonary Aspergillosis, IPA): 主要見於嚴重免疫不全者 (如嗜中性白血球低下、移植後)。早期CT 表現可見Halo sign (結節周圍的GGO)。也可表現為結節或實質化。診斷需結合宿主因素、影像異常和微生物學、antigen與病理。

慢性肺麴菌病 (CPA): 存在空腔w or w/o aspergilloma, 影像有progressive change, 伴有肺部及/或全身症狀。

麴菌結節 (Aspergillus nodule): solitary or multiple nodules (<3cm), 可能伴有central cavity。

過敏性支氣管肺麴菌病 (ABPA): 常見於有asthma病史者, 影像可見proximal or central bronchiectasis和肺部浸潤 (可見黏液栓塞)。

真菌感染可能導致consolidations和cavitation。

總結影像鑑別思路以協助經驗性治療

1. Pattern: 主要的影像模式是consolidations、GGO、nodules、cavitation、miliary nodules、bronchiectasis, mixed。
2. Distribution: unilateral vs bilateral? Focal or diffuse? Location? 分佈是alveolar (跨肺段/葉) 還是bronchovascular (沿支氣管分佈) 或 interstitial pattern?
3. Sign: 是否有air bronchogram、bulging fissure、tree-in-bud、halo sign、ball-in-hole、Crazy-paving 等。
4. Clinical Hx: 病人的免疫狀態(最重要)、年齡、systemic disease、症狀、病程緩急等。

總結影像鑑別思路以協助經驗性治療

Differential diagnosis:

單側實質化：首先考慮典型細菌性肺炎。

雙側 GGO 或間質性病變：需高度懷疑病毒性肺炎或伺機性感染（PJP, CMV）。結合免疫狀態鑑別PJP vs. CMV。

Cavitation：鑑別診斷廣泛，感染方面需考慮TB、肺膿瘍（細菌）、NTM、真菌（麴菌、隱球菌）。需注意腔壁特徵。

結節或多發結節：鑑別包括TB、NTM、真菌（隱球菌、麴菌結節）、敗血性栓塞（細菌性）。結合病史（如免疫狀態、靜脈導管史）有助鑑別。

瀰漫性小結節（粟粒狀）：需考慮粟粒性TB、某些真菌（隱球菌、Histoplasmosis）、病毒、Nocardia、DPB。TB 是台灣重要的鑑別診斷。

支氣管擴張伴有感染徵象：常與細菌（尤其是NTM MAC）或真菌（ABPA）相關。

Empiric treatment:

根據最可能的病原體類別（細菌 vs. 病毒 vs. 真菌 vs. 伺機性）選擇抗生素、抗病毒藥物或抗真菌藥物。當影像提示細菌性肺炎時，經驗性使用廣效抗生素是常見做法。若免疫不全病人出現雙側GGO，經驗性涵蓋PJP 和CMV 是重要考量。影像提示真菌感染特定模式時，需根據懷疑的真菌種類給予經驗性抗真菌治療（如懷疑IPA 給予抗麴菌藥物）。

影像模式的判讀必須結合臨床病史

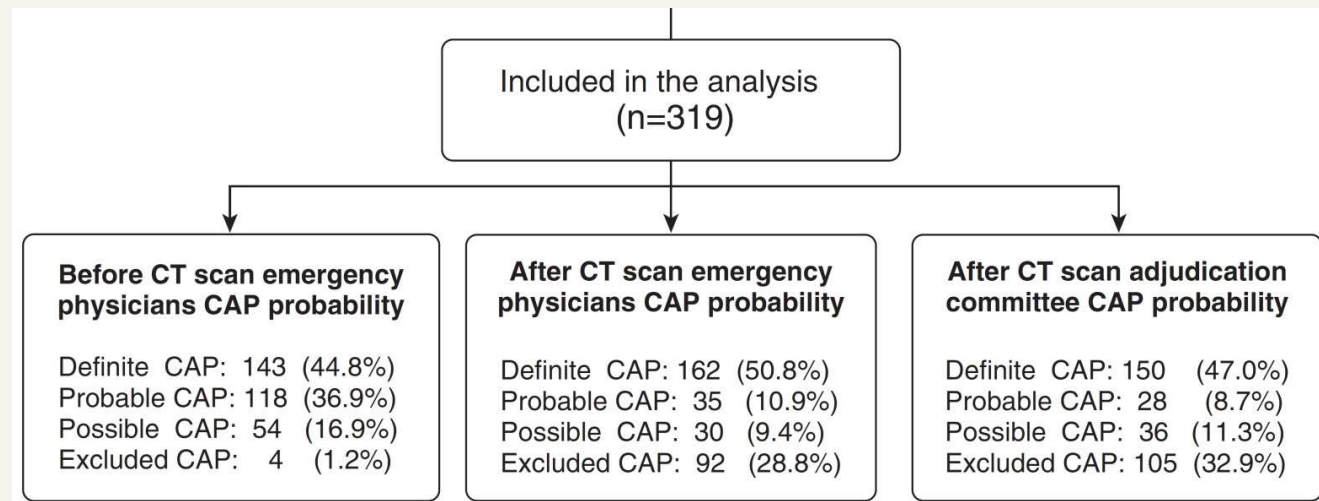
重要的是，影像模式的判讀必須結合臨床病史，特別是病患的免疫狀態。例如，在免疫功能正常的病人中，實質化更常見於細菌；而在免疫功能低下者，即使是GG0 或不典型的實質化，也需高度警惕伺機性感染，如PJP、CMV 或侵襲性真菌感染

Pulmonary Infections

- (1) Detection of infection: CxR -> CT chest
- (2) Differentiation: infections? Non-infectious lung disease?
- (3) Infection: complications
- (4) Specific pathogens: Chronic fibrocavitary disease

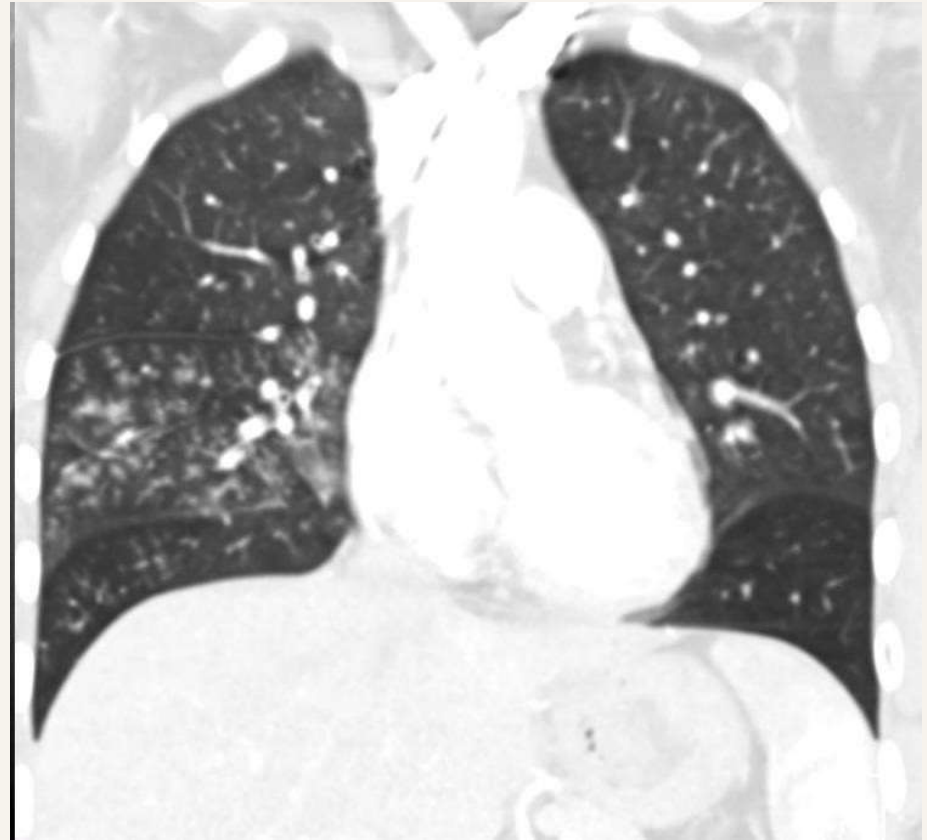
Early Chest Computed Tomography Scan to Assist Diagnosis and Guide Treatment Decision for Suspected Community-acquired Pneumonia

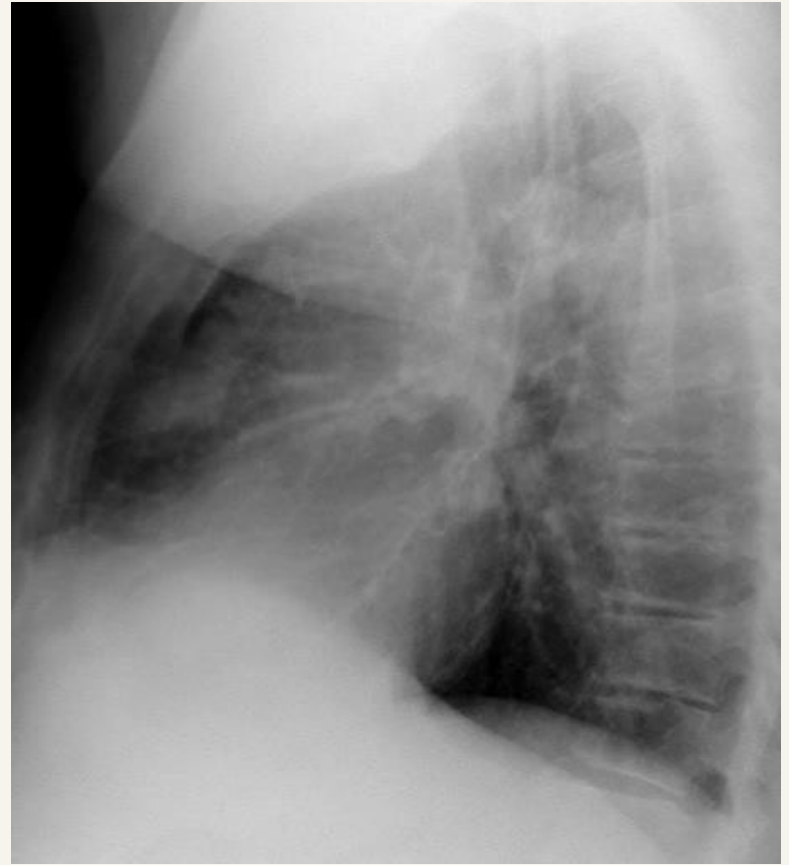
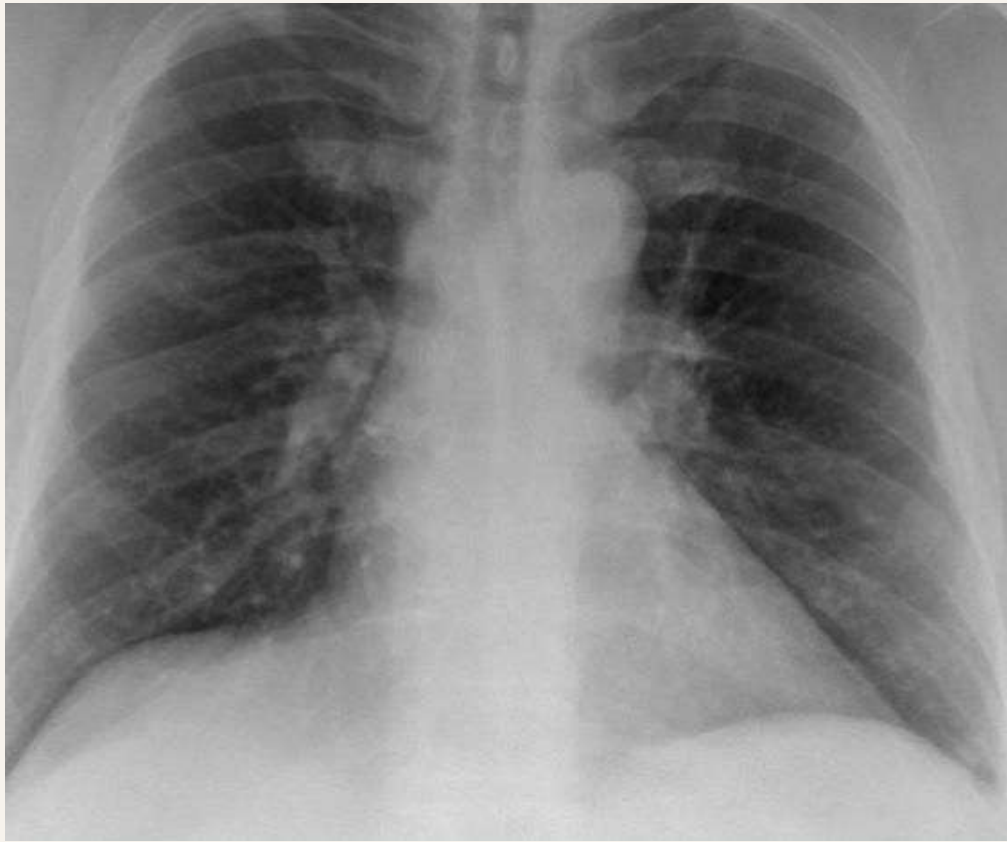
- Claessens 2015, AJRCCM
- CxR positive -> CT negative in 1/3
- CxR negative -> CT positive in 1/3

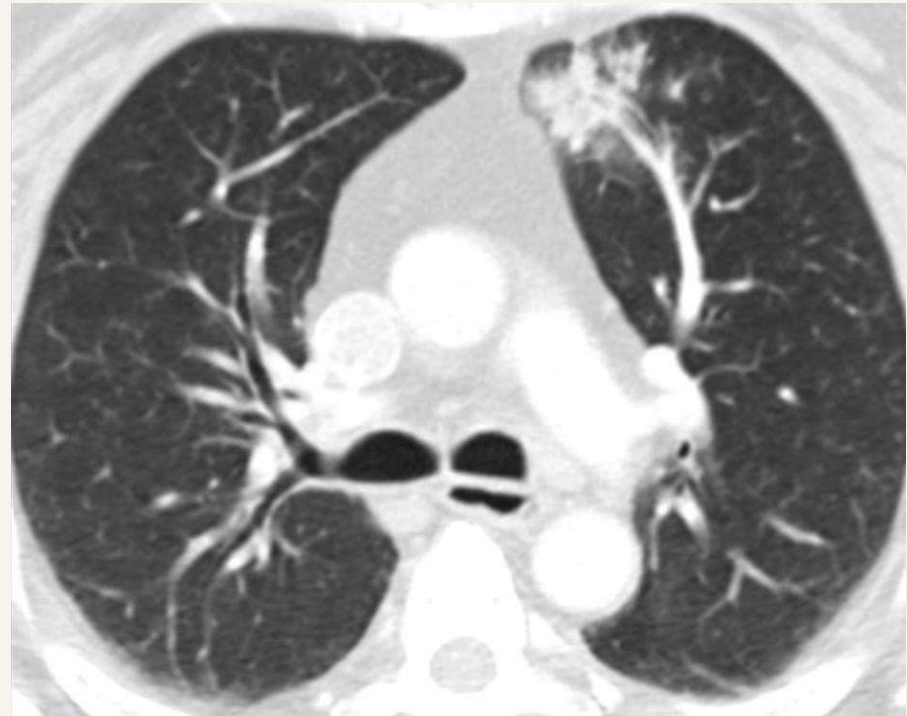


Am J Respir Crit Care Med 192, 8, 974–982, 2015

Occult Pneumonia



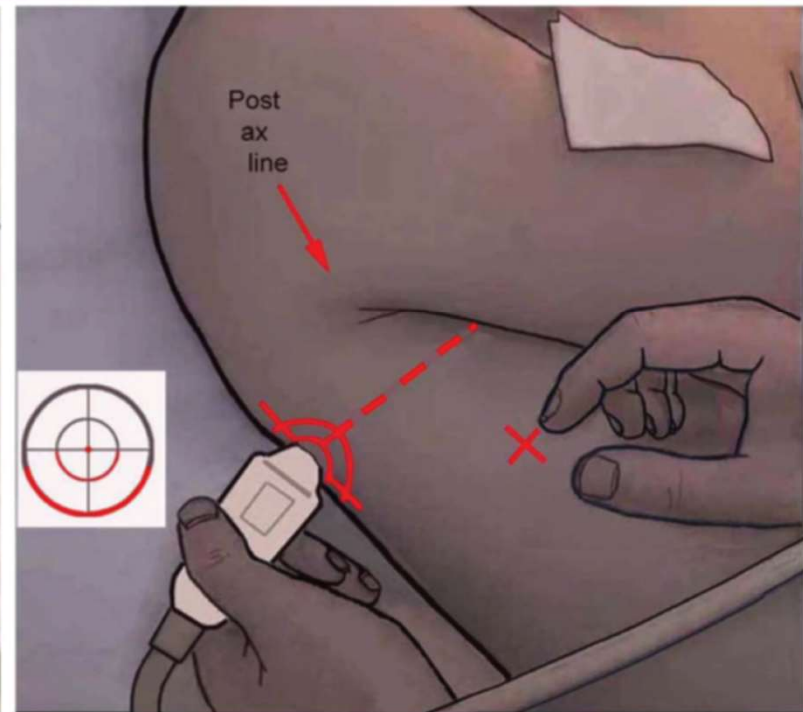
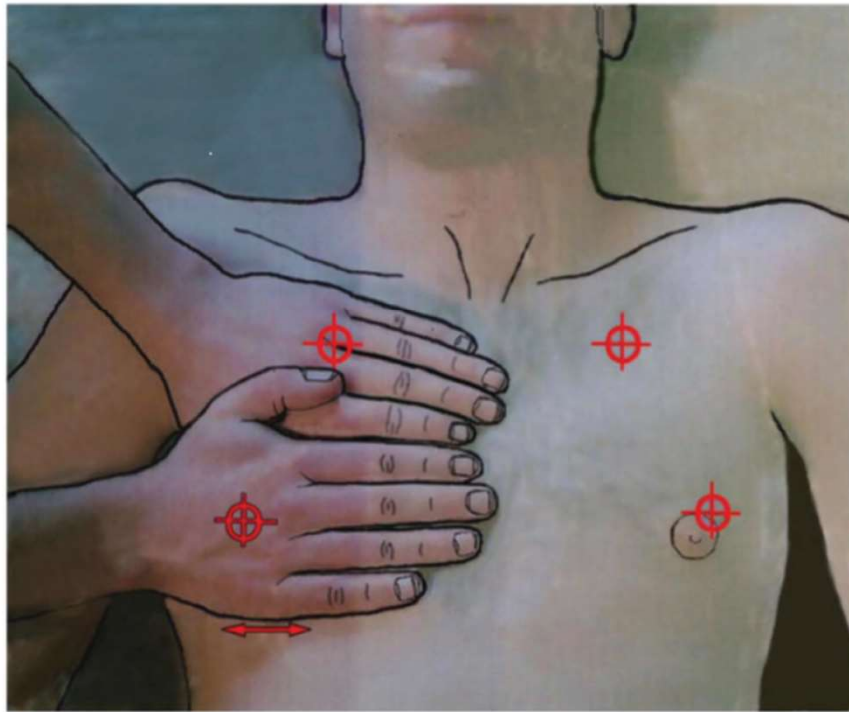


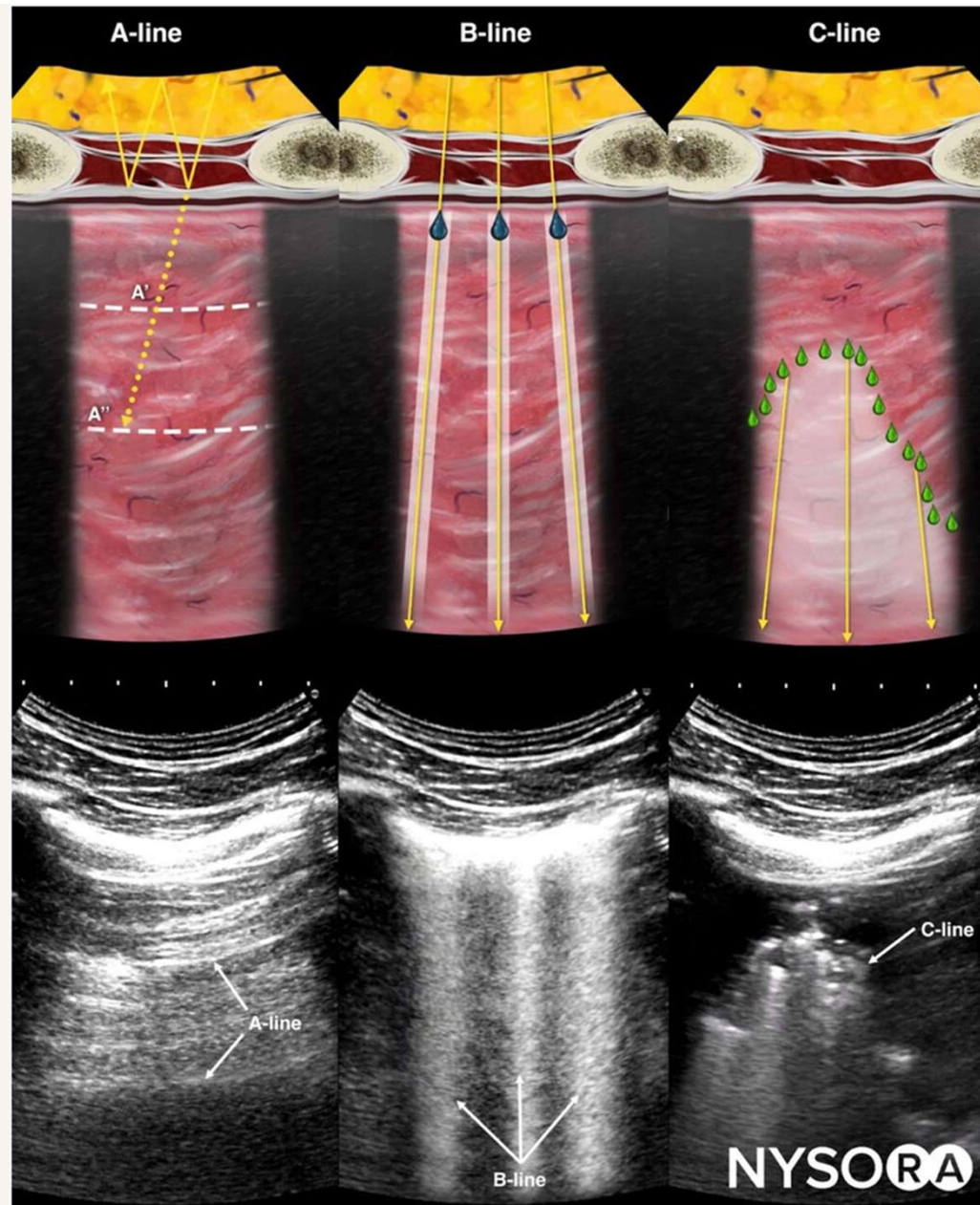


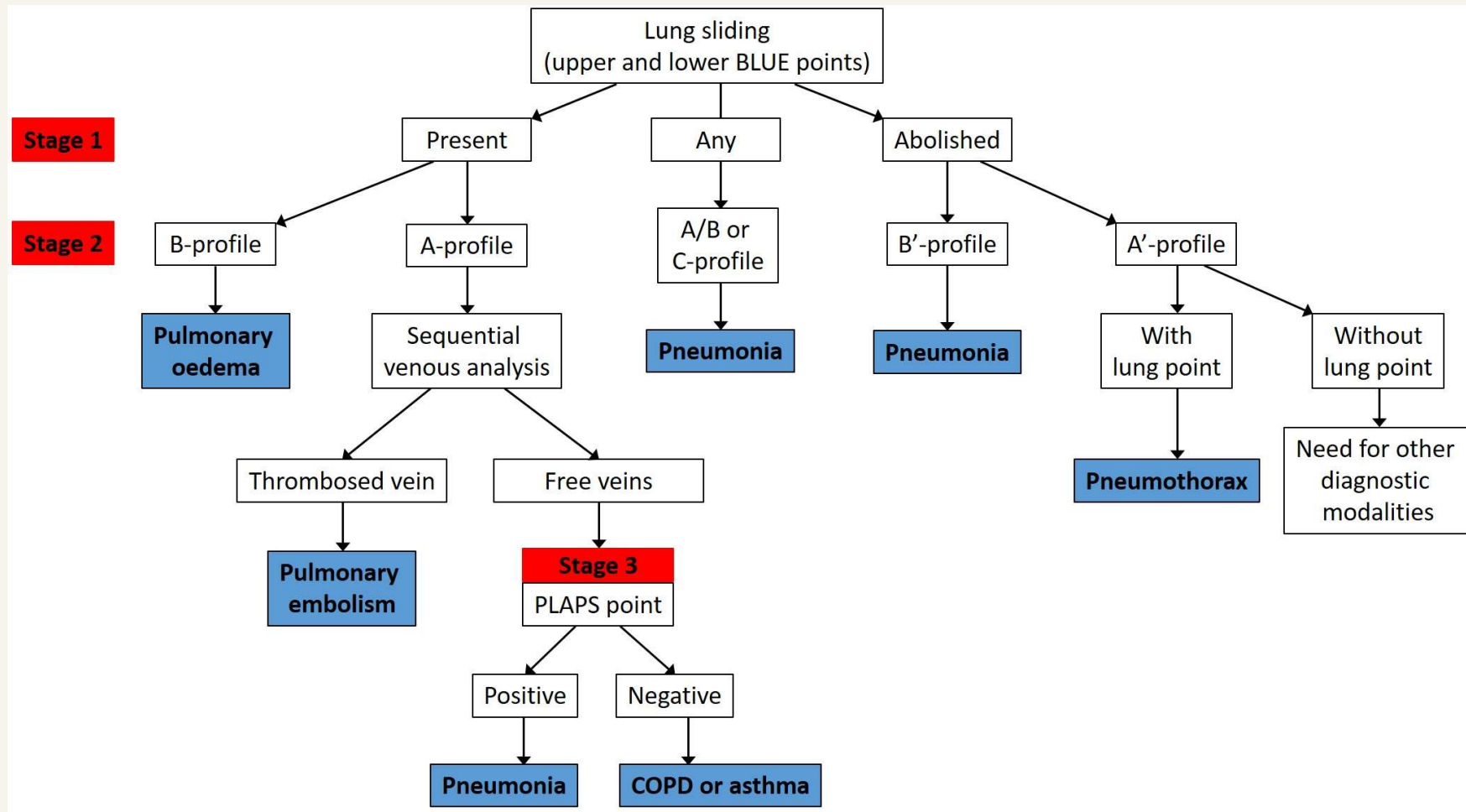
The Blue Protocol

Looks for six clinical conditions:

- | | |
|------------------------------|----------------------------|
| 1. Pulmonary Edema | 4. COPD/Asthma |
| 2. Pulmonary Embolism | 5. Pneumothorax |
| 3. Pneumonia | 6. Pleural Effusion |







(2) Differentiation: infections? Non-infectious lung disease?

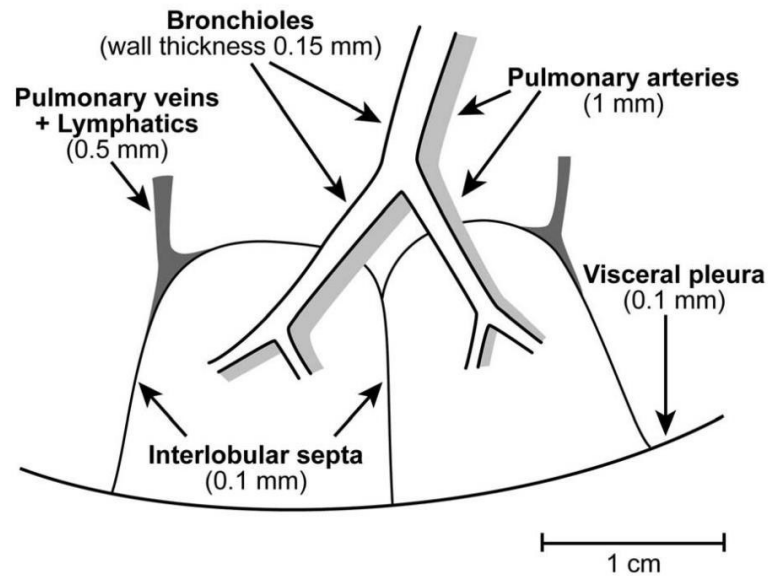
- (1) Septal thickening (線)
- (2) Nodule patterns (點)
- (3) Consolidation patterns (面)

(線)

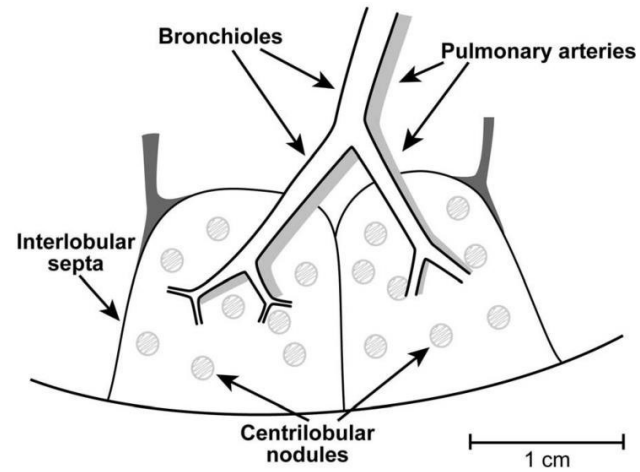
(點)

(面)

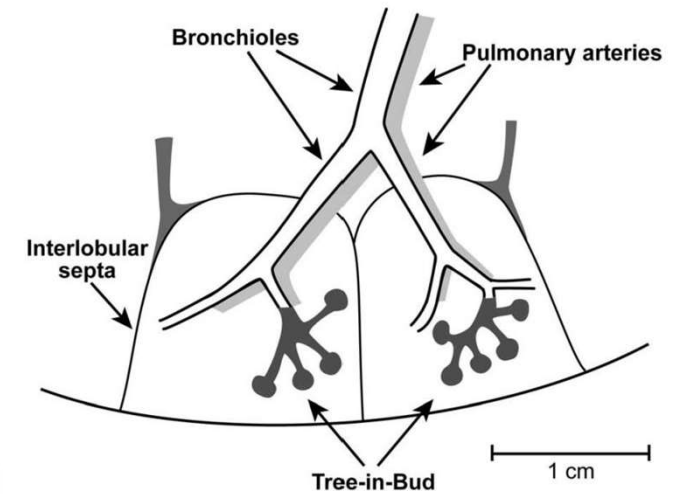
Normal Secondary Lobular Anatomy



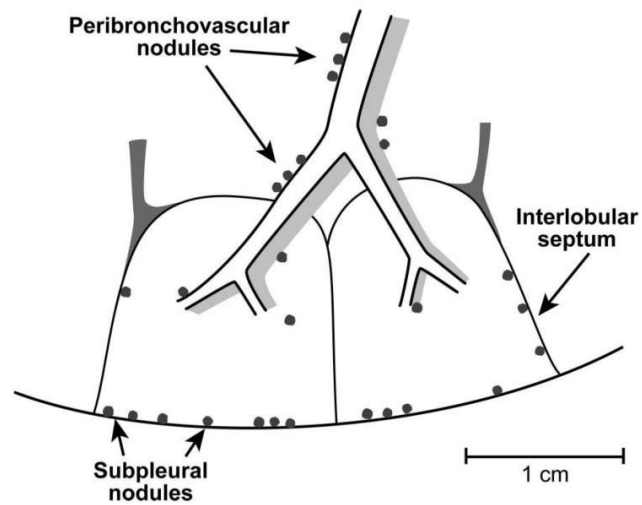
Centrilobular Disease



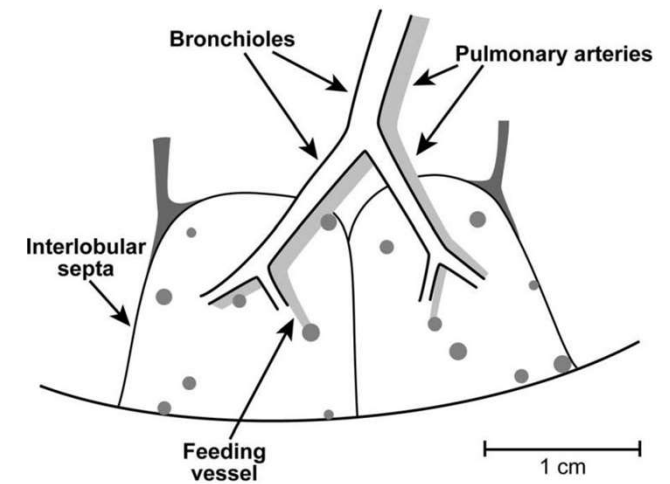
Bronchiolar Disease



Perilymphatic Disease



Random Nodules

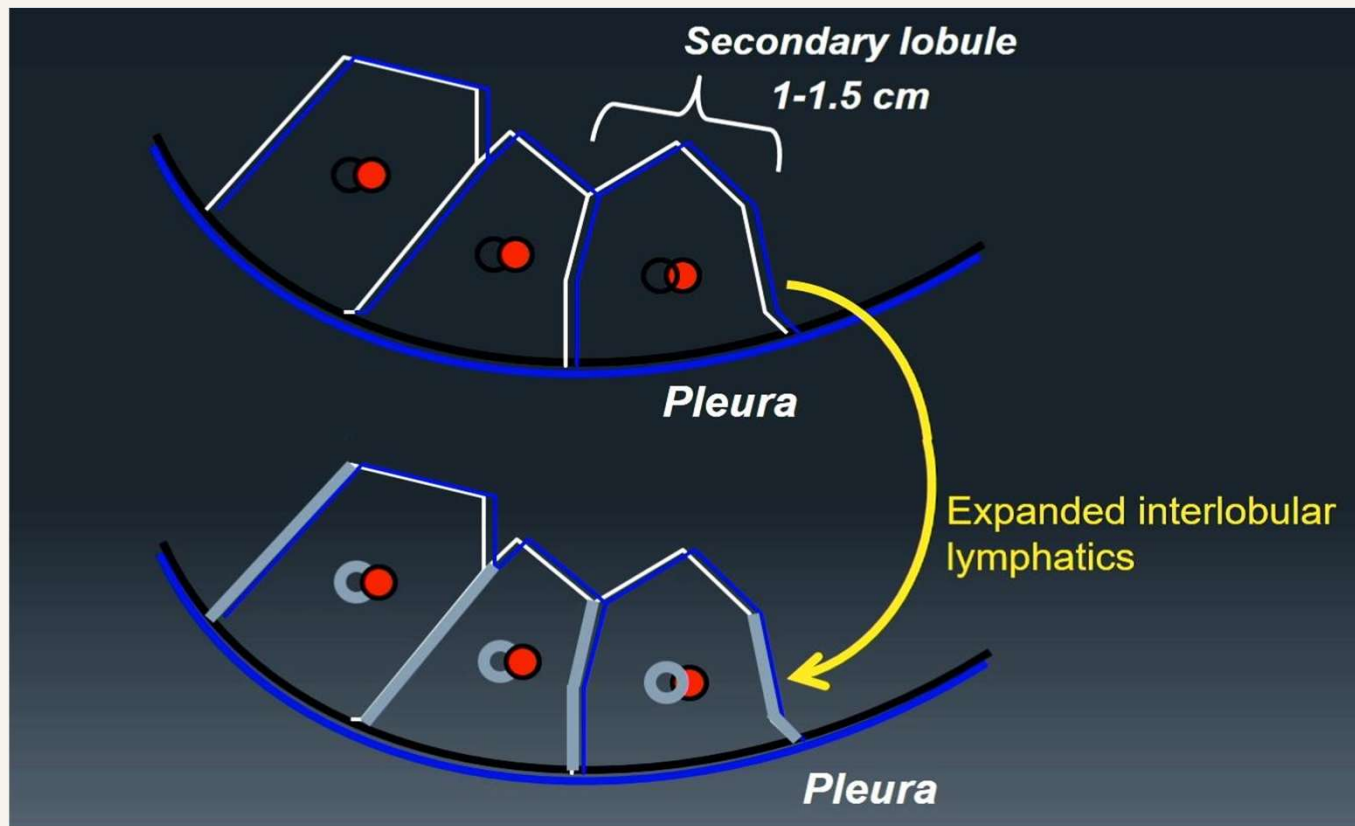


(2) Differentiation: infections? Non-infectious lung disease?

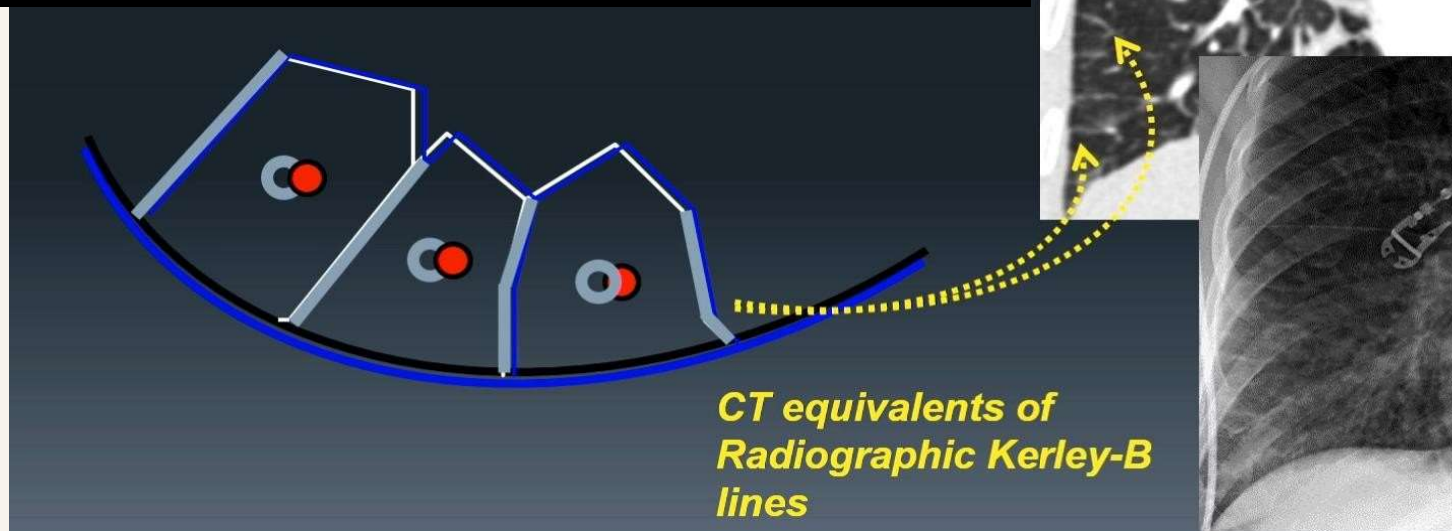
- **Septal thickening**
- Nodule patterns
- Consolidation patterns



CT pattern: interlobular septal thickening (dominant)



CT pattern: interlobular
septal thickening (dominant)



CT pattern: interlobular septal thickening

■ **Common: non-infectious**

=> Congestive heart failure

=> Lymphangitic carcinoma

=> Acute eosinophilic pneumonia

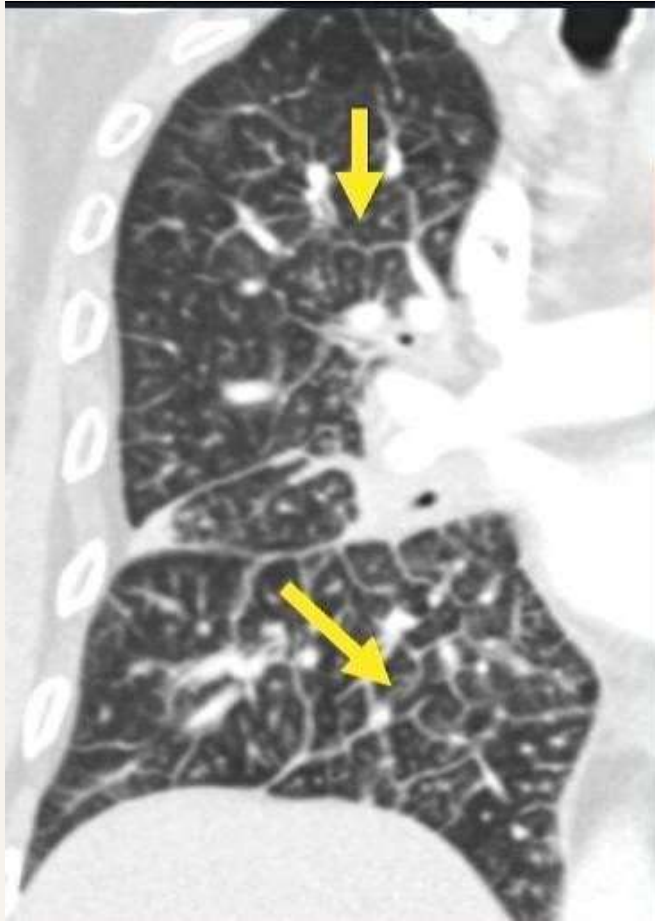
=> Drug reaction

■ **Infections: rarely dominant or diffuse**

⇒ Hantavirus (if cardiac dysfunction present)

⇒ Rickettsia diseases

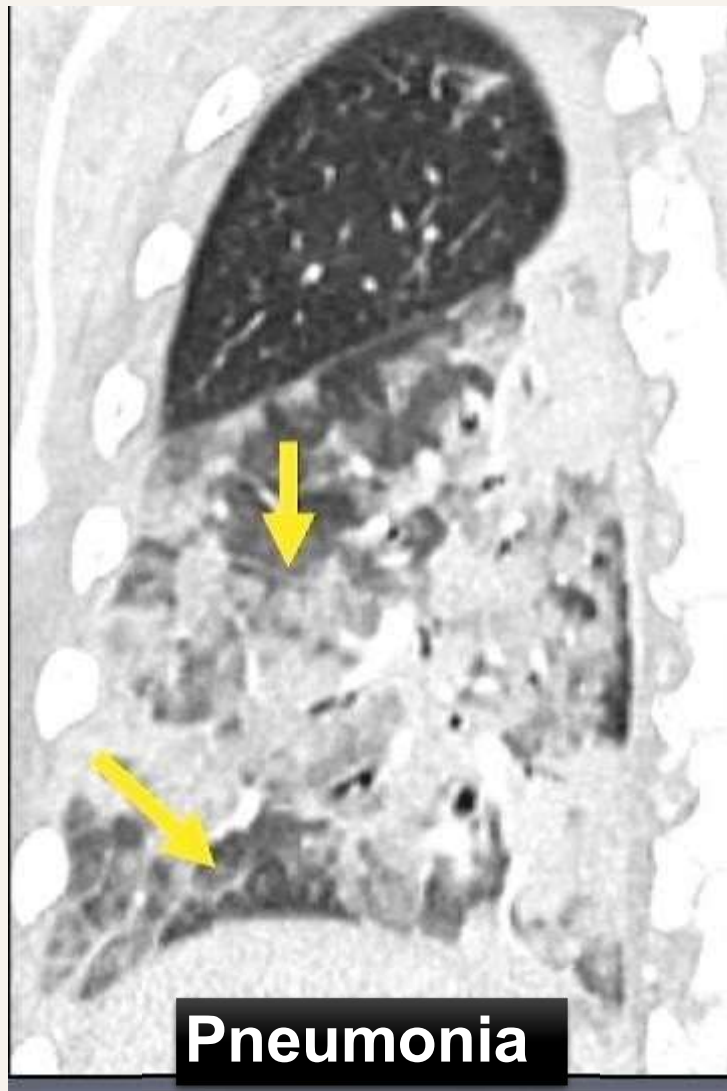
(Common: Scattered thickened septa intermixed with other opacities)



Lymphangitic carcinomatosis



Acute eosinophilic pneumonia



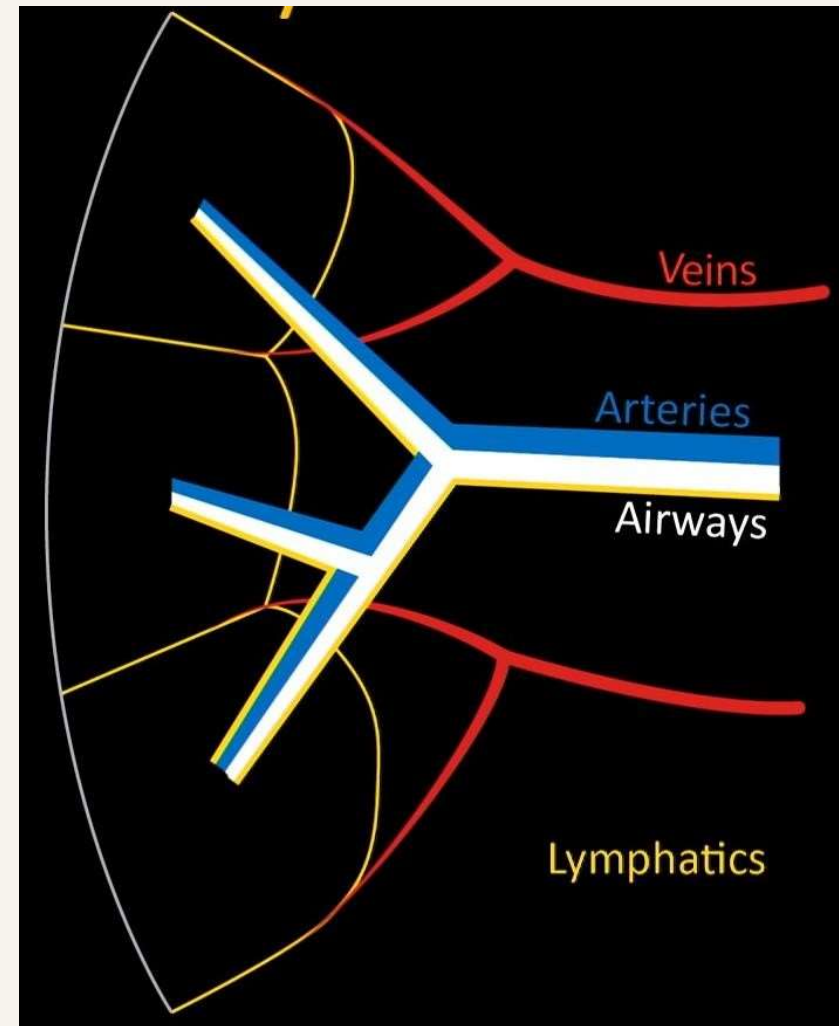
(2) Differentiation: infections? Non-infectious lung disease?



- Septal thickening
- **Nodule patterns**
- Consolidation patterns

Secondary Pulmonary Lobule

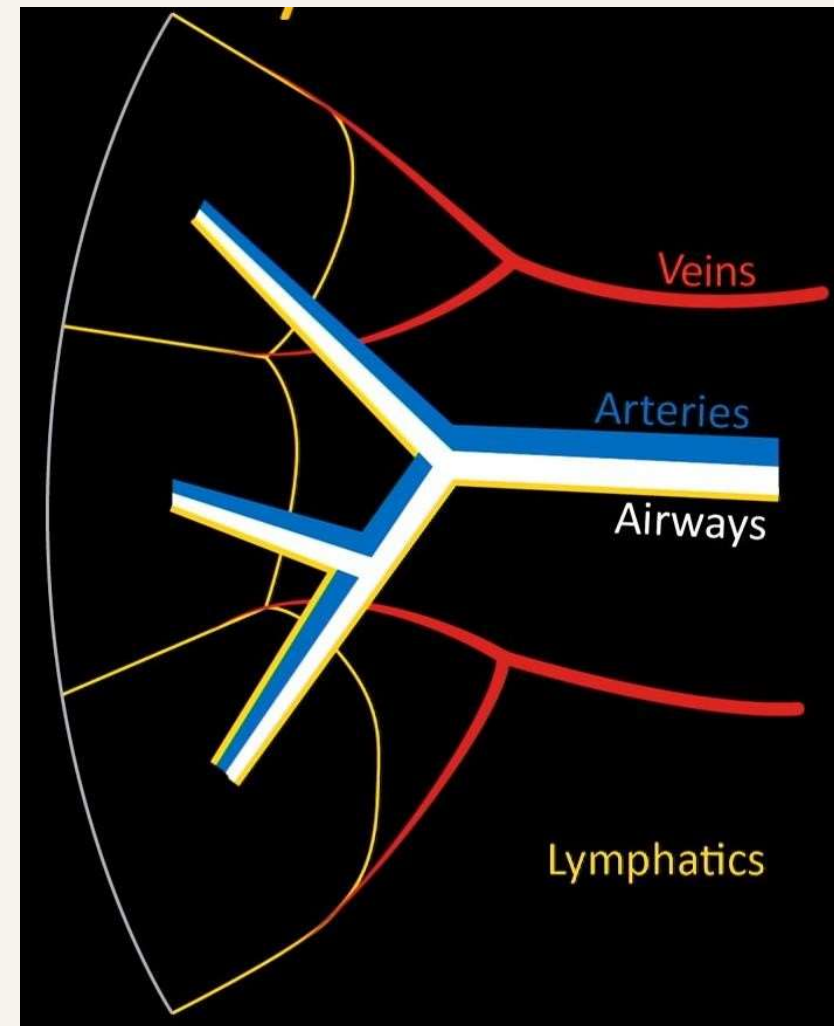
- Smallest unit of lung margined by connective tissue
- 1.0-2.5 cm in diameter
- Fundamental unit of lung structure



Webb WR. Thin-section CT of the secondary pulmonary lobule: anatomy and the image--the 2004 Fleischner lecture. *Radiology* 2006; 239:322-338

Secondary Pulmonary Lobule

- Polygons;
- Central:
 - => arteries, airways, and lymphatics;
- Interlobular septa:
 - => the veins and lymphatics
- Lymphatics: both in the interlobular septa and at the center



Webb WR. Thin-section CT of the secondary pulmonary lobule: anatomy and the image--the 2004 Fleischner lecture. *Radiology* 2006; 239:322-338

Do they touch the pleura?

Three Patterns of nodules:

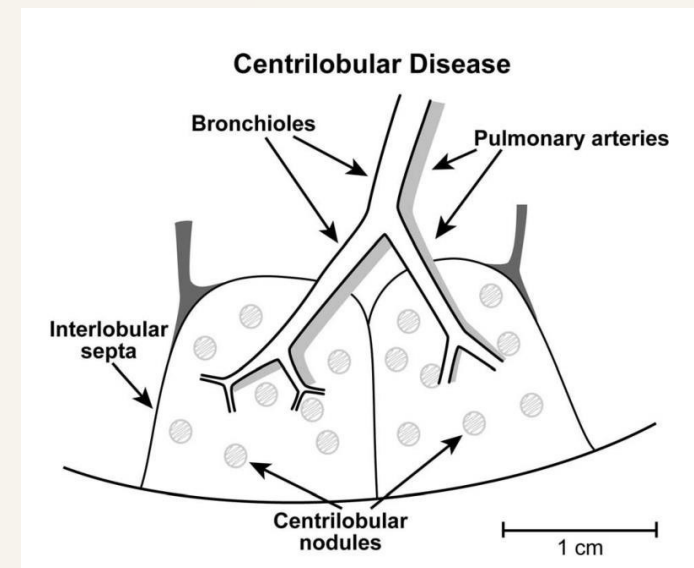
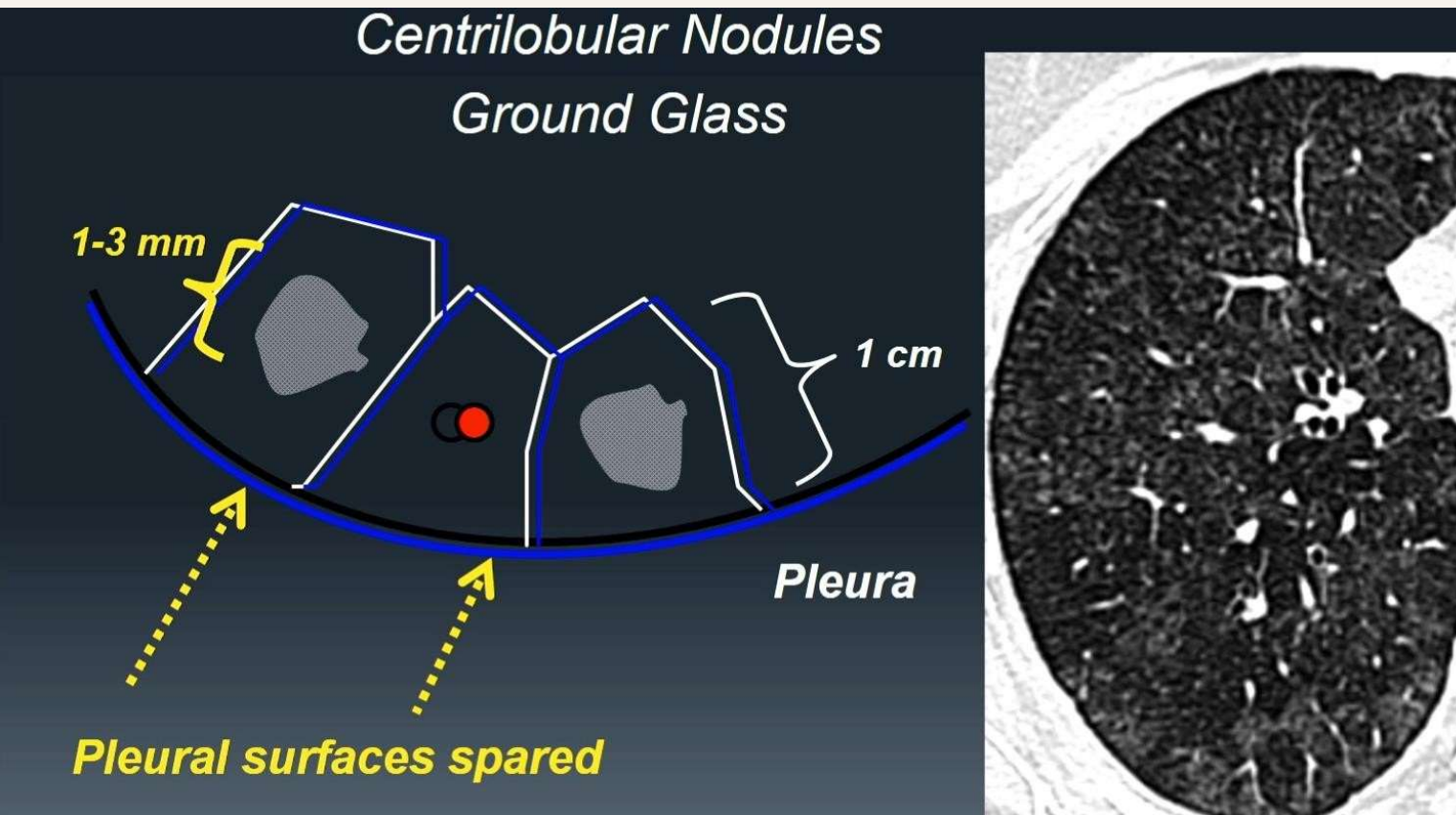
- (1) **Centrilobular**: spare pleural surfaces
- (2) **Random**: Both touch the pleura
- (3) **Perilymphatic**: Both touch the pleura

The most important question (the key): **Do they touch the pleura?**

⇒ No! -> centrilobular nodules -> small airway diseases!

⇒ Yes! -> Random or perilymphatic nodules!

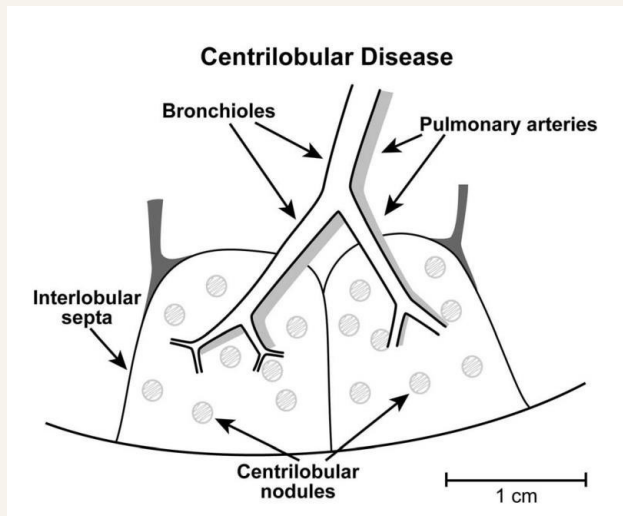
CT pattern: Centrilobular nodules



CT pattern: Centrilobular Ground Glass nodules

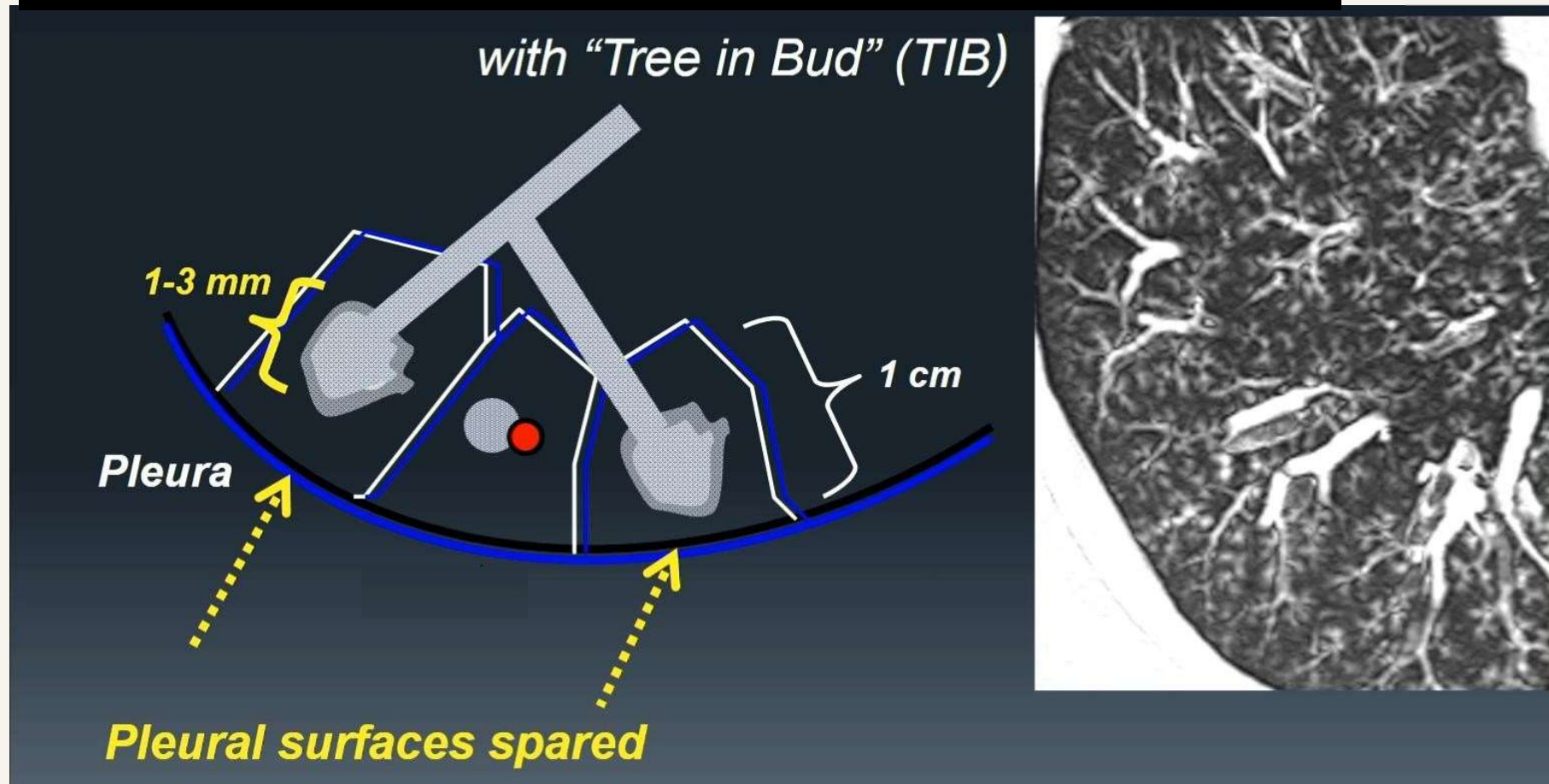
Non-infectious disease: common

- Hypersensitivity pneumonitis
- Respiratory bronchiolitis
- Pulmonary hemorrhage/pulmonary vasculitis



CT pattern: Centrilobular nodules with “Tree-in-bud” (TIB)

(點)



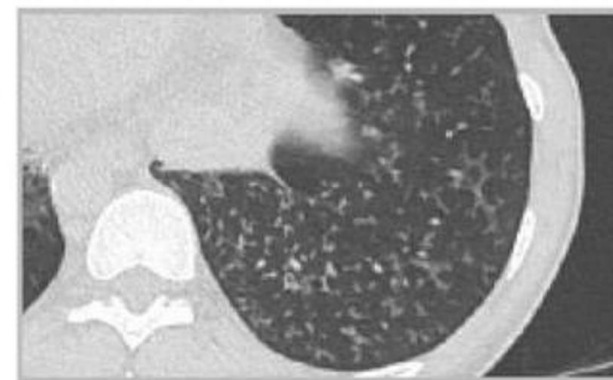
樹芽徵 (Tree-in-bud pattern)

影像表現：細支氣管末端及其遠端肺泡腔內充滿分泌物或感染物質，在 CT 上表現為呈樹枝狀分佈的中心小葉性小結節和分枝狀線樣影，形似發芽的樹枝。

與感染的關聯：樹芽徵強烈提示細支氣管的感染或發炎，常見於感染性細支氣管炎，如結核、非結核分枝桿菌、某些病毒或真菌感染。

Tree-in-bud sign

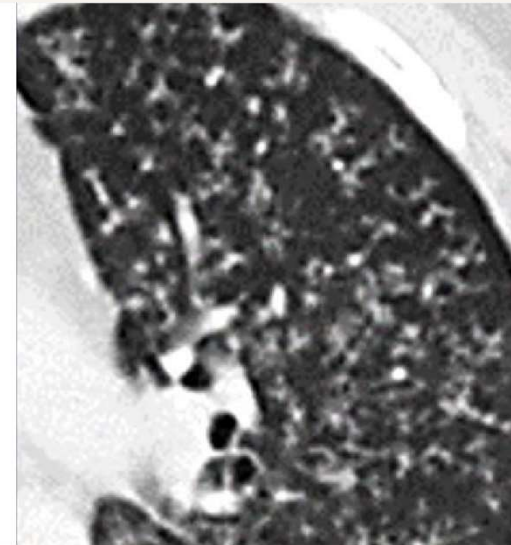
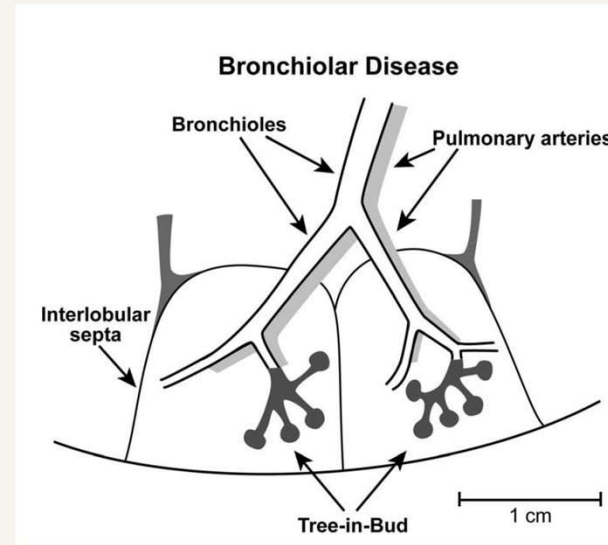
- Multiple centrilobular nodules arranged in a linear branching pattern.
- DDx: NTM, atypical pna, viral bronchiolitis, aspiration pneumonitis



CT pattern: TIB

Centrilobular nodules

- Mycobacterial
- Bacterial: H. influenza
- Mycoplasma –usually adults
- Viral (RSV, Parainfluenza, Influenza, Human Metapneumovirus)



Tuberculosis

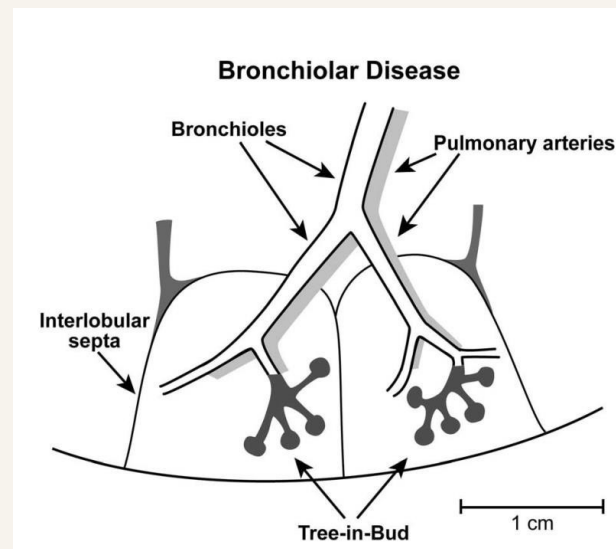


Influenza

CT pattern: TIB

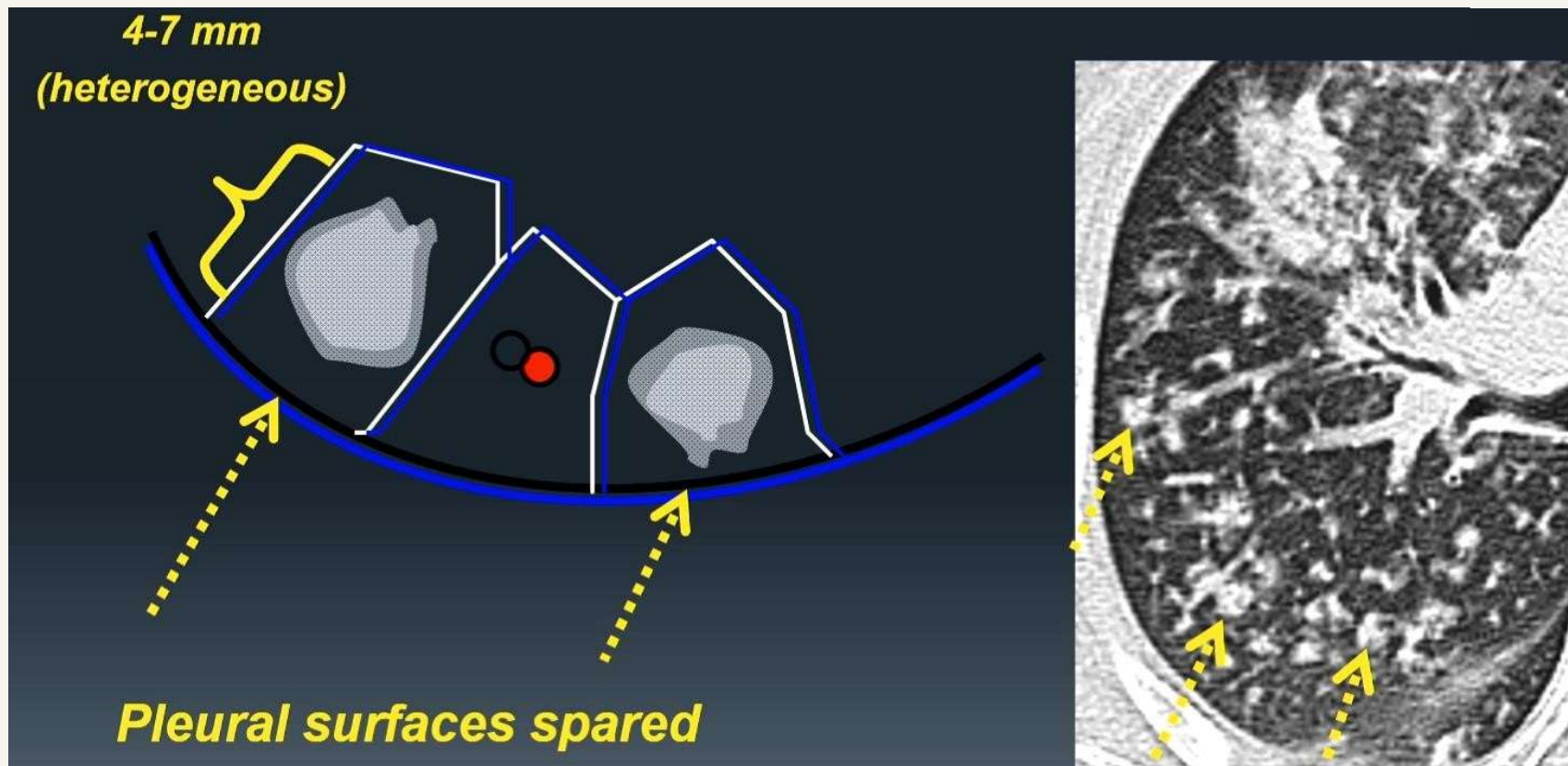
Centrilobular nodules

- Viral
- Radiologic pattern may be dominated by bacterial co-infection
- Influenza
- Rhinovirus infections



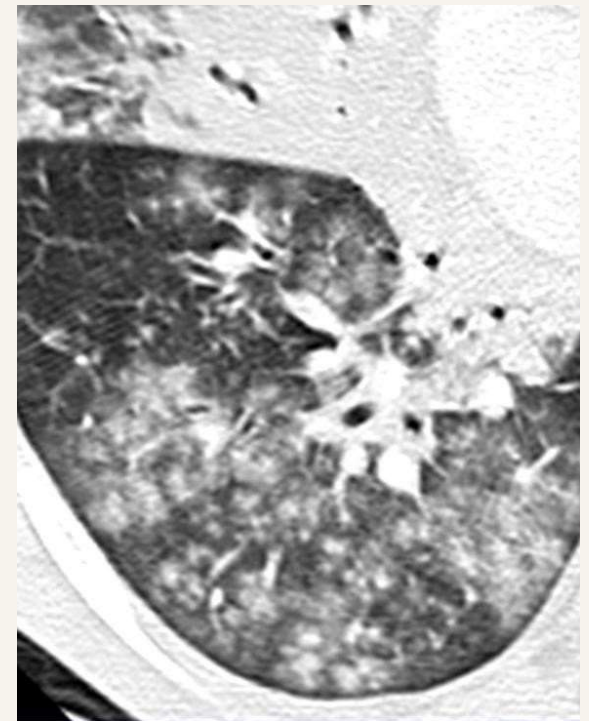
CT pattern: Soft tissue Centrilobular nodules

(點)

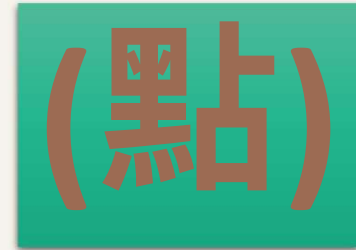


CT pattern: Soft tissue Centrilobular nodules

- Soft tissue centrilobular nodules: **Bigger size**
- **Heterogeneous** in size
- Patchy
- **Common in infections:**
= Acinar consolidation; often associated with TIB
- **Non-infectious causes:**
= aspiration; invasive adenocarcinoma-chronic;

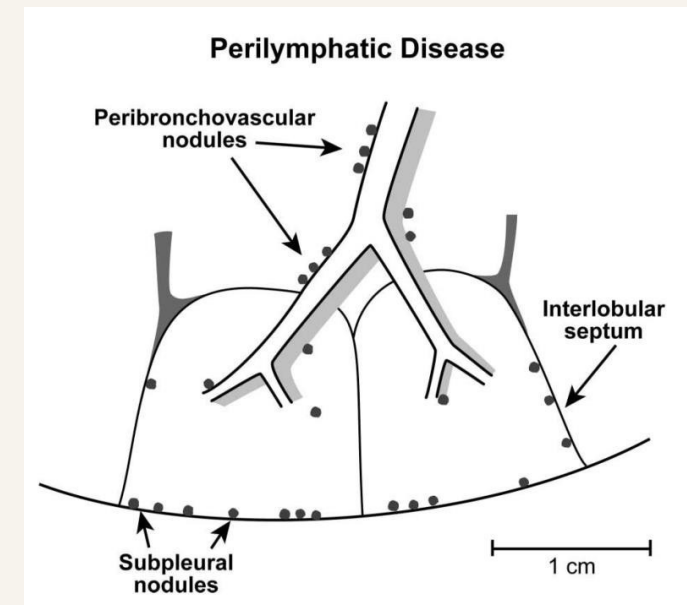
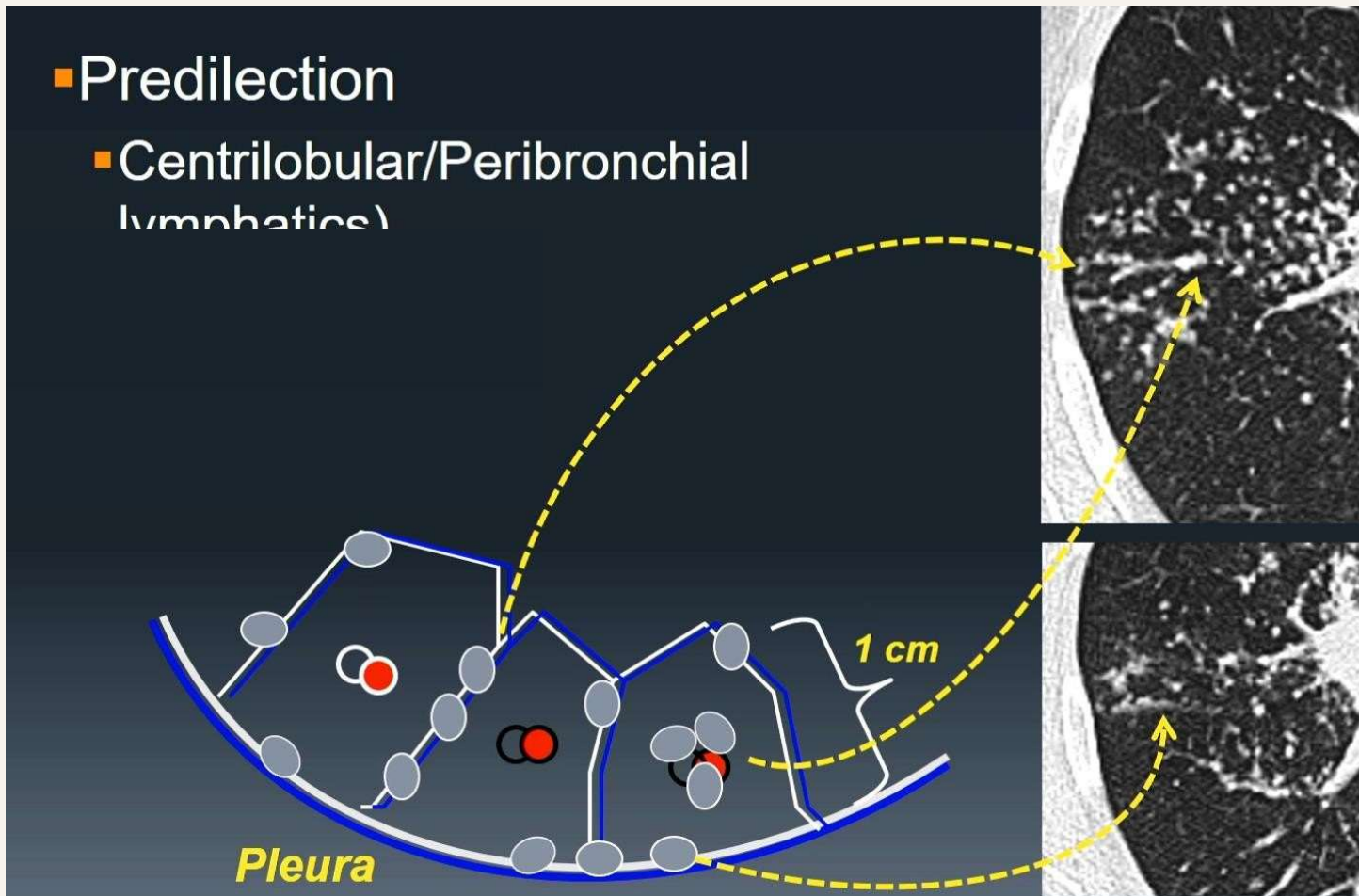


CT pattern: Perilymphatic nodules



- Predilection

- Centrilobular/Peribronchial (lymphatics)



CT pattern: perilymphatic nodules

- Centrilobular/Peribronchial lymphatics
- Interlobular Septa
- Pleural Surfaces
- Nodules “clumpy” (often)
- **DDx: Sarcoid, silicosis and lymphangitic cancer**
- **Usually not from infection**

Case: Diagnosis: Sarcoidosis

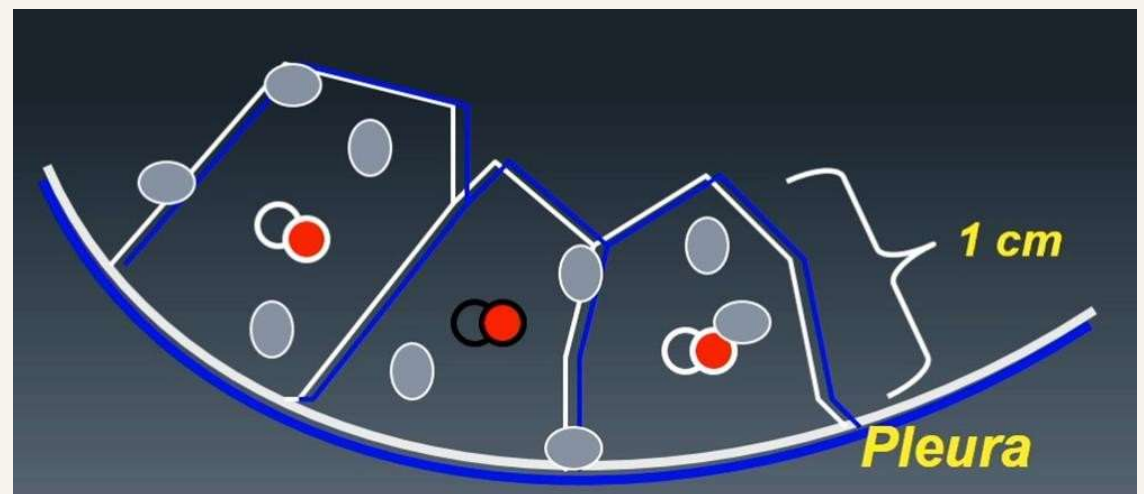
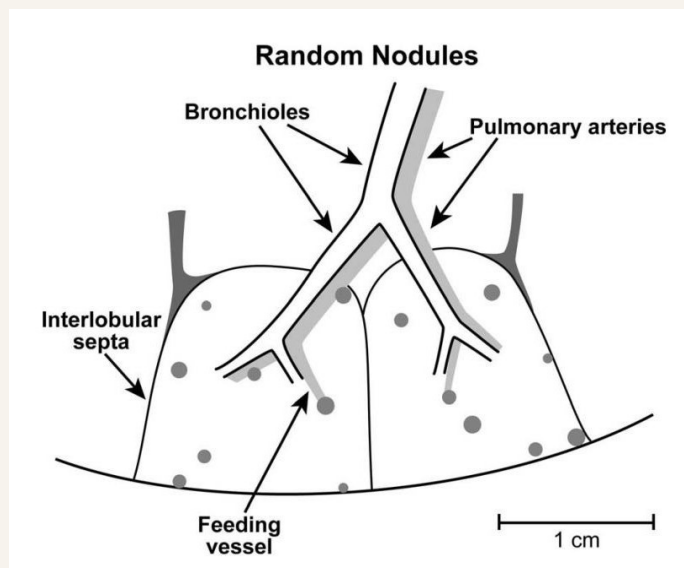
- 52 Y/O
- Female
- ER: chest pain
- Hx of 2 cm thyroid nodule
- CxR
- CT chest





CT pattern: Random nodules

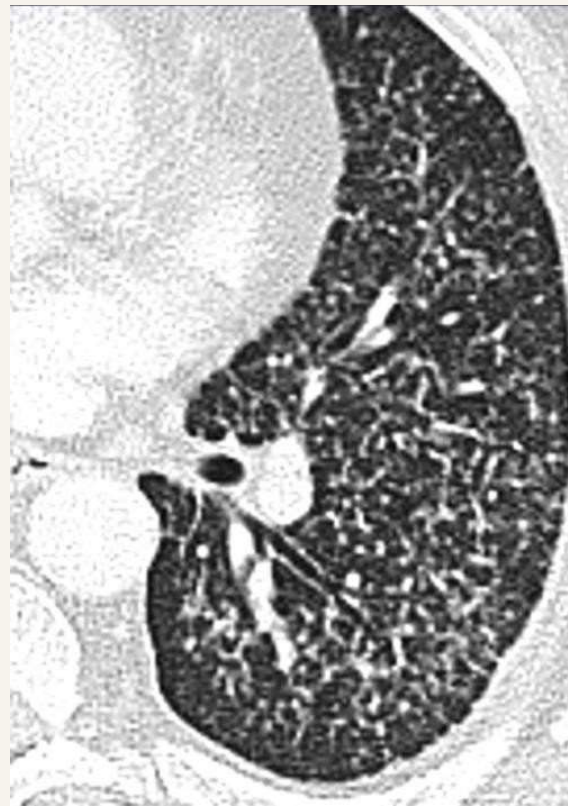
- Diffuse, randomly contact interlobular septa and pleural surfaces (hit the pleural surfaces)
- Infection – **miliary TB**, endemic fungi
- Non-infectious – **Metastatic neoplasm**
- **Blood-borne usually**



CT pattern: Random nodules

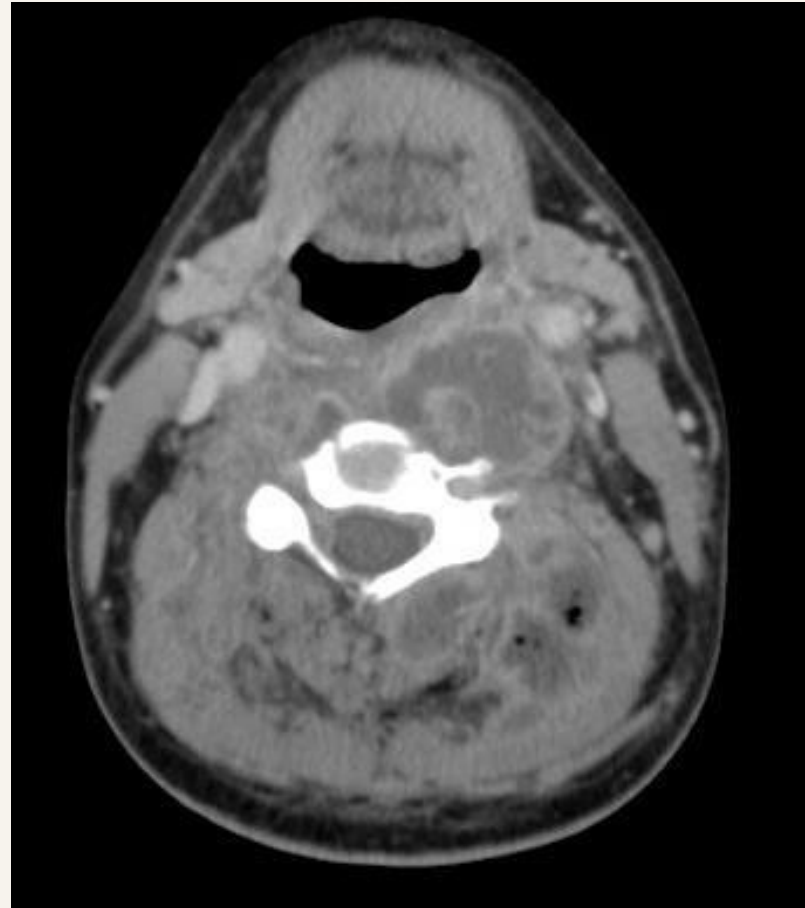
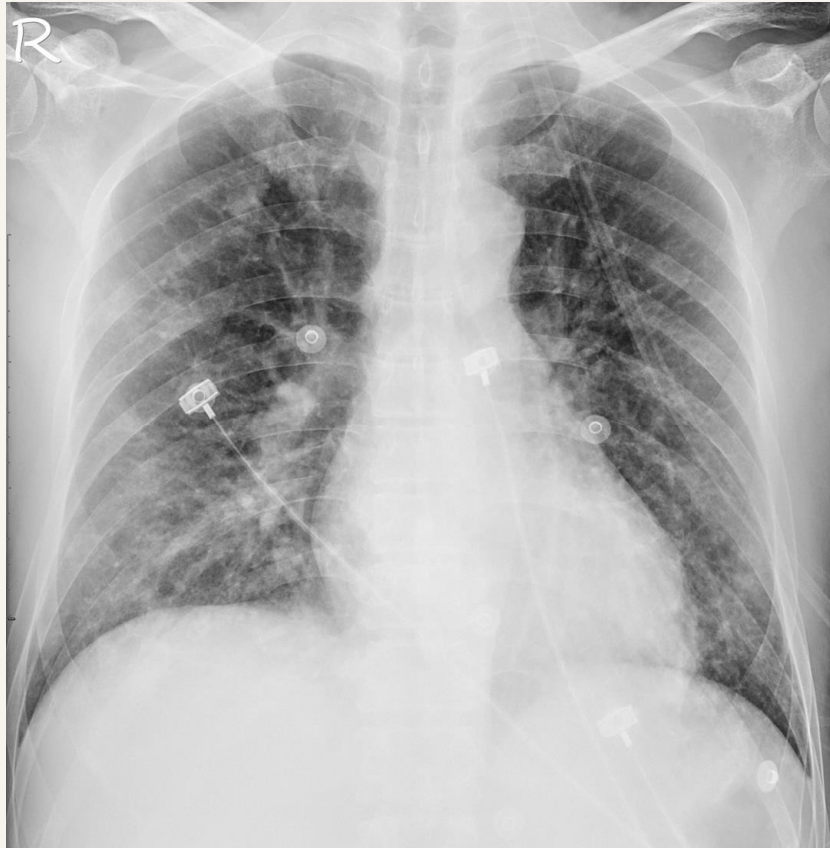


Miliary Tuberculosis

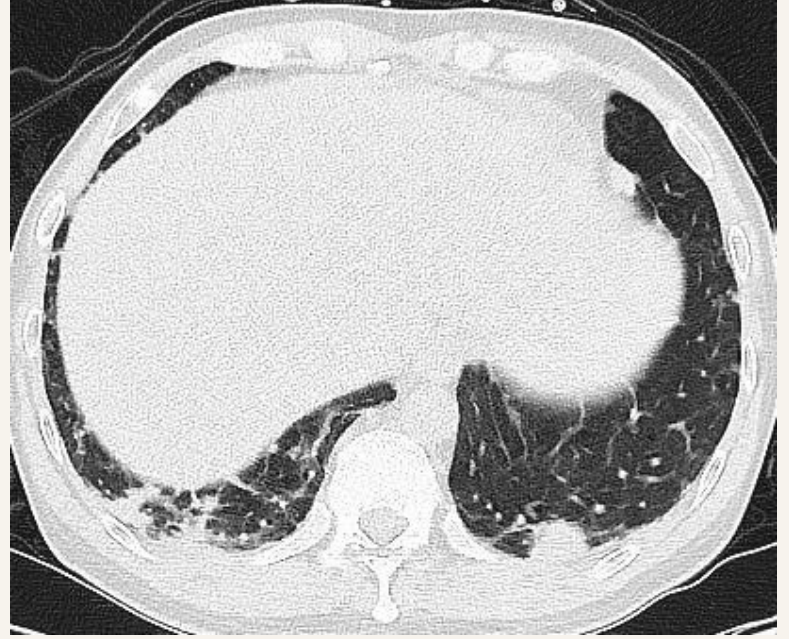
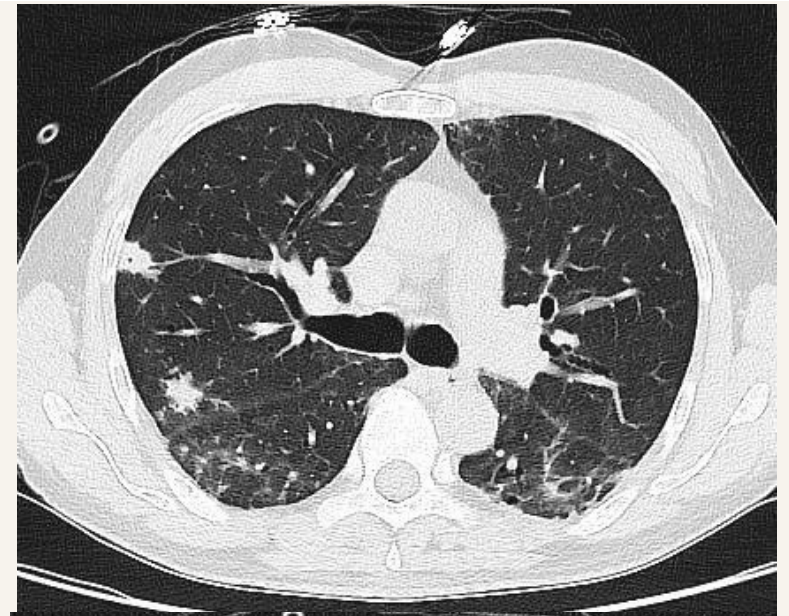
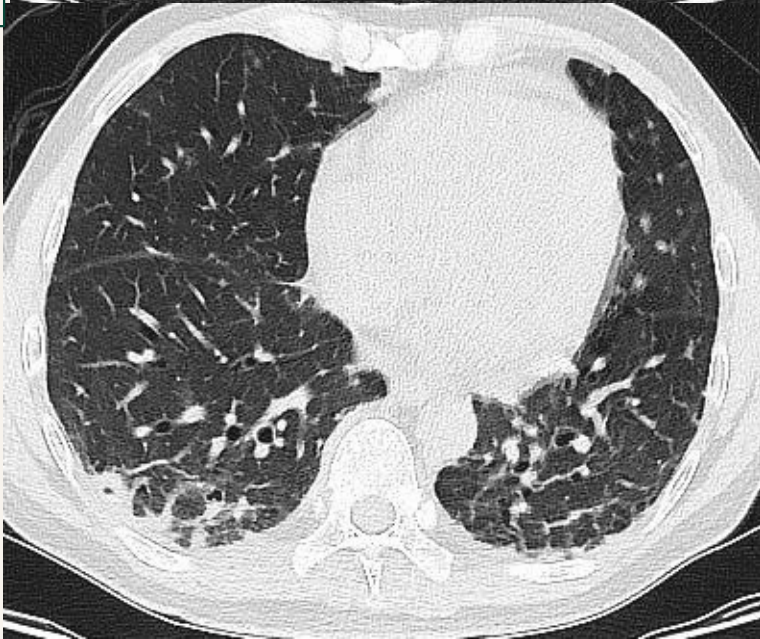
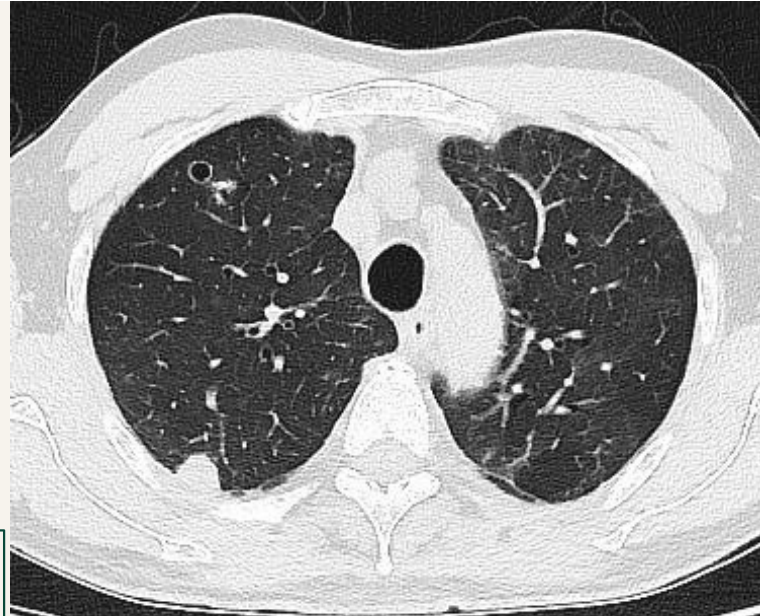


Metastasis: testicular cancer

Nodular pattern: M/54, deep neck infection



Septic emboli



Summary of nodular CT patterns

<i>Nodule pattern</i>	=	Etiology
■ <i>Centrilobular with TIB</i>	=	Infection >> Non-Infection
■ <i>Centrilobular soft tissue</i>	=	Infection (acute) > Non-infectious
■ <i>Random</i>	=	Infection / Non-infection
■ <i>Centrilobular ground glass</i>	=	Non-infectious > Infection
■ <i>Perilymphatic</i>	=	Non-infectious



(2) Differentiation: infections? Non-infectious lung disease?

- Septal thickening
- Nodule patterns
- **Consolidation patterns**

(3) CT pattern: “Consolidation” pattern

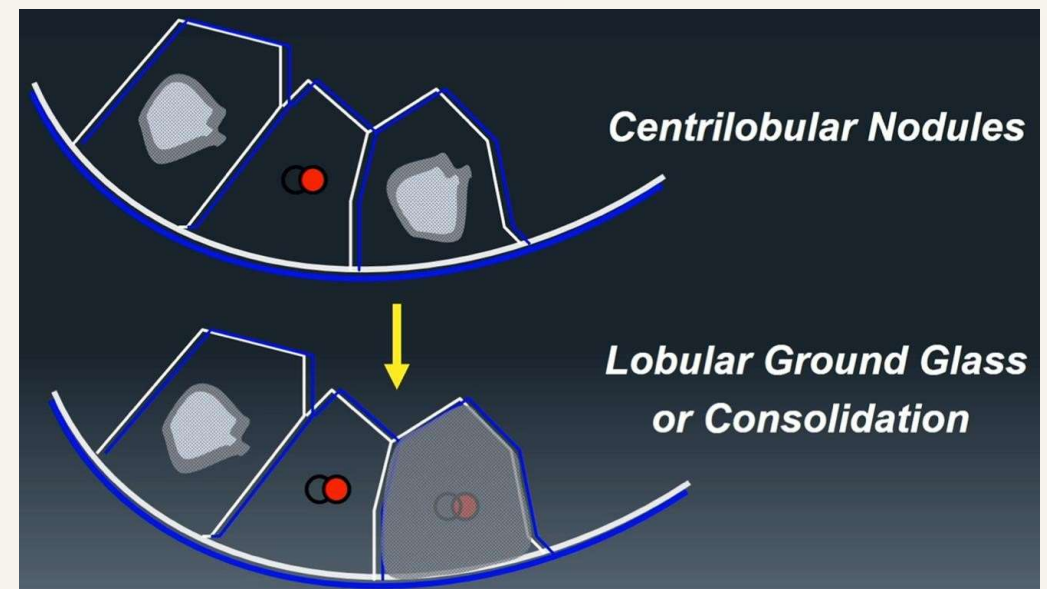


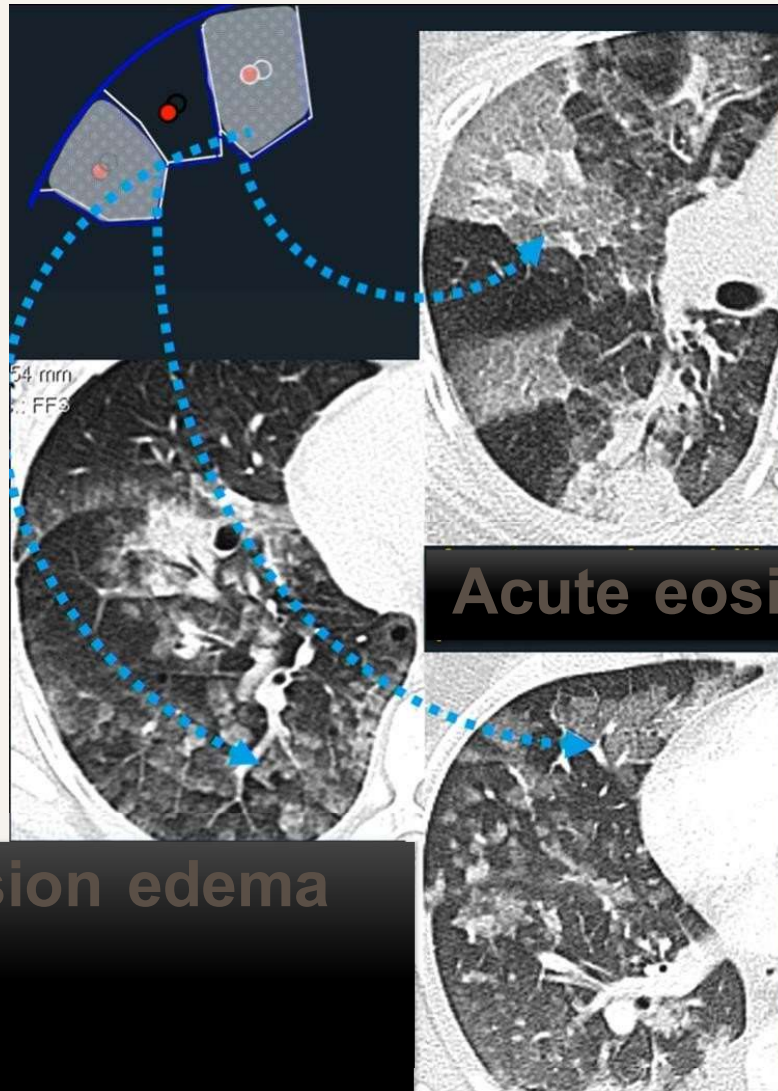
- Lobular Ground Glass or Consolidation : lobular opacities
- **Accompanying tree-in-bud nodules? Or peribronchial opacities?** => infections (high possibility) => bronchopneumonia (viral, bacterial)
- **PJP: CT pattern: often without airway abnormalities;**
but COPD with PJP?

CT Pattern: Lobular Opacities



- Infections
- Non-infectious
 - = Pulmonary edema
 - = Pulmonary hemorrhage
 - = Acute eosinophilic pneumonia
 - = Hypersensitivity Pneumonia





Acute eosinophilic pneumonia

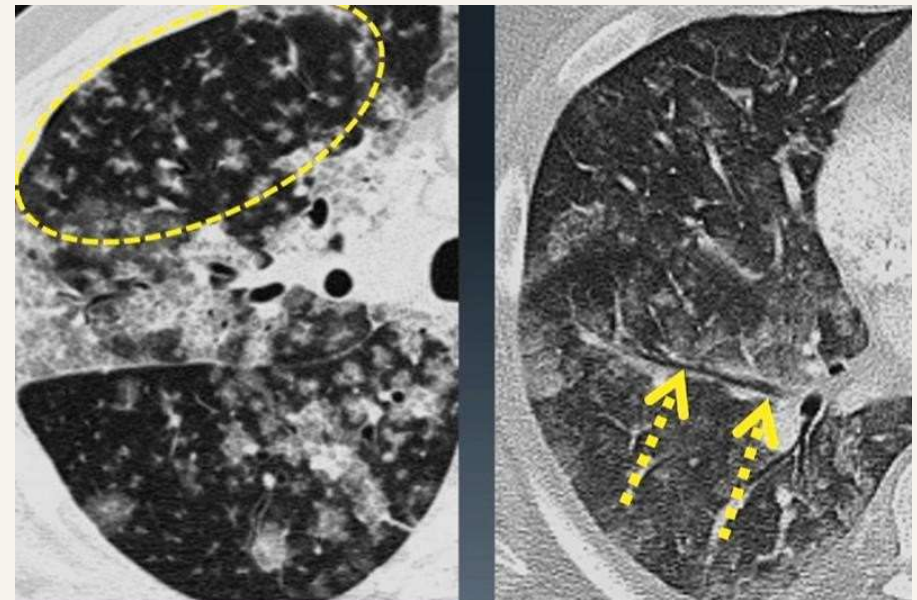
Re-expansion edema

Fat emboli

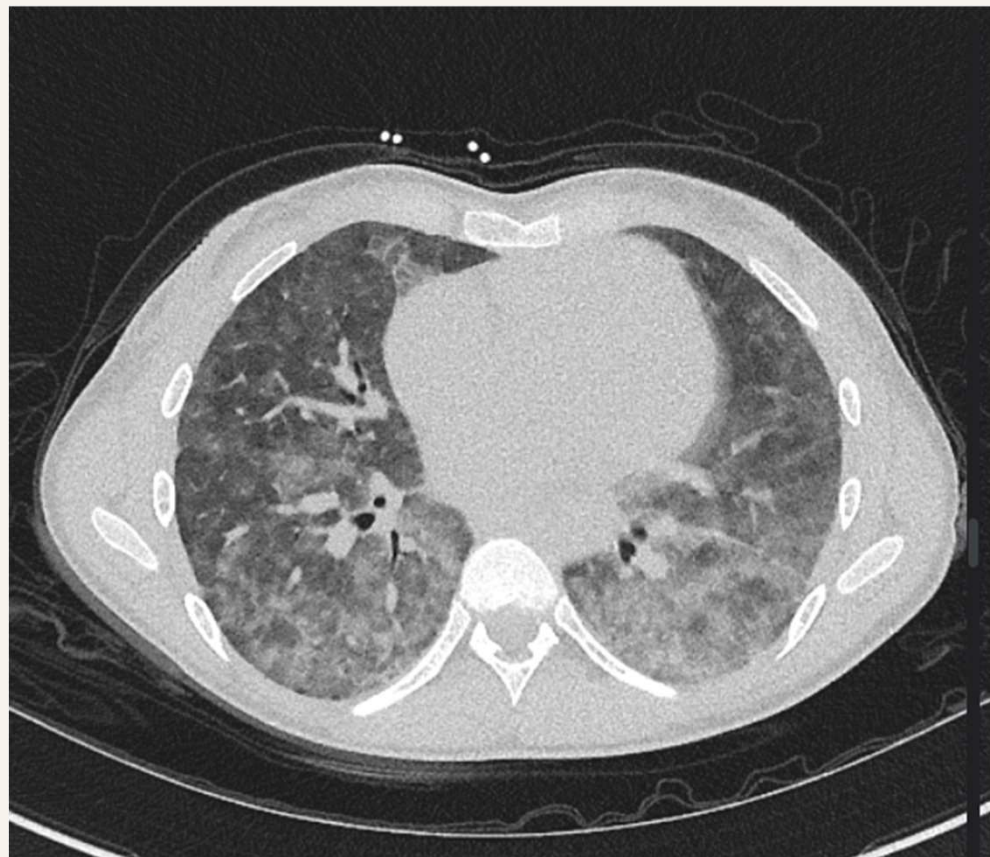


CT Pattern: Lobular Opacities

- Infections
- Bronchopneumonia –Viral, Bacterial
- Many infections will demonstrate accompanying **tree in bud nodules** or **peribronchial opacities**
- An area of central lobular nodules; peribronchial thickening
- But! PJP often without these airway abnormalities (no TIB; no peribronchial vascular distribution)



PJP

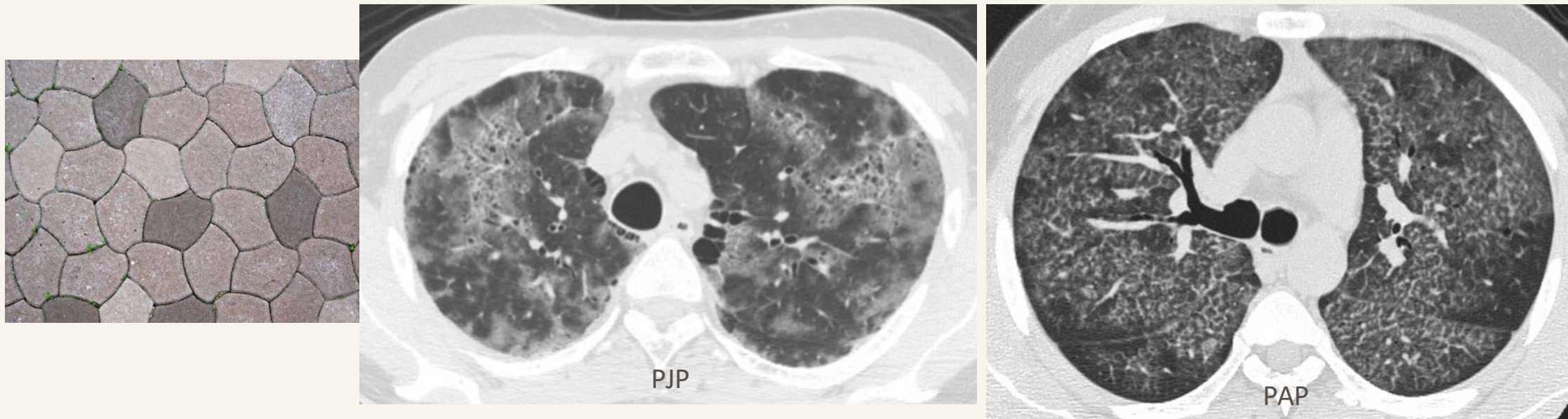


<https://radiopaedia.org/>

Crazy-paving pattern (鋪磚路徵):

影像表現：在毛玻璃狀病變的背景上，疊加增厚的肺小葉間隔和肺小葉內線條，看起來像不規則的鋪磚路面。

與感染的關聯：經典上 Crazy-paving 最早描述於肺泡蛋白沉著症 (PAP)，但也
可以見於多種其他疾病。Pneumocystis jiroveci Pneumonia (PJP)，以及急性
間質性肺炎 和某些職業性肺病，也提到可能與肺水腫、出血、藥物毒性、腫瘤
等有關。



CT pattern: Non-segmental consolidation vs “Non-aerated” lung from atelectasis

Passive atelectasis

- Volume loss
 - = Bronchi/vessels crowded
 - = Fissures shifted
 - = Areas < lobar more evident on CT than CxR
- Air bronchograms common
- High attenuation post contrast

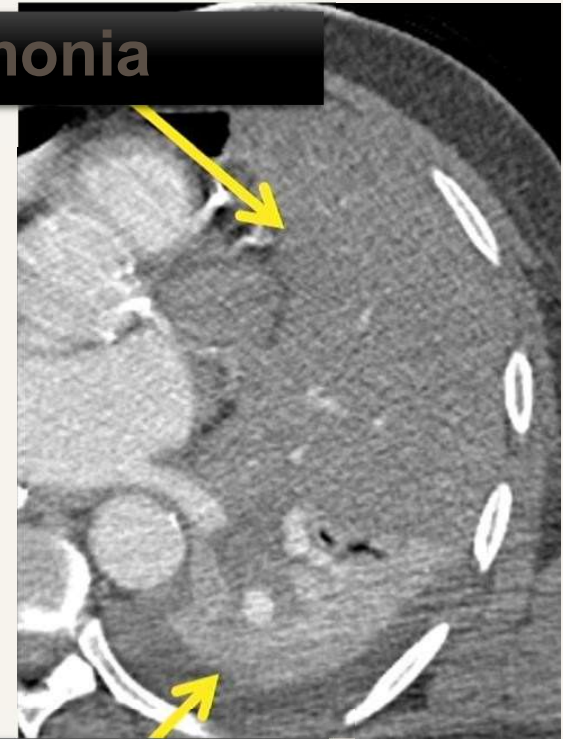


CT pattern Non-segmental consolidation (Pneumonia)

Pneumonia

- Volume loss: Minimal
- Air bronchograms: common
- **Low attenuation – post contrast**

Pneumonia



Passive atelectasis

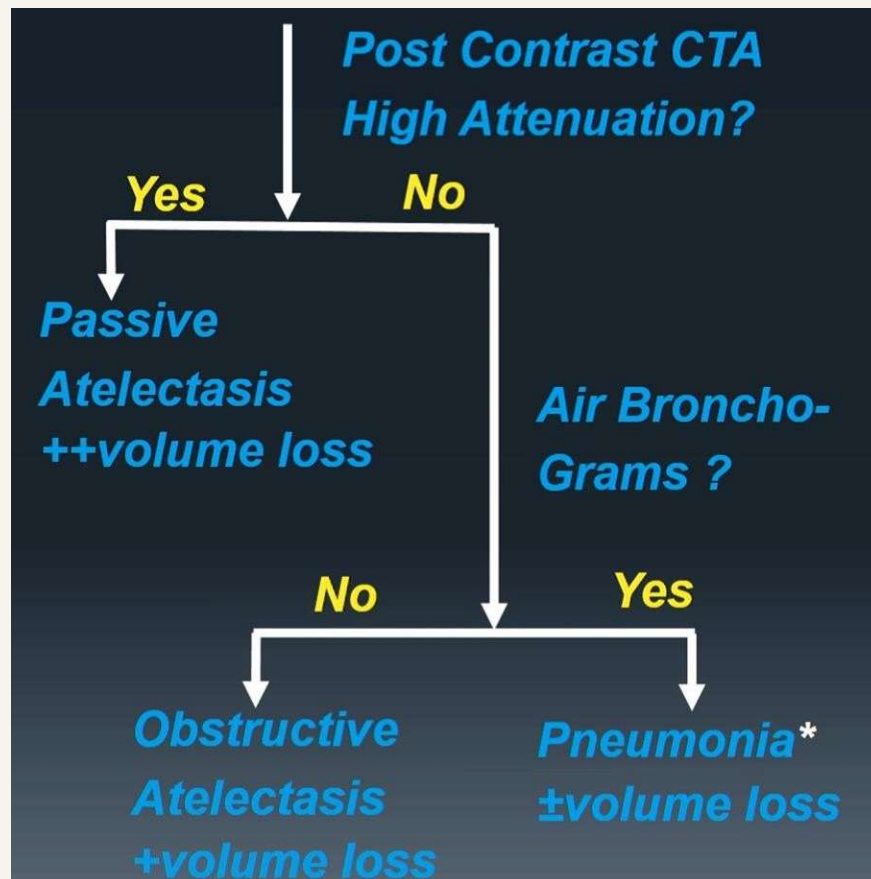
CT pattern: Non-segmental consolidation vs “Non-aerated” lung from atelectasis

Obstructive atelectasis

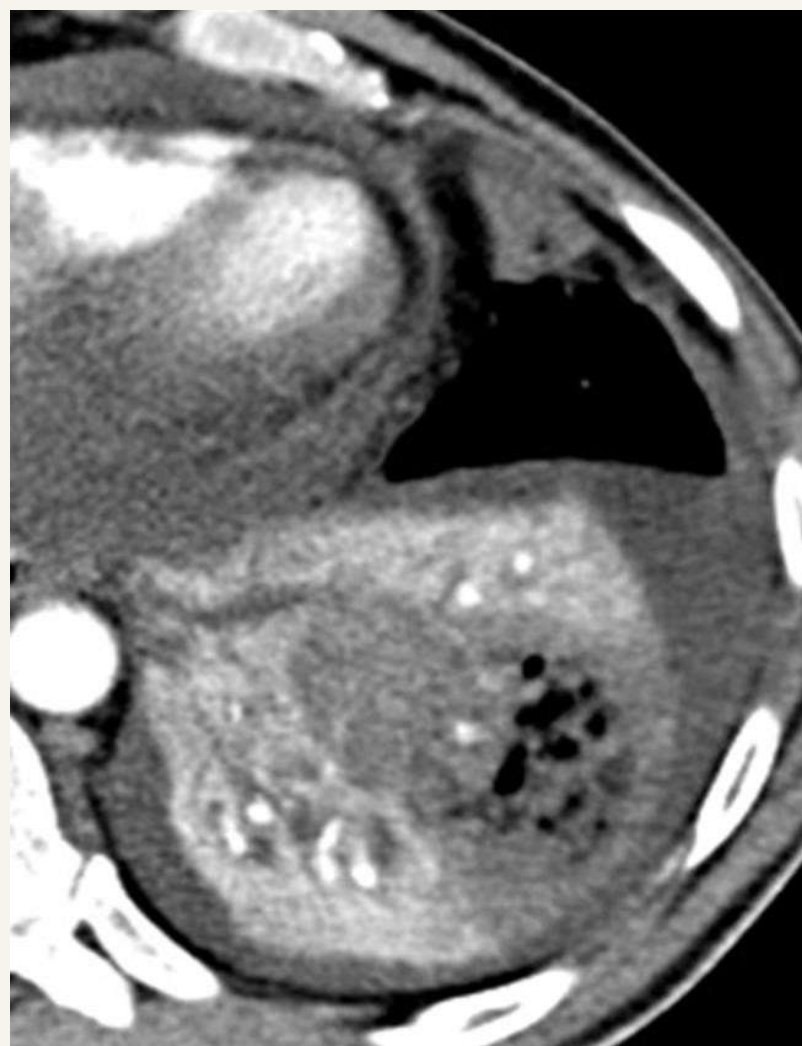
- Volume loss variable (depending on how much secretions are behind the obstruction)
- Absent air bronchograms (usually)
- **Low attenuation**
- Vessels well delineated peripherally

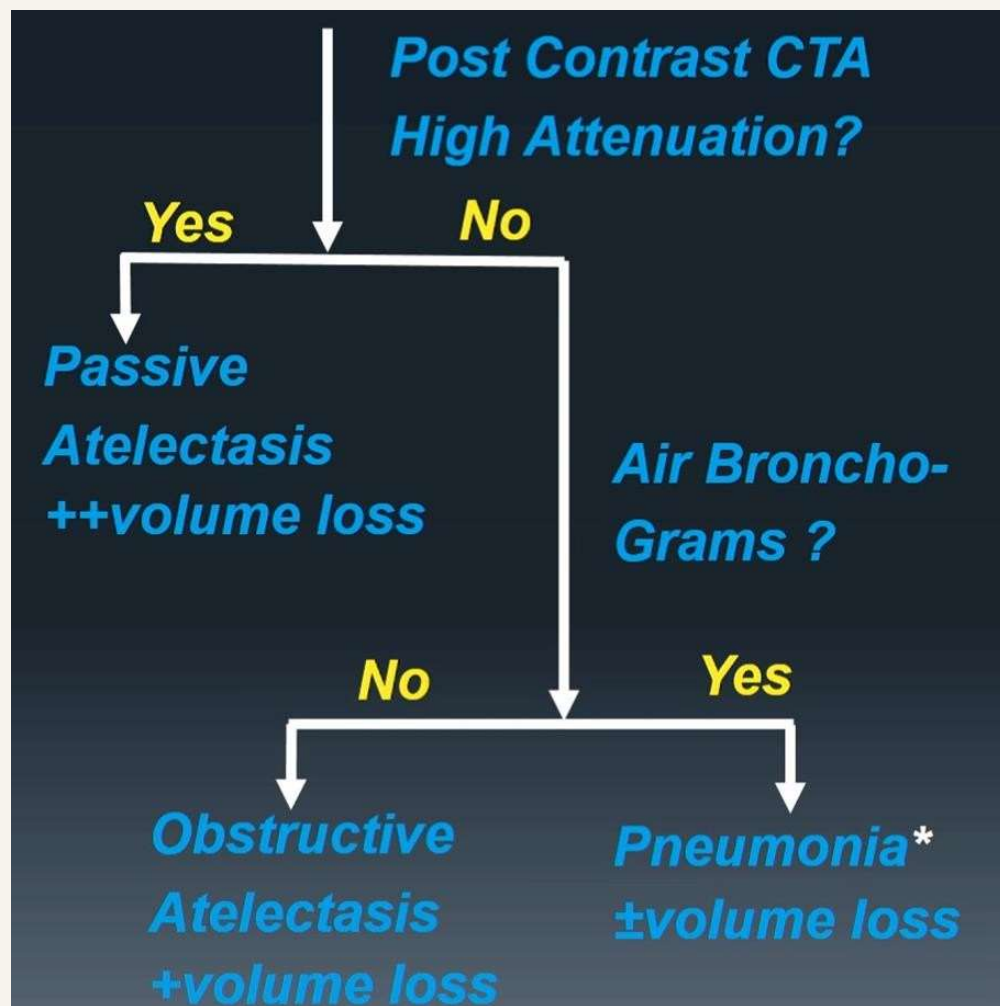


CT pattern Non-segmental opacities



Confounders: contusion,
pulmonary infarction,
adenocarcinoma





**Pulmonary
infarction**

Passive atelectasis

CT pattern Non-segmental "Non-aerated" lung: **subacute/chronic**

- Subacute to chronic – prior imaging diagnostic
- Adenocarcinoma (Invasive Mucinous)
- Lymphoma –variable enhancement (sometimes look like adenocarcinoma; sometimes higher enhancement)
- GPA
- Cryptogenic organizing pneumonia
- Sarcoidosis



Adeno Ca:

airless lung with low attenuation and the vessels are very well delineated



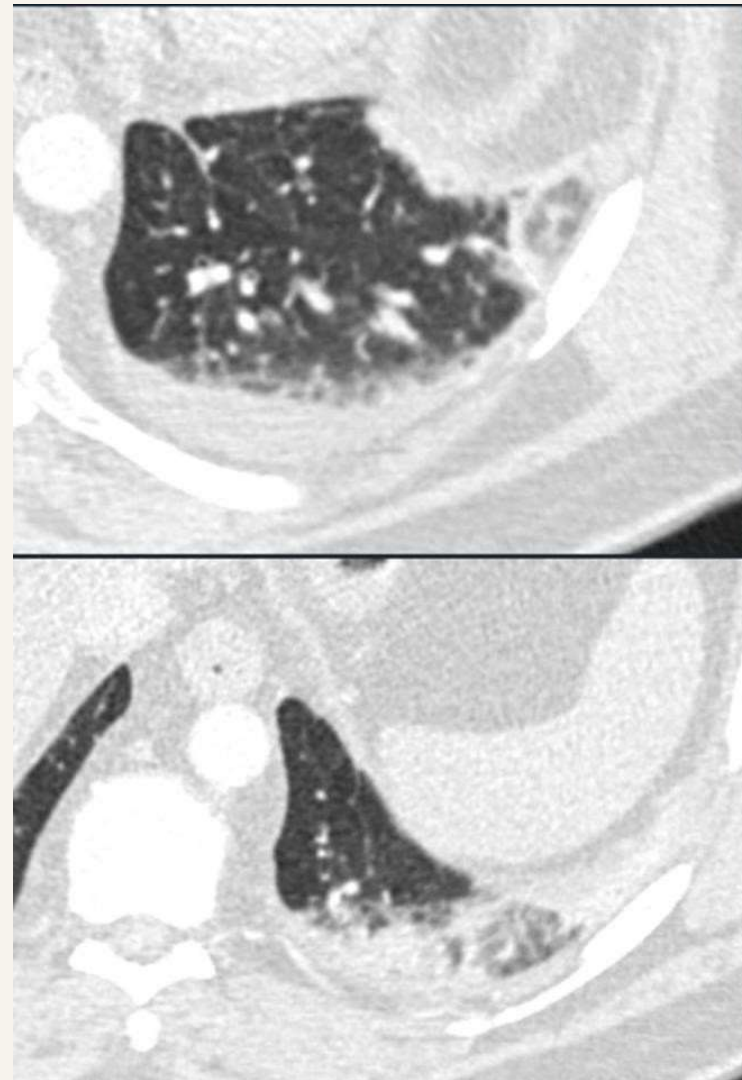
Lymphoma

–variable enhancement (sometimes look like adenocarcinoma; sometimes higher enhancement)



Case

- 42 Y/O Male
- **ER: for LUQ pain**
- Abdominal CT -> admission
- How to use abdominal CT for further differential diagnosis of lung diseases!
- **Next step?** Pulmonary CTA?
Empiric treatment for CAP?
US guided thoracentesis?
Echocardiogram for tricuspid valve?

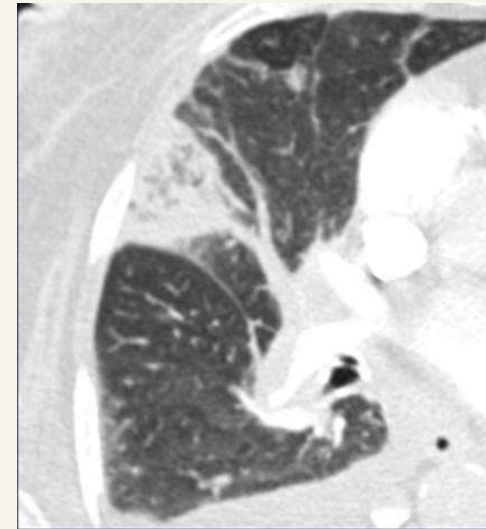


CT pattern: segmental opacities

- Infection: common
- **Non-infectious- occasional**
- ***Pulmonary infarction***
 - = Lower lobes
 - = Peripheral
 - = Truncated apex
- **Vessel sign** = enlarged vessel leading to wedge shaped opacity : specific but uncommon (Great! But insensitive!)
- **Air bronchograms** are uncommon
- **Segmental opacity with central lucency!**

Non-specific in distinguishing from infection!

**Segmental opacity with
central lucency!**



Vessel sign = enlarged vessel
leading to wedge shaped opacity



Pulmonary Infarction

- Segmental consolidation with central lucency
- 46% Sensitive
- 98% Specific
- Appearance fits description of “**reversed halo sign**”
- Differential varies widely depending on clinical setting

Atoll sign (reverse-halo sign)

- Central GGO surrounded by a crescentic or circumferential denser consolidation
- DDx: COP, IFI, PJP, LG, GPA, lipoid pneumonia, sarcoidosis, paracoccidioidomycosis



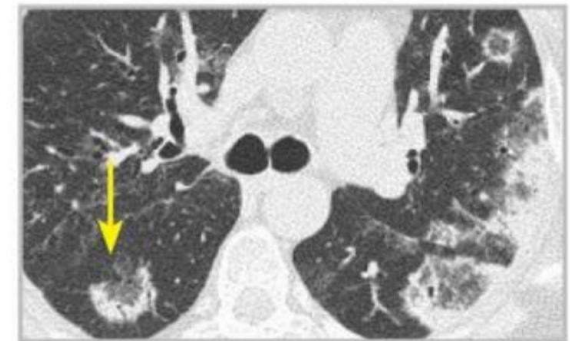
Reversed Halo Sign

影像表現: a focal rounded area of GGO surrounded by a crescent or complete ring of consolidation 區域性的毛玻璃狀病變或結節，周圍環繞一圈較高密度的實質化區域，形狀像環狀珊瑚島 (atoll)。

與感染的關聯: 雖然這個徵象與Organizing Pneumonia, OP 關係密切，但 Reversed Halo Sign 也可見於多種感染，包括麴菌病 (Aspergillosis)、隱球菌病 (Cryptococcosis)，以及黏液真菌病 (Mucormycosis)，也可能見於細菌感染和肺結核或敗血性栓塞。

Atoll sign (reverse-halo sign)

- Central GGO surrounded by a crescentic or circumferential denser consolidation
- DDx: COP, IFI, PJP, LG, GPA, lipoid pna, sarcoidosis, paracoccidioidomycosis

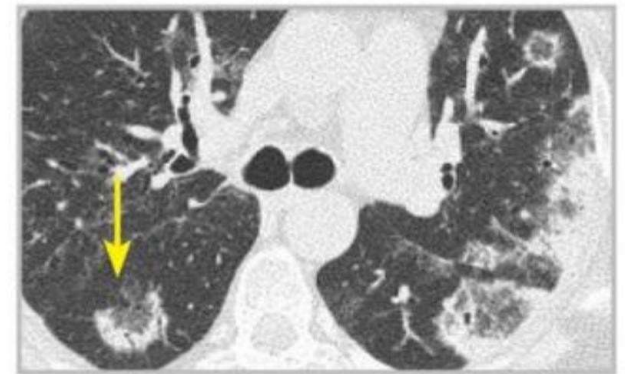


Differential diagnosis of “reversed Halo”

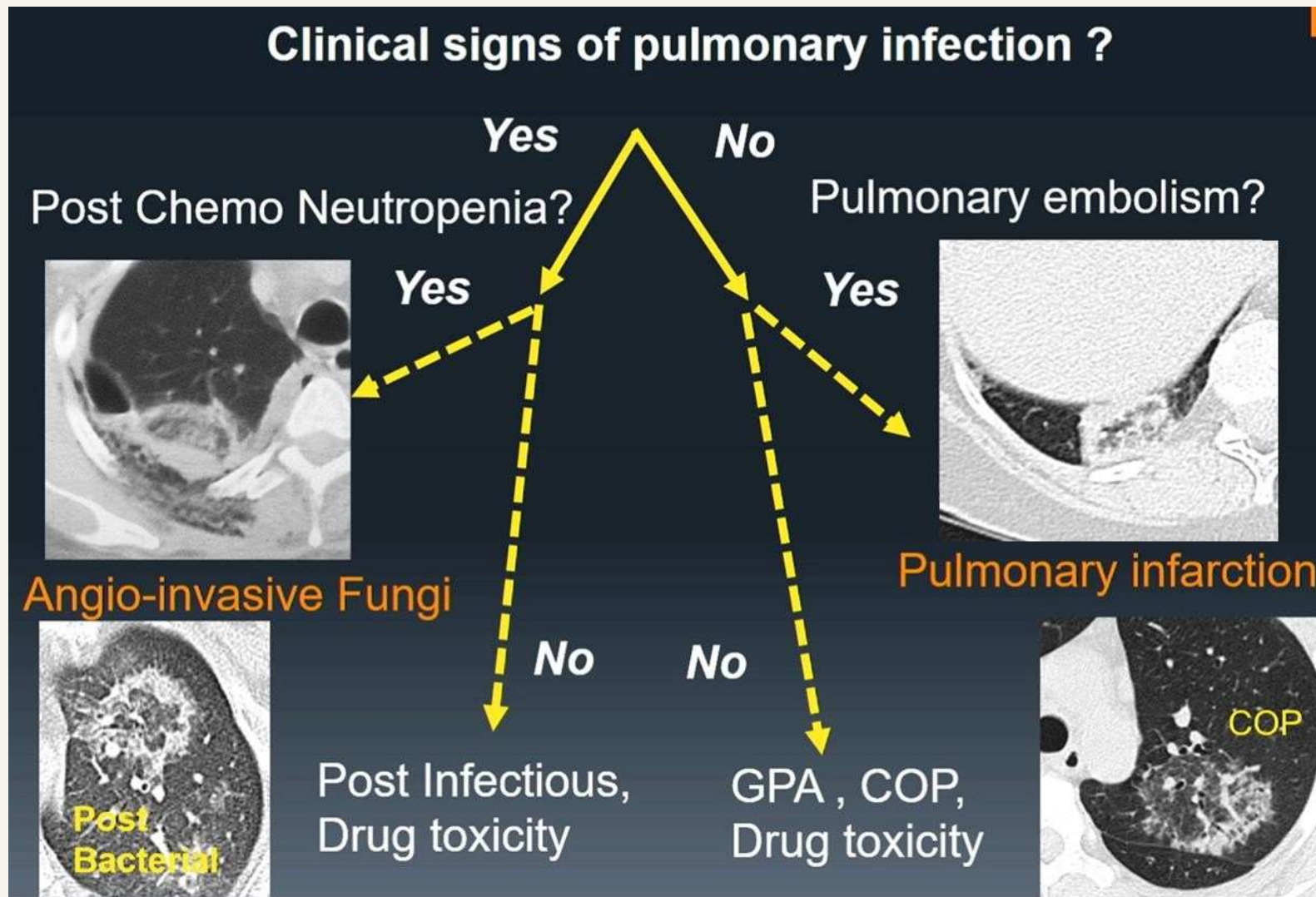
- Clinical signs of pulmonary infection?
- Post Chemo Neutropenia? -> Angio-invasive Fungi
- Post infections, drug toxicity
- Pulmonary embolism? Pulmonary infarction
- GPA, COP, Drug toxicity

Atoll sign (reverse-halo sign)

- Central GGO surrounded by a crescentic or circumferential denser consolidation
- DDx: COP, IFI, PJP, LG, GPA, lipoid pneumonia, sarcoidosis, paracoccidioidomycosis



Reversed Halo sign



Complications of Pneumonia

- Pleural disease
- Lung necrosis
 - (1) Low attenuation parenchymal with and without abscess formation – common
 - (2) Abscess : common
 - (3) Pneumatocele – occasional

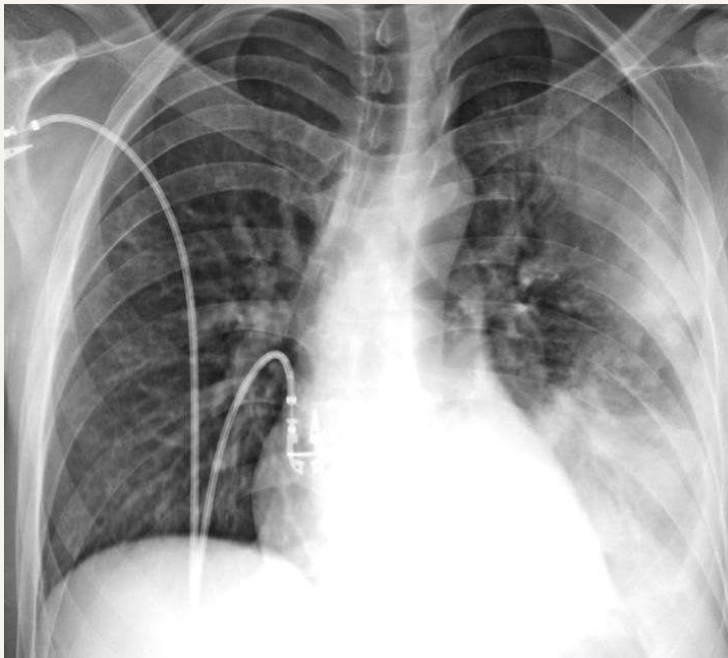


Pneumonia: Complications

- Pneumonia-> Lung abscess or empyema? mixed: cancer? TB? Foreign body? -> bronchiectasis ? Pulmonary sequestration? Hiatal hernia? Fistula?
- Pleural disease?
- Lung necrosis :
= low attenuation parenchyma -> abscess formation -> Pneumatoceles

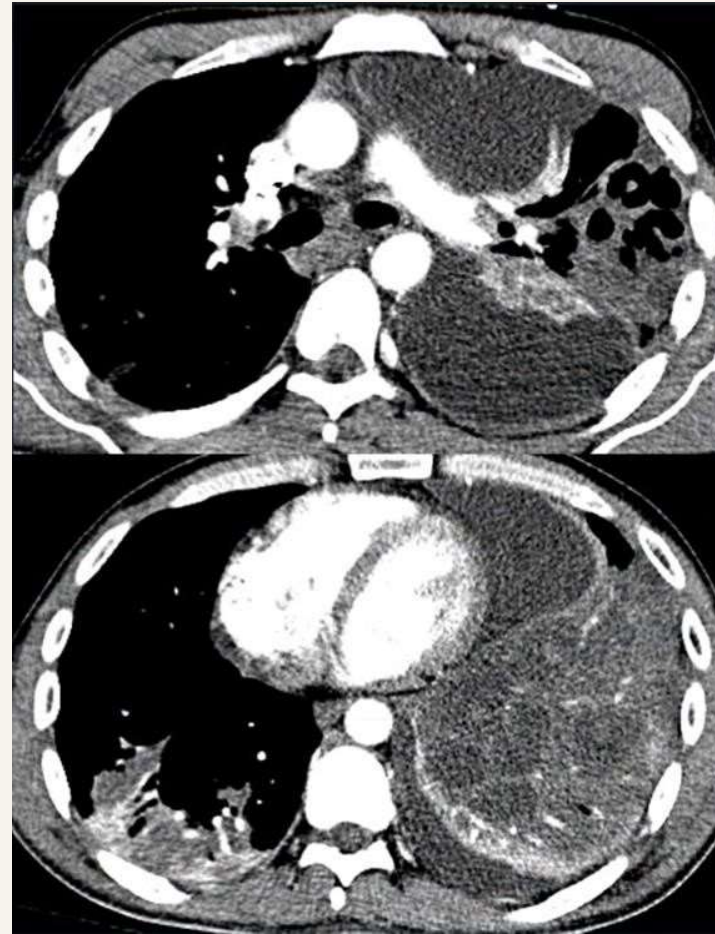
Case

- Community acquired pneumonia – course
- Day 1 vs Day 6



Community acquired pneumonia – course

MRSA pneumonia



Pulmonary necrosis

- Diffuse necrosis
- Non enhancing lung parenchyma approaching water attenuation
- Without discrete margin
- Can have associated **gas locules**
- Staphylococcal pneumonia, pneumococcus, Klebsiella
- Prolonged hospital stay (**antibiotics treatment: duration?**)

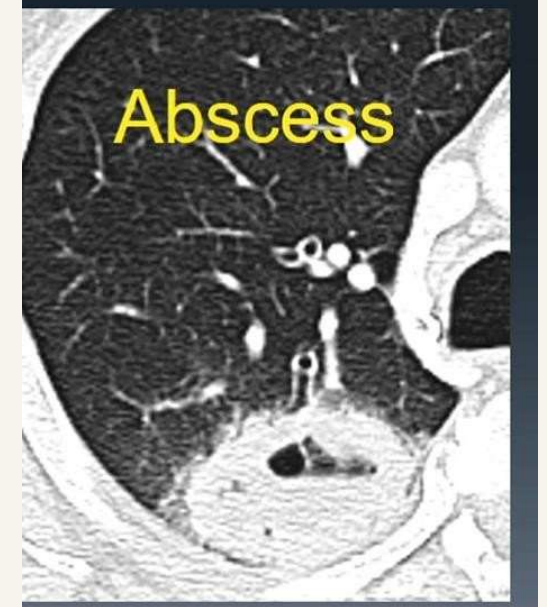
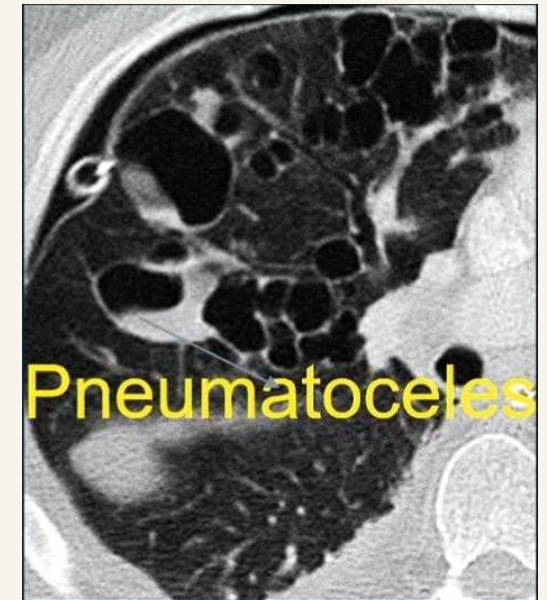
Pneumatoceles

Pneumatocele

- Focal necrosis allows air to dissect into parenchyma
- Displaces parenchyma rather than destroying it
- Thin walled, associated with pneumothoraces

Abscess

- Thick, irregular walls
- Destroyed lung, vessels and bronchi may end abruptly at margin



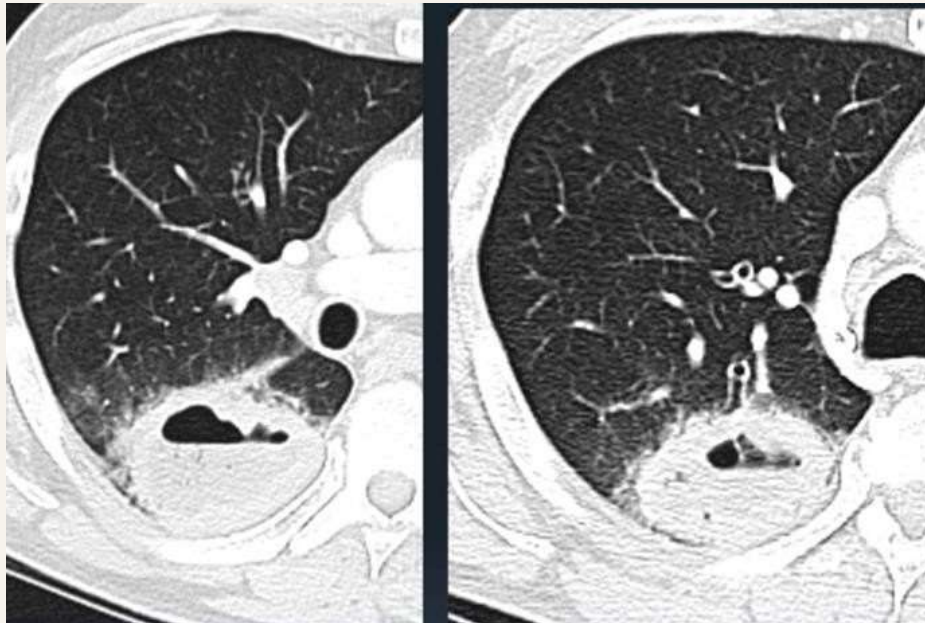
Lung abscess

- Empyema: Drain
- Lung abscess: Drain or not?



Abscess vs Empyema

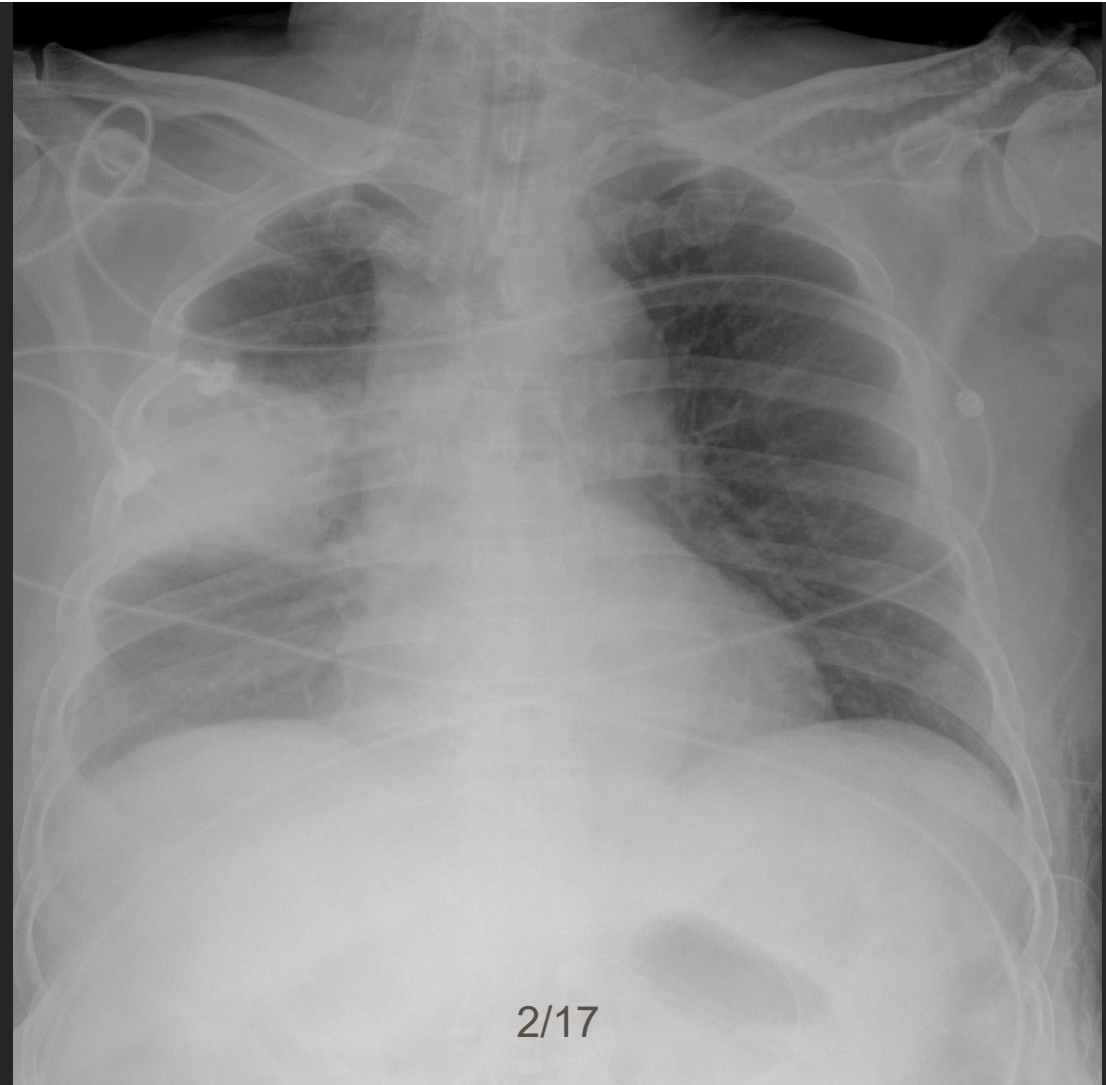
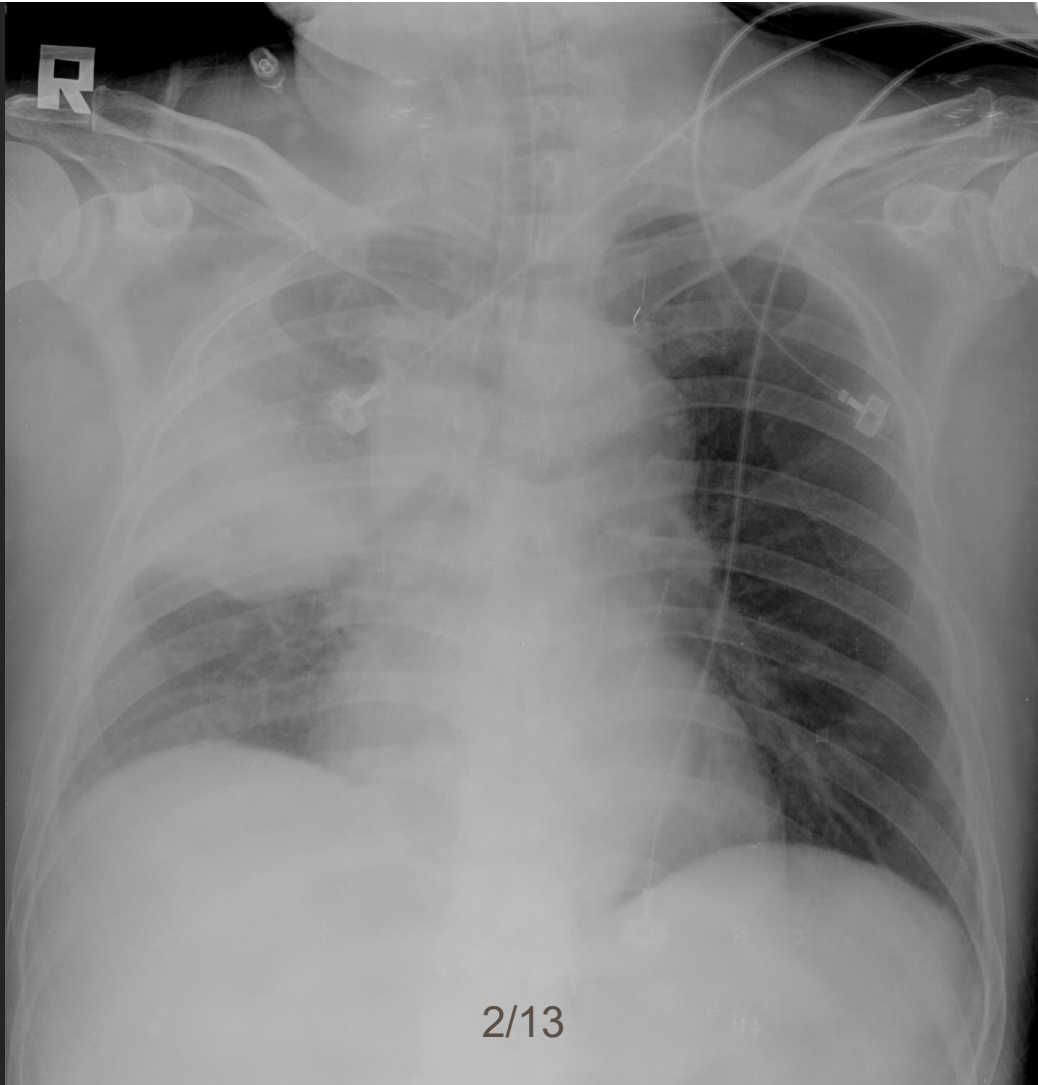
- **Abscess:** Round, irregular inner margin, truncates vessels/bronchi
- **Empyema:** lenticular/smooth inner margin/deviates vessels/bronchi (push vessels and bronchi aside);



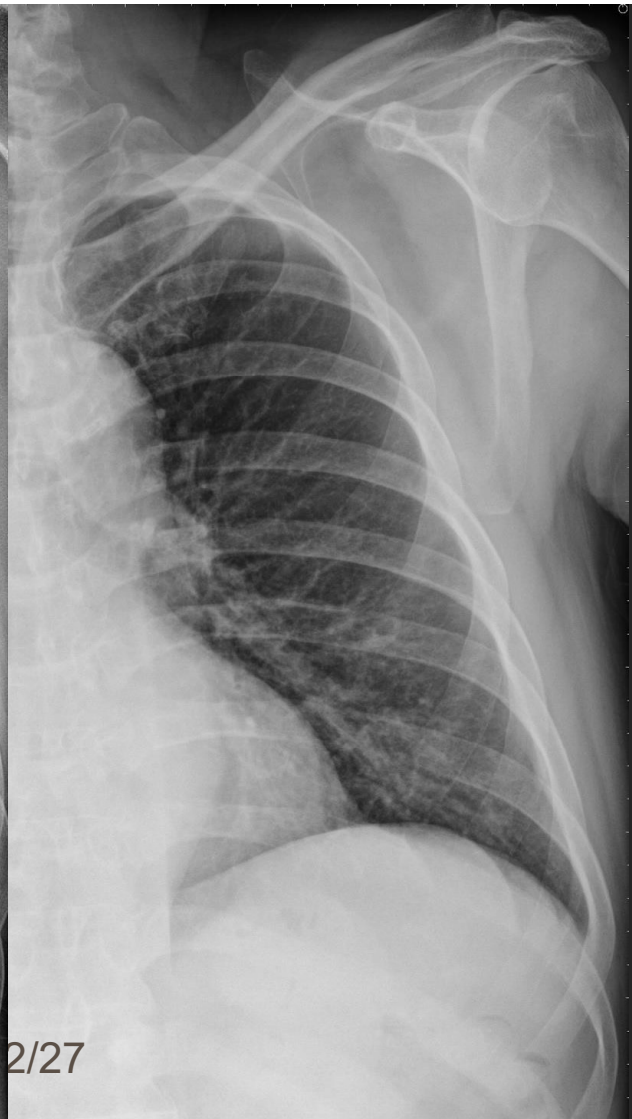
CT of complications of pneumonia - Necrosis

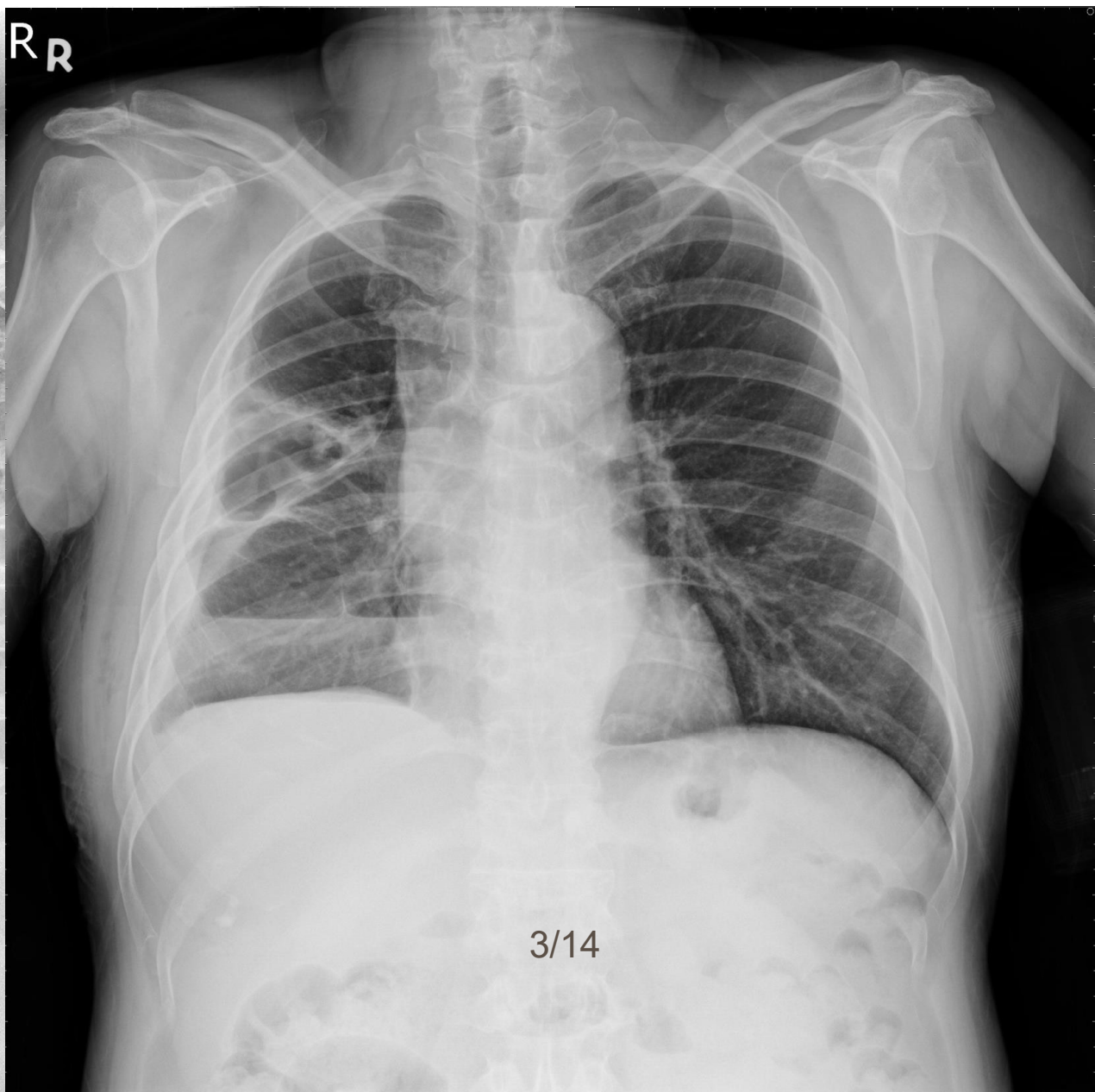
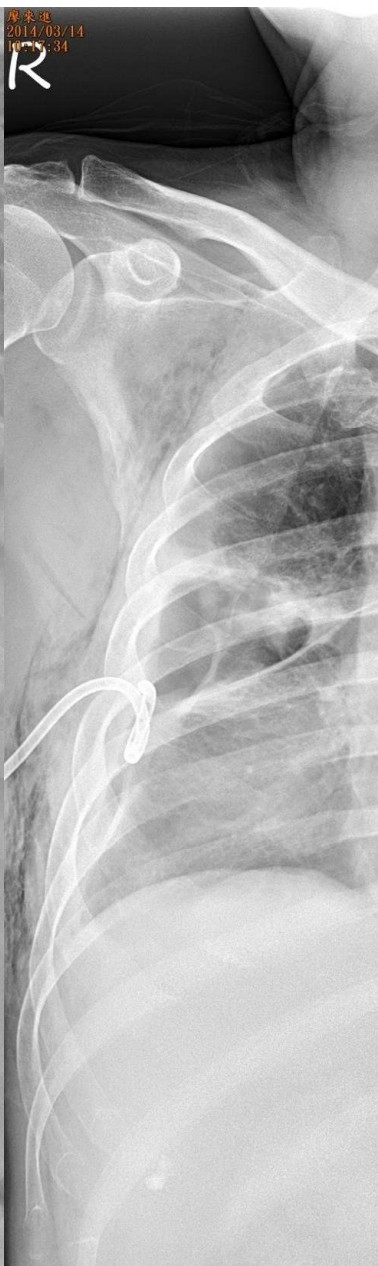
- Underlying lung abscesses present in 10-50 % of empyemas, probably due to rupture into pleural space
- Catheter drainage can transform unruptured abscess (without empyema) to ruptured abscess
- Example: 3 days later: lung abscess -> multilocular empyema





67歲男性，糖尿病，發燒三天，呼吸喘





Diagnosis?

- Case: cough
- CT chest: what is *the best first step* in the management of this patient?

Cough

Case: Tuberculosis

- Case: cough
- CT chest: what is the best first step in the management of this patient?
- **Answer: “respiratory isolation first!”**
- CT chest:
- (1) Central lobular nodules; with Tree-in-bud; spare the pleural surface
- (2) A cavity (Cavitation)
 - 20-45% on CxR
 - Posterior upper lobes/superior segment of lower lobes



Case

- 57 Y/O Male
- COPD
- Increased cough for more than 3 months
- Quanti-FERON-TB GOLD: negative
- DDX:



Non-Tuberculous mycobacteria

Mycobacterium Avium Complex (MAC)

“Non-classic” Most common form

- Multiple ill-defined nodules clustered around airways
- **Bronchiectasis : often greatest in middle and lingula**

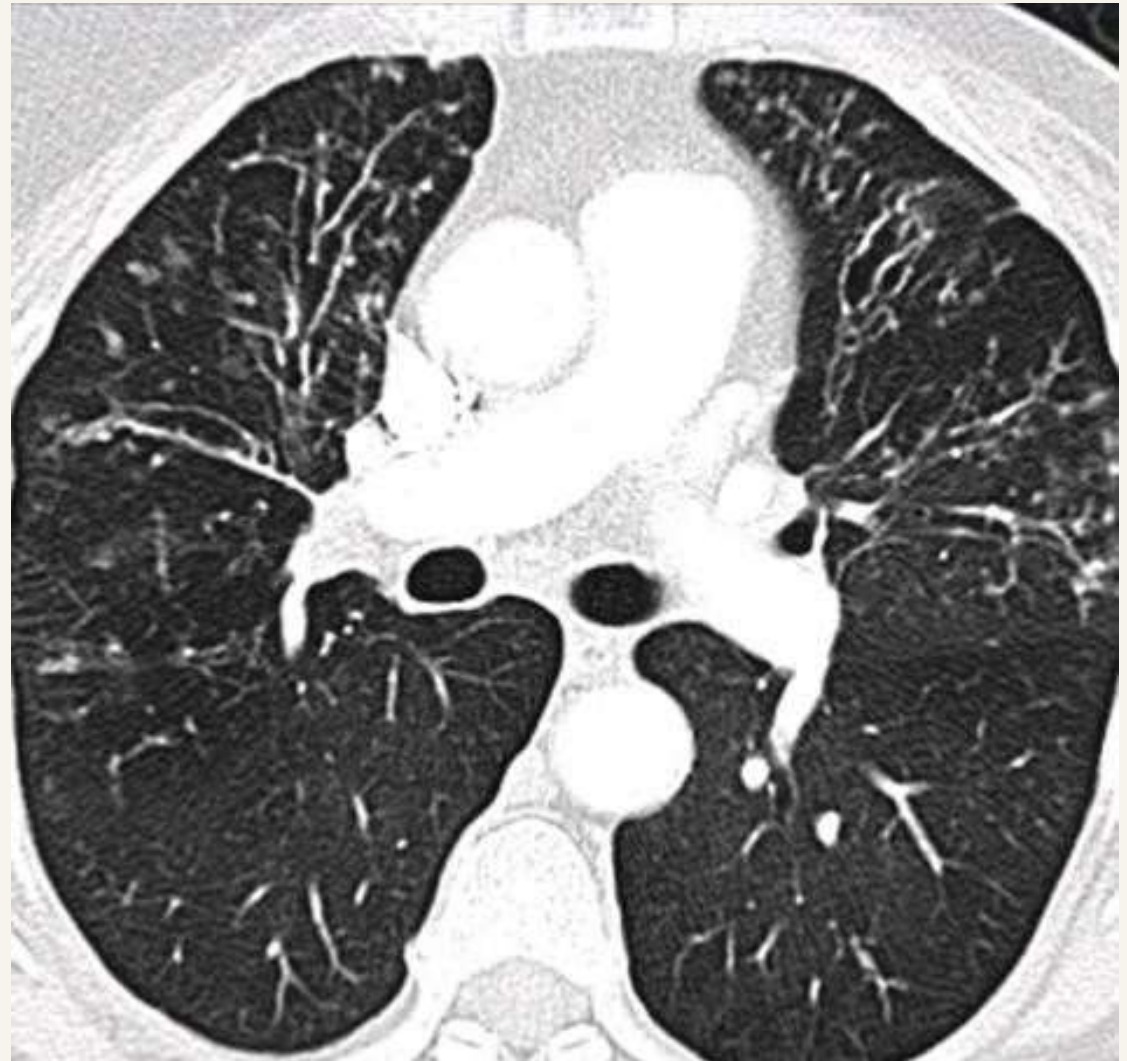
“Classic” Post primary TB-like

- Thinner walled cavities > TB
- Unilateral disease > TB
- Pleural thickening adjacent to cavity > TB

NTM-MAC

“ Non-classic” Most common form

- Multiple ill-defined nodules clustered around airways
- **Bronchiectasis** : often greatest in middle and lingula



NTM-MAC

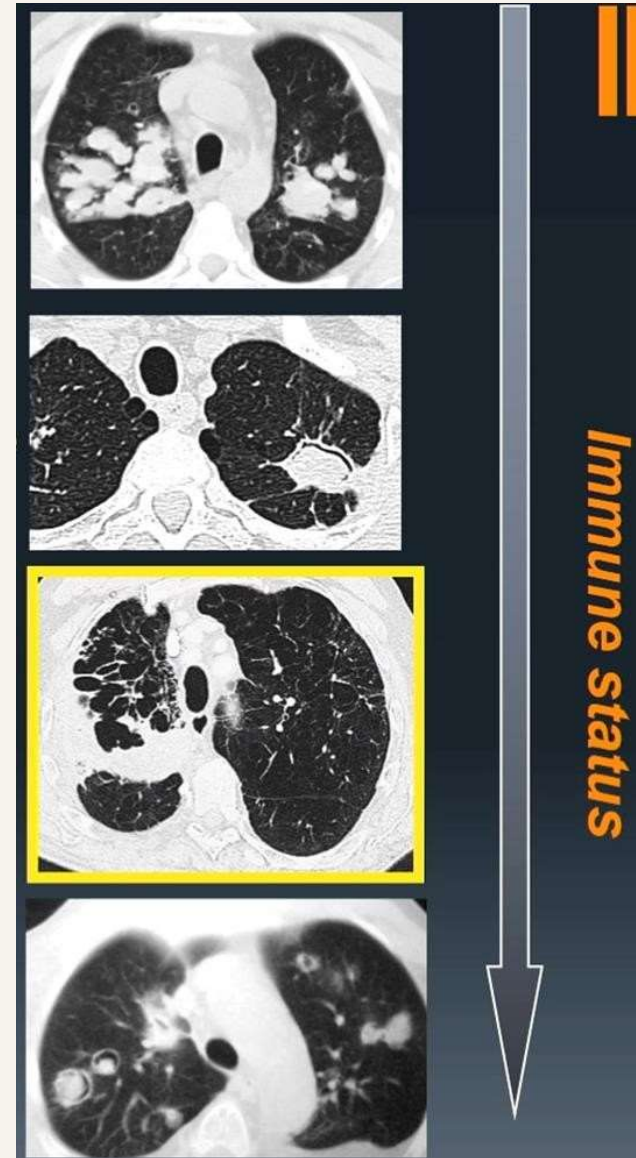
“Classic” Post primary TB-like

- Thinner walled cavities > TB
- Unilateral disease > TB
- Pleural thickening adjacent to cavity > TB



Aspergillus infections: immune status

- ABPA: Asthma
- Aspergilloma: forms in existing cavity lung disease
- **Chronic pulmonary aspergillosis:** DM, underlying lung disease (prior TB, COPD)
- **Invasive:** neutropenia, immuno-suppressives



Case: Allergic bronchopulmonary aspergillosis

- Almost exclusively seen in patients with asthma or CF
- Eosinophilia; high IgE
- CT shows central bronchiectasis and mucous impaction
- Muroid impaction has high attenuation on CT (30%)
**(Calcium of the aspergillus;
high dense mucus impaction)**



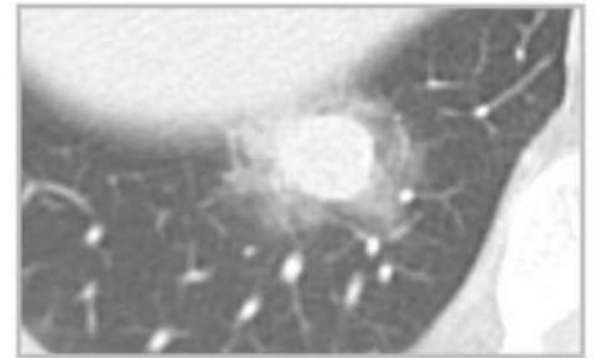
Halo Sign:

影像表現：在一個實質化病灶或結節的周圍，環繞一圈毛玻璃狀病變。

與感染的關聯：Halo Sign 在免疫功能低下患者中，是侵襲性肺麩菌病（Invasive Pulmonary Aspergillosis, IPA）的經典徵象，代表病灶周圍有出血。

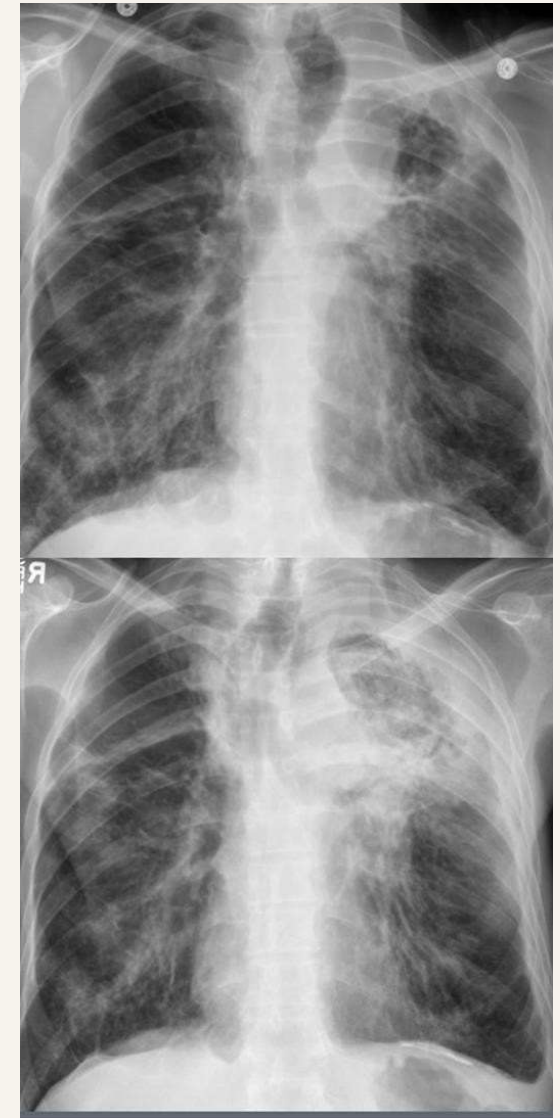
Halo sign

- SPN or mass surrounded by a circumferential GGO
- DDx: invasive pulm aspergillosis, pulm mucormycosis, GPA, amyloidosis, sarcoidosis, mets to the lung



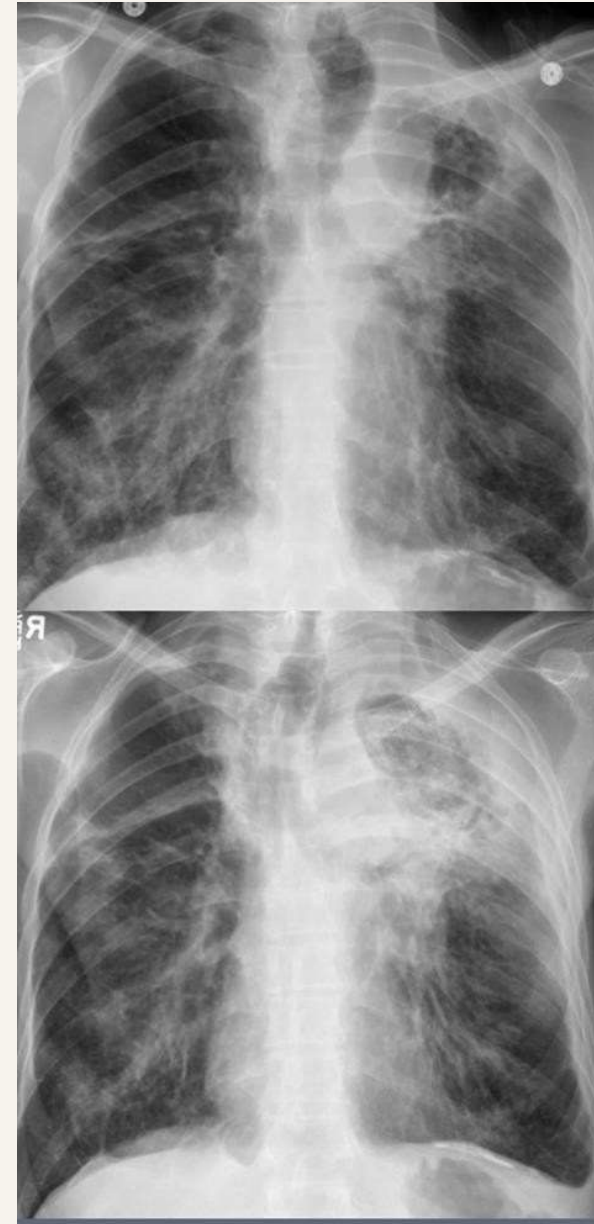
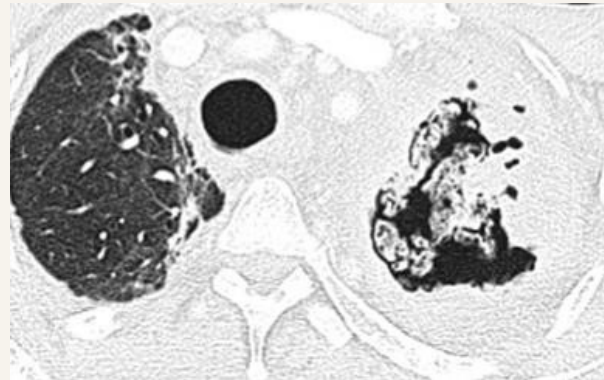
Chronic pulmonary aspergillosis

- Subcategories not well differentiated by imaging
 - = Subacute invasive aspergillosis
 - = Chronic cavitory aspergillosis
 - = Fibrosing aspergillosis
- Associated diseases
 - = Worldwide: affects 20% of patients with **cavitory TB**
 - = Where TB is rare, **COPD** is major risk factor
 - = Middle aged/elderly patients
 - = Cough, fever, weight loss over months



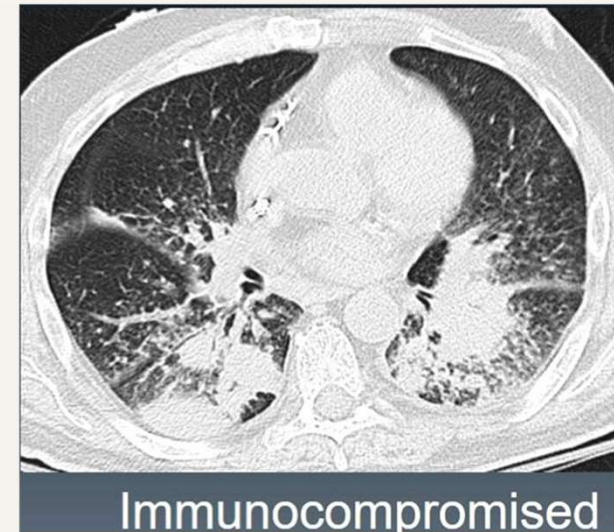
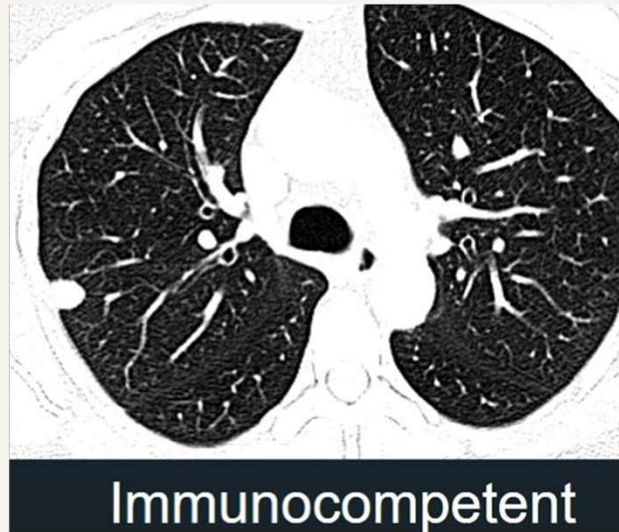
Chronic pulmonary aspergillosis: Imaging

- Upper lobe disease initially
- Chronic consolidation, cavity formation and pleural thickening
- Untreated may progress to bilateral lung fibrosis



Cryptococcus

- **Cryptococcus Neoformans**
One or more macronodules:
immuno-competent
No upper lobe predilection
Consolidation and cavitation (within nodules or consolidation) more common in immunocompromised hosts
- **Cryptococcus Gattii**
Nodules/Masses
Consolidation

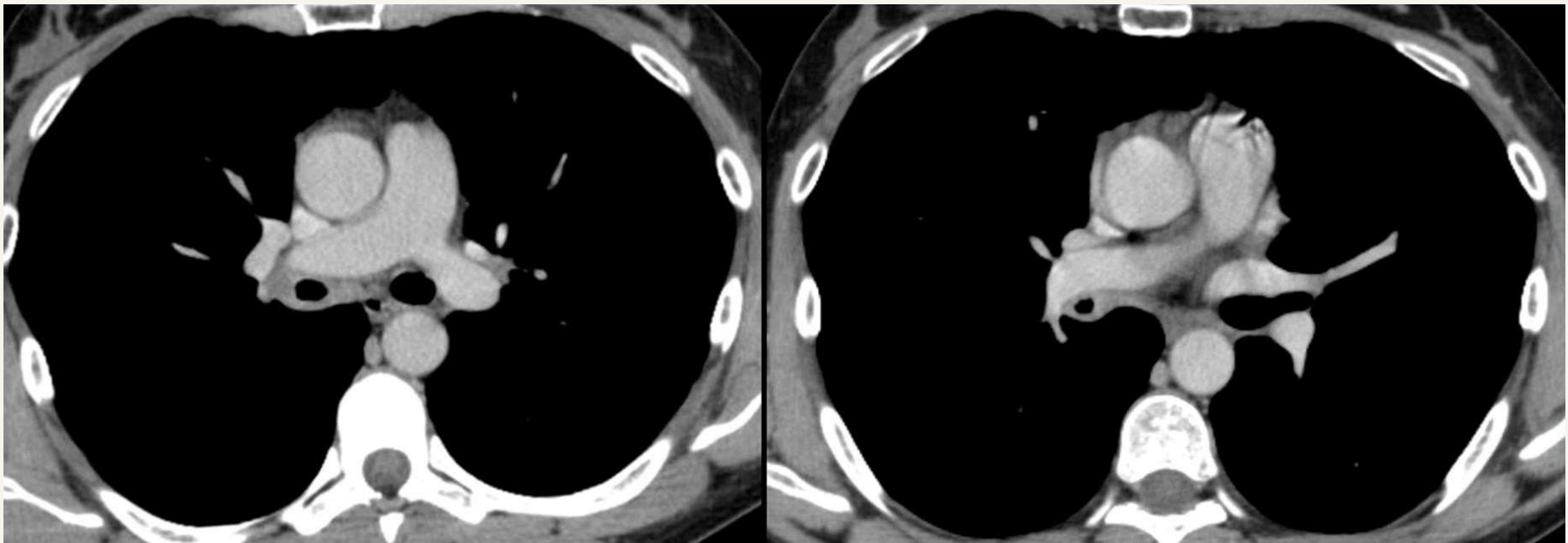


Large airways diseases: neoplastic

- **Goal: Location!** (Not to guess the histology)
- Primary tracheal neoplasm: < 1% of all bronchial neoplasms
- Squamous cell carcinoma and adenoid cystic carcinoma: > 80%

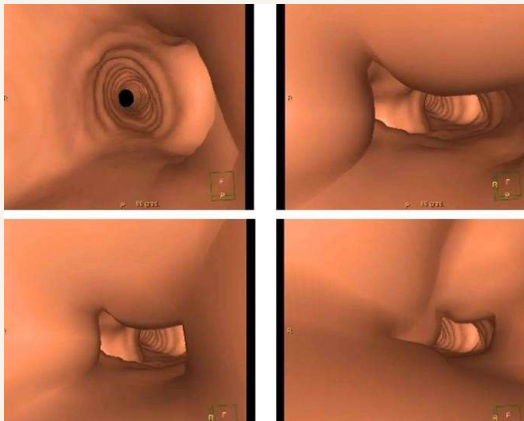
Case

- 47 Y/O; female; Wheezing; Former smoker: 10 pack-year
- Normal laryngoscopy



Lung window and mediastinal window

- The narrowing of the lumen of the bronchus intermediates
- A surrounded soft tissue mass
- Virtual bronchoscopy



Case: Adenoid cystic carcinoma

- Usually arise from distal trachea or proximal main bronchi
- Most: Polypoid intraluminal mass or Invade adjacent structures
- Scant: Rarely multifocal or diffuse

Case: Dx?

- 39 Y/O female
- Progressive shortness of breath
- **Wheezing? Localized? Asthma? True or not true?**
Pulmonary function test?



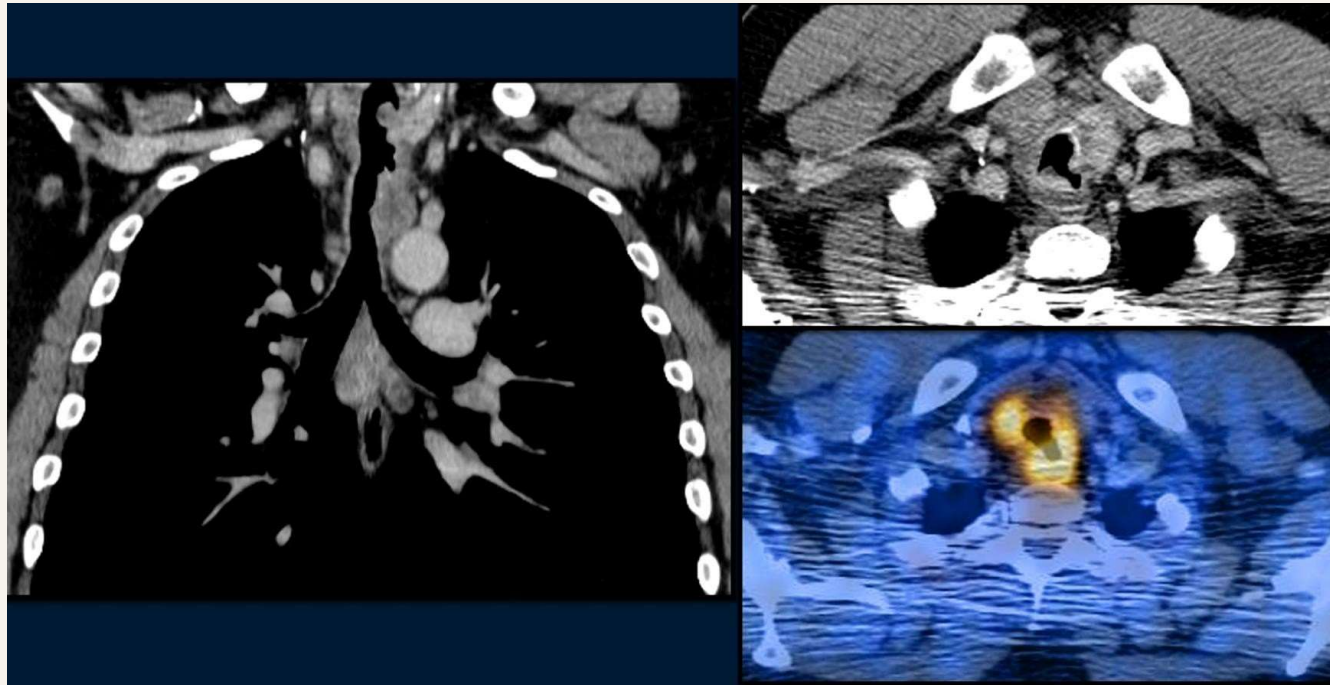
Case: Dx: Adenoid cystic carcinoma

- Coronal and Axial view
- A mass invade the adjacent structures and protrude into the lumen of a trachea
- Invade the adjacent esophagus
- Image: not for pathologic diagnosis!



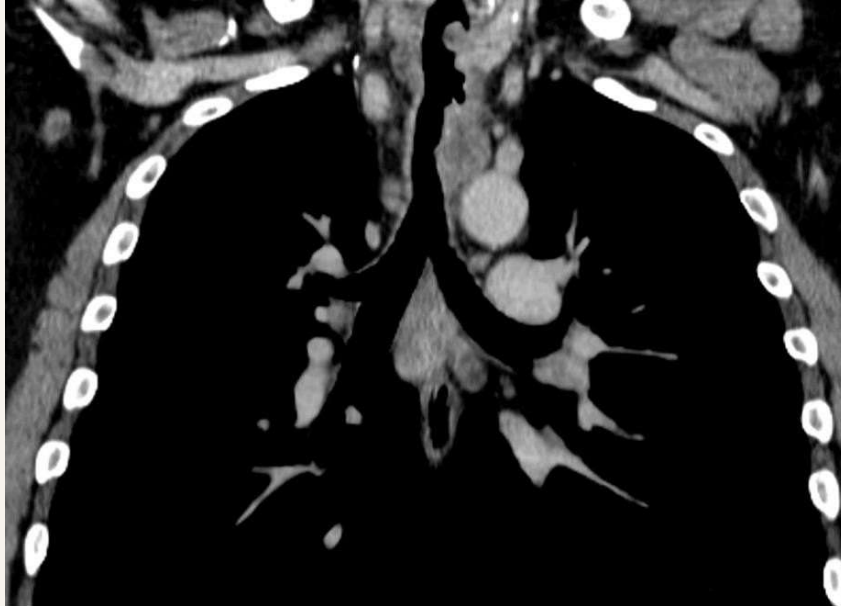
Case

- 54 Y/O Male
- Shortness of breath



Case: Dx: Squamous cell carcinoma

- Irregular thickening of the tracheal wall, heterogeneous with some areas of necrosis: extension into the lumen;
- PET scan: avid FDG uptake in the whole mass

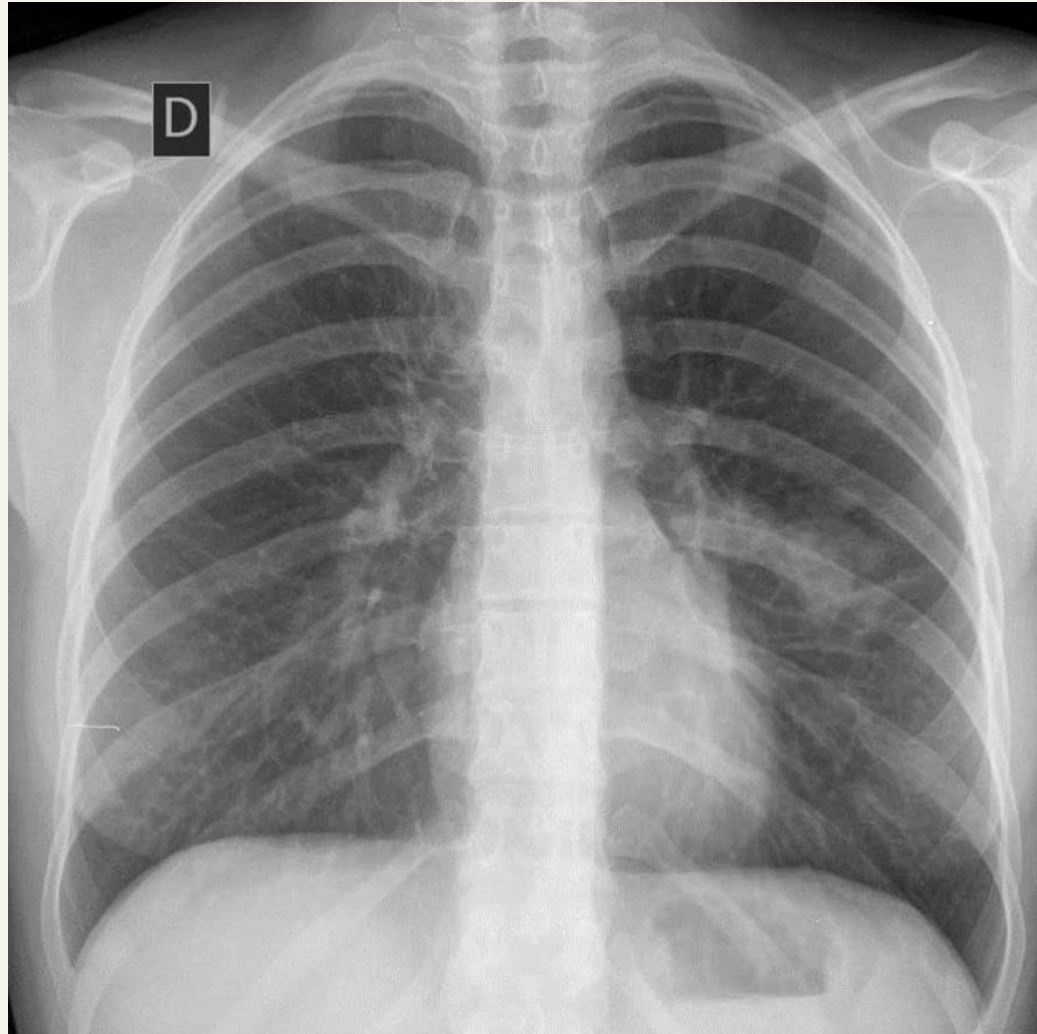


Case: Squamous cell carcinoma

- **Male; usually smokers > 50 Y/O**
- Poor prognosis
- **Intraluminal polypoid mass (most common)**
- **Eccentric nodular wall thickening**
- Frequently extends into mediastinum and adjacent structures
- Rarely diffusely infiltrate tracheal wall

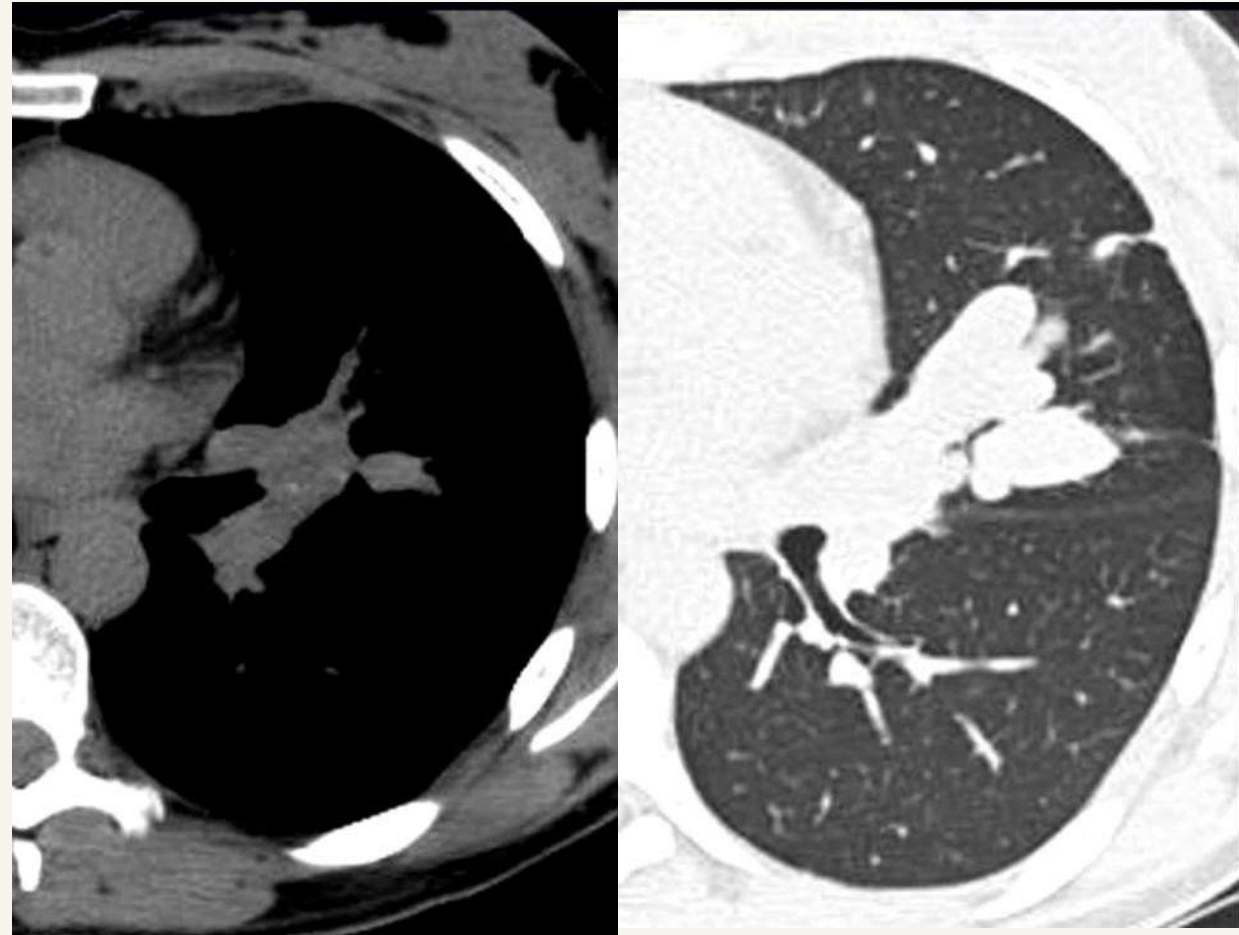
Case

- 42 Y/O: Male: s/s: cough and shortness of breath
- CxR: tubular opacity in the mid left lung



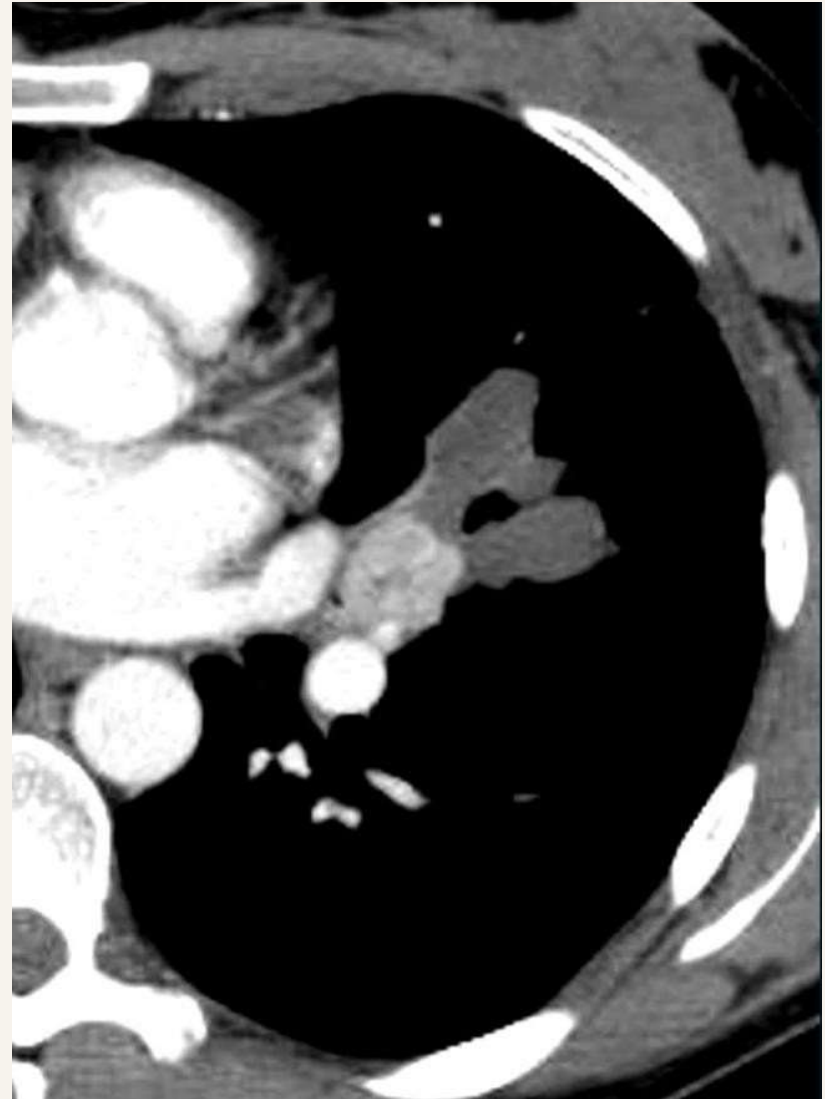
Case

- 42 Y/O: Male: s/s: cough and shortness of breath
- CxR: tubular opacity in the mid left lung
- CT chest: Without contrast: nodular lesions within the bronchus; tubular lesions in the lung window, **fingering**;



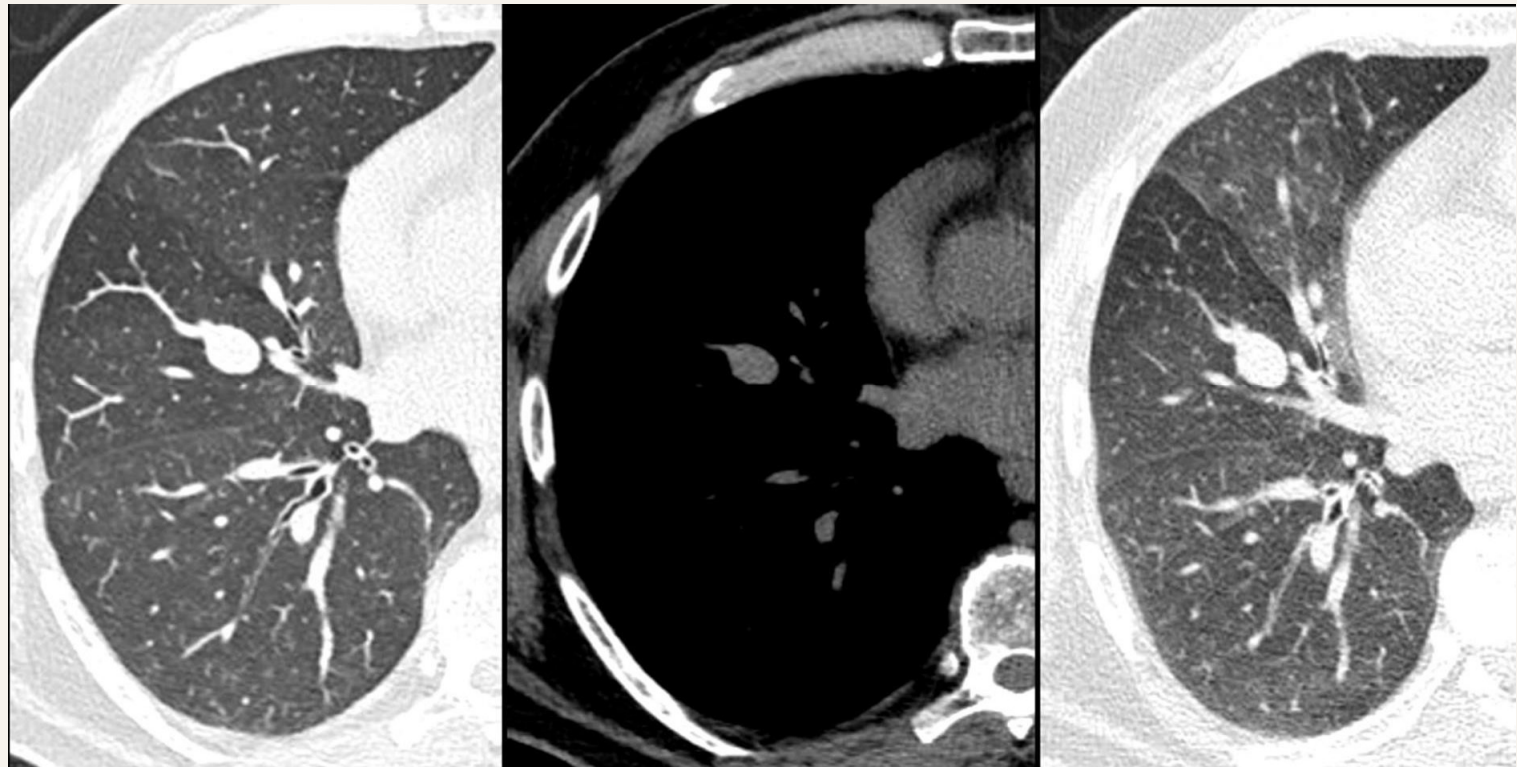
CT chest with contrast

- **IV contrast: important!**
- Tubular opacities
- Enhancing nodule lesion
- CT chest: With Contrast -> **tubular opacities, enhancing nodule lesion;**
- Bronchiectasis and secretion of mucus within bronchi;



Case:

- 51 Y/O male (Young)
- Smoker: 30 pack-years
- A nodule, middle lung;
- **Margin: smooth!**
- Some air-trapping distal to the nodule lesion => lesion within the bronchi!

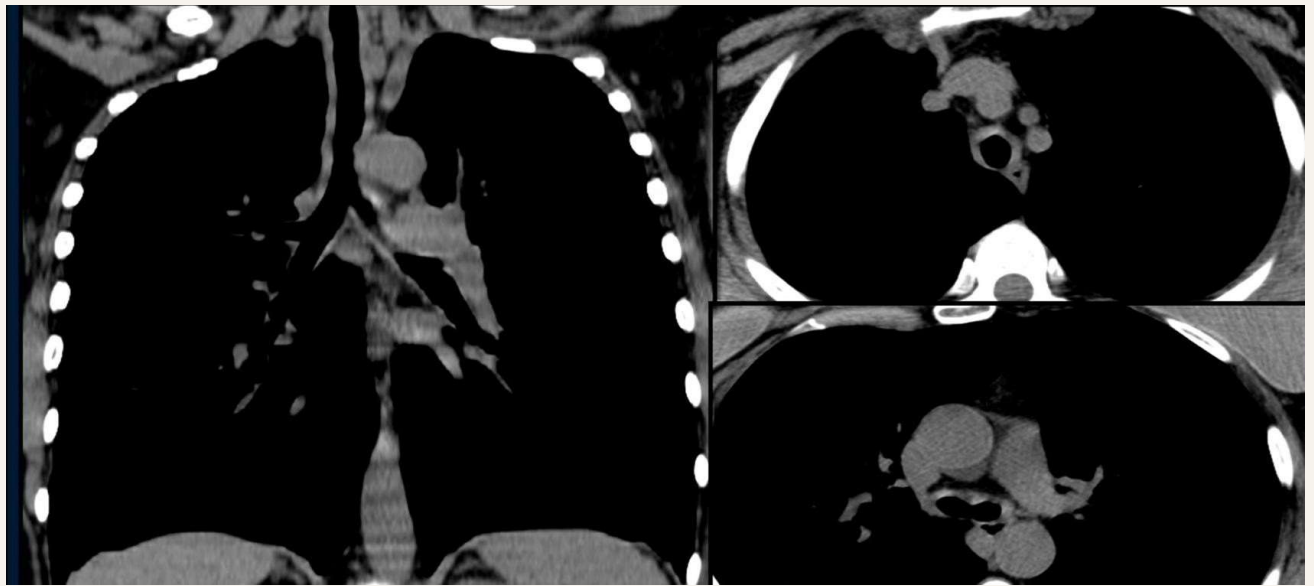


Case: Diagnosis: Carcinoid

- Hilar or discrete endobronchial mass
- Orient along long axis of airways
- **Smooth or slightly lobulated margins**
- Typically enhance following contrast administration

Case:

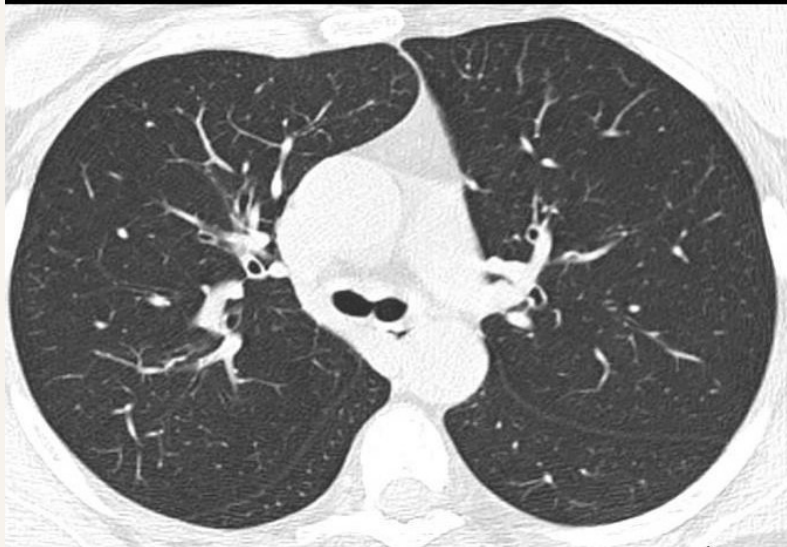
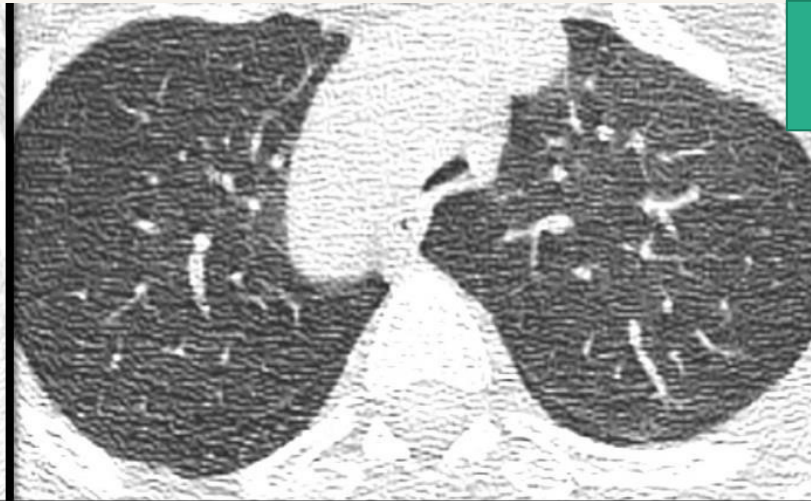
- 54 Y/O; female
- s/s: Wheezing and auricular pain
- CT chest: Some thickening of the trachea, smooth and regular;
- Mainly in their anterolateral portions of the trachea



**Inspiratory
CT**



**Expiratory
CT**



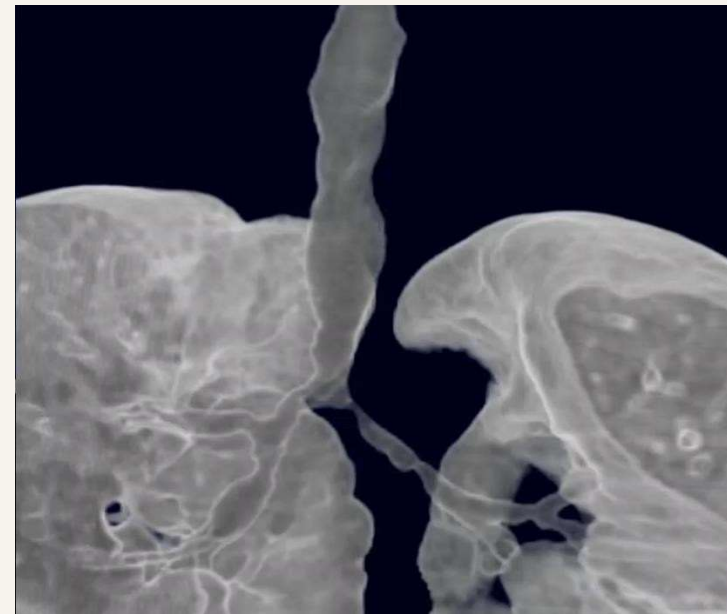
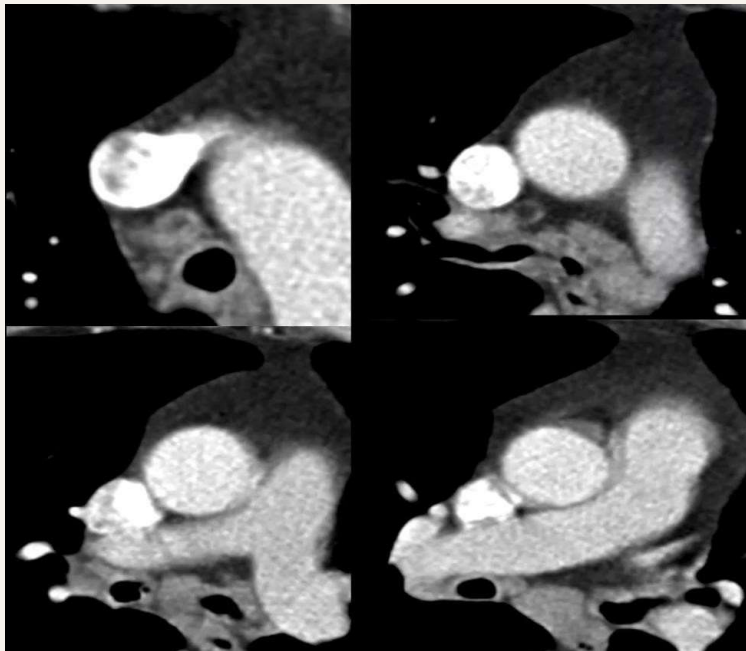
Inspiratory and Dynamic Expiratory CT: collapse and air trapping

Case: Relapsing polychondritis

- Clinical information: **Recurrent episodes of cartilage inflammation** (ear, nose, joints, larynx and tracheobronchial tree)
- CT shows **smooth tracheal and bronchial wall thickening**, with or without calcification)
- Characteristic **sparing of posterior tracheal membrane**
- Diffuse tracheal narrowing (a late finding)

Case: Granulomatosis with polyangiitis

- Case: circumferential thickening of trachea and main bronchi
- Stenosis on the left main bronchi;

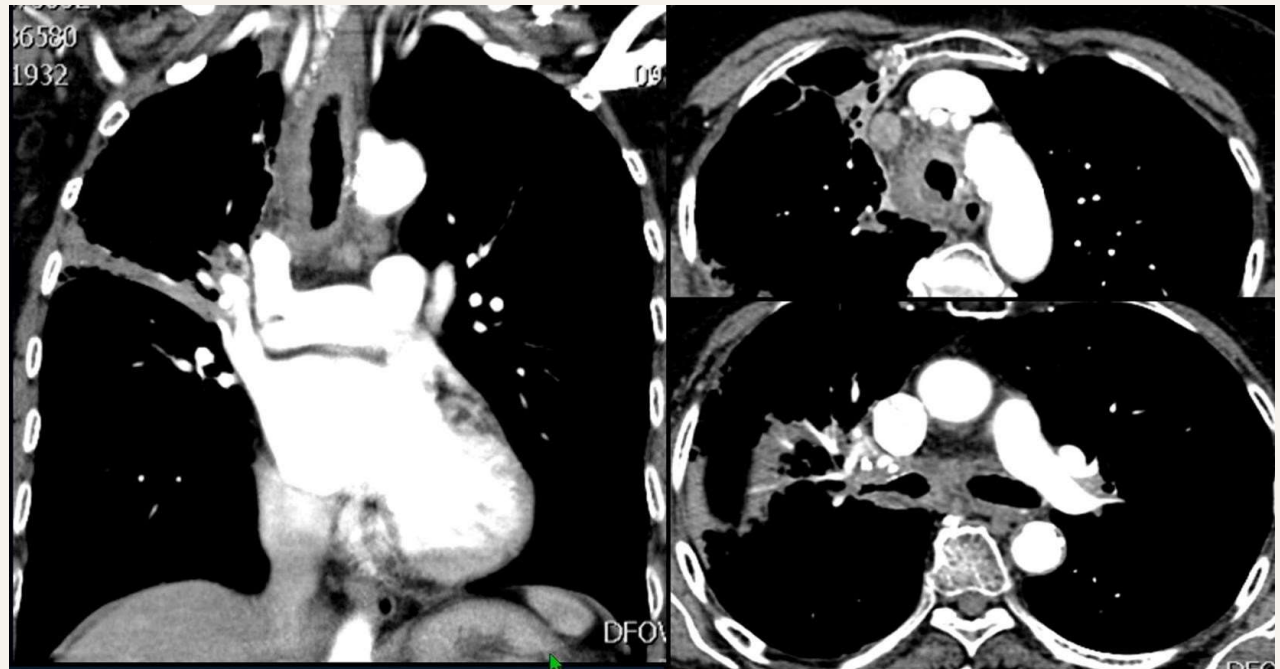


Case: Granulomatosis with polyangiitis

- Large airway involvement just over half of patients
- Circumferential wall thickening
- Tracheal or bronchial stenosis (especially **subglottic trachea**)
- **Tracheobronchomalacia**

Case:

- A thickening of the trachea and main bronchi;
- Irregular thickening, some atelectasis
- Right hilar: some calcifications



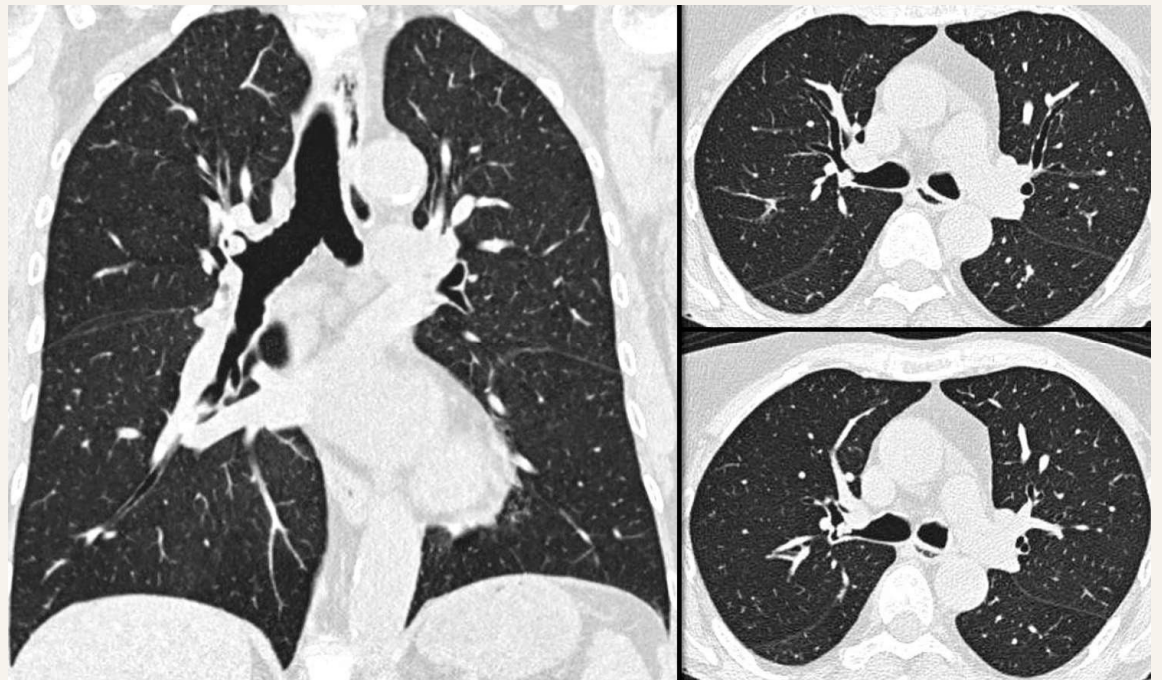
Large airways diseases: Infection

Tuberculosis

- Usually involves **distal trachea and proximal bronchi**
- Tracheobronchial wall thickening and stenosis
- **Late stage of stenoses usually long (>3cm)**
- **Left main bronchi (LMB) > right main bronchi (RMB)**
- Concentric luminal narrowing
- Atelectasis or obstructive pneumonitis
- Lymphadenopathy

Case: Foreign body

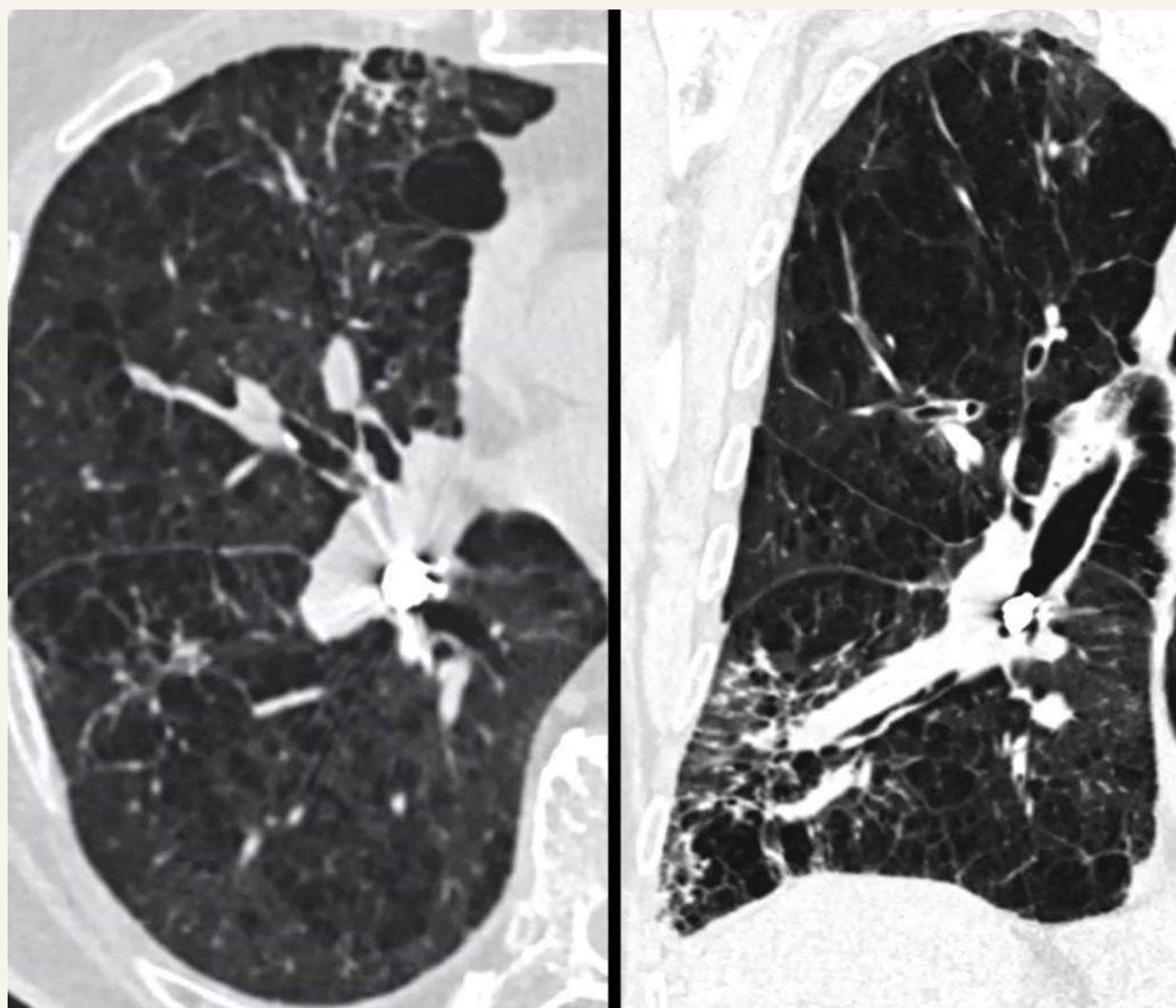
- Case: 45 Y/O female
- S/S: Cough and dyspnea
- CT chest: A nodule lesion in the right bronchus
- **Foreign body (Corn)**



Case: Foreign body

- 84 Y/O Male
- S/S: Cough
- Former smoker 80 pack-years
- CxR: emphysema; right lower lung: **A dental device in the right lower bronchi**; obstructive pneumonitis; inflammation;



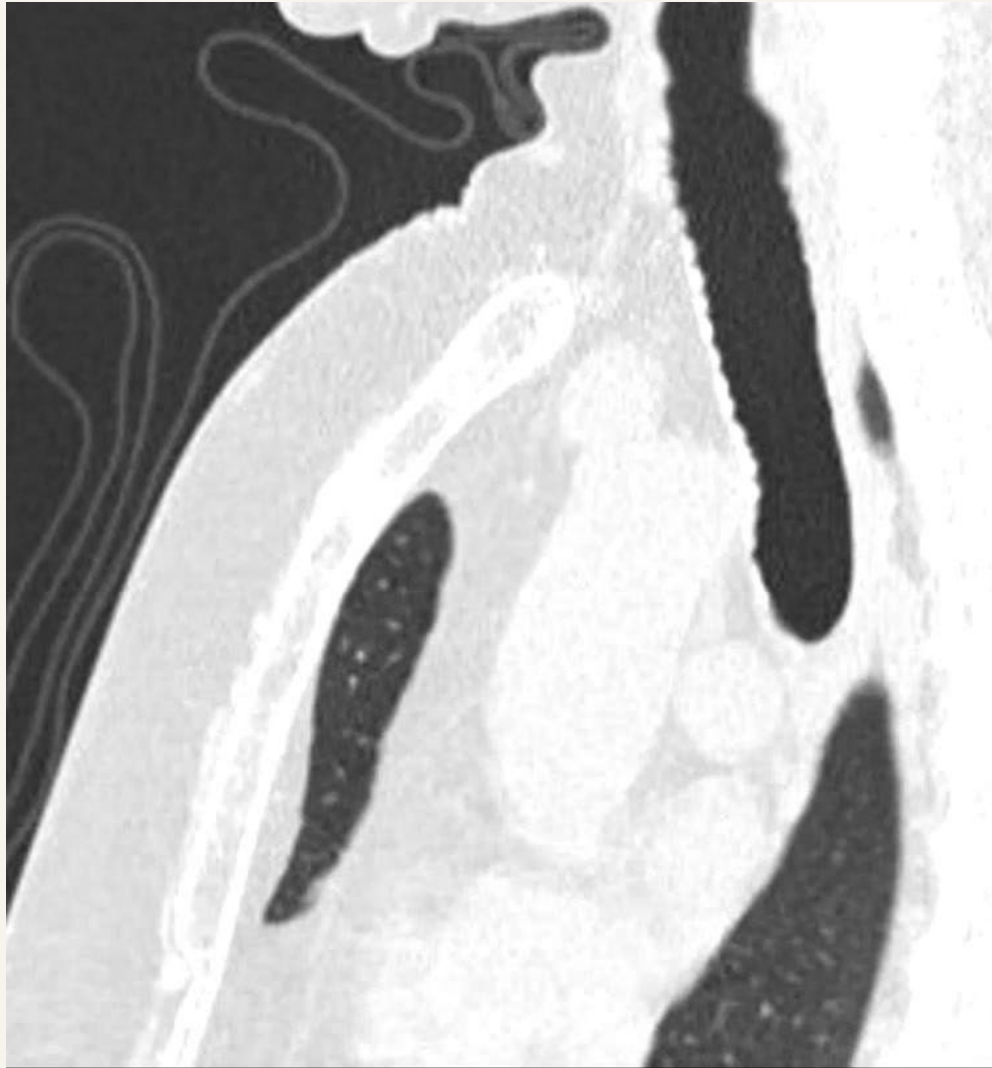


Large airways diseases: Foreign body

- Most commonly caused by **aspiration**
- Incidence in children is higher than in adults
- Food (nuts), teeth, dental devices and medical instruments
- S/S: Cough, wheezing, stridor, dyspnea
- **Normal chest radiograph dose not exclude foreign body:**
ER

Case: Tracheobronchomalacia

- Case: 62 Y/O female
- **Recent history of asthma**
- S/S: Dyspnea
- Former smoker: 5 pack-years
- Inspiratory and Dynamic Expiratory CT:
- Use dynamic expiratory CT for dyspnea patients!
- Sagittal: CT: collapse of trachea; Tracheobronchomalacia

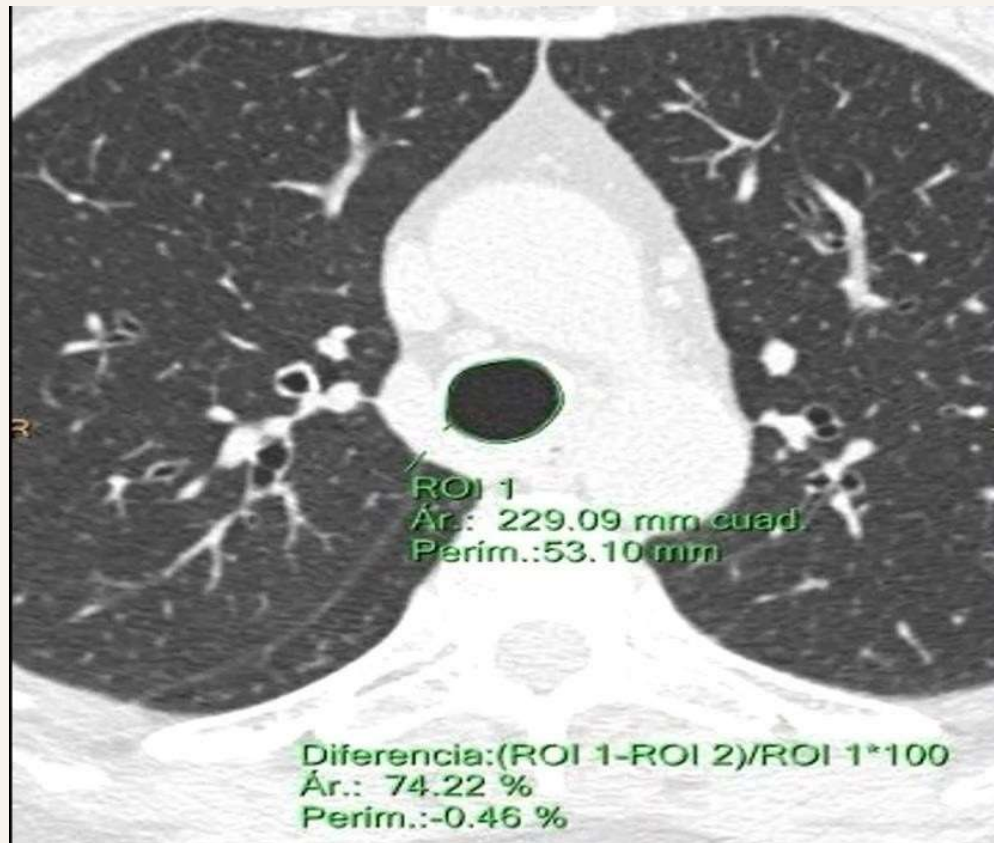


Inspiratory CT

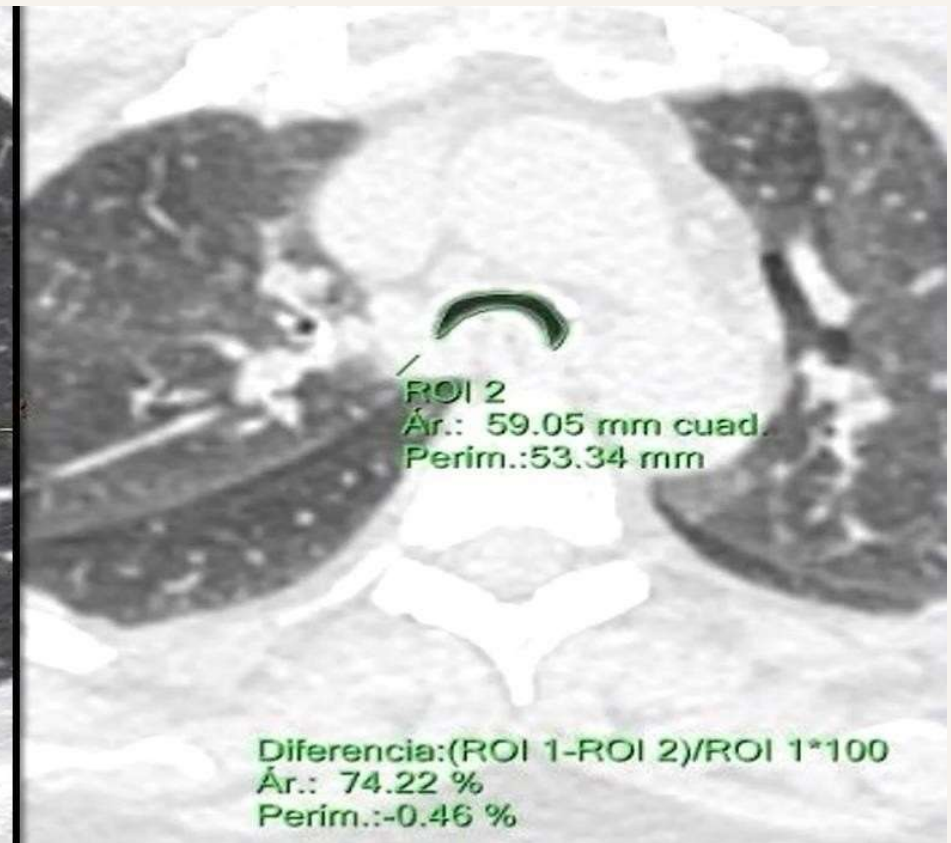


Dynamic Expiratory CT

Tracheobronchomalasia



Inspiratory CT



Dynamic Expiratory CT

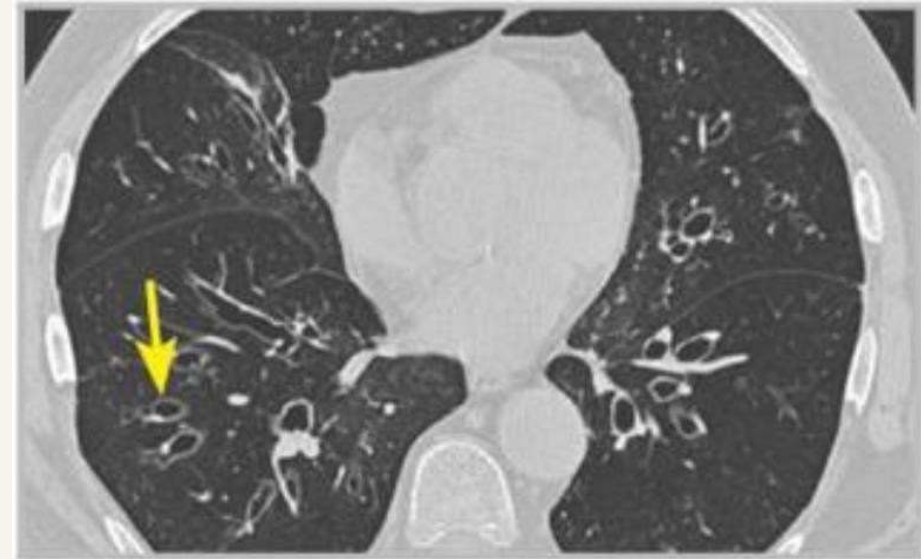
Large airways diseases: Miscellaneous

- Tracheobronchomalacia
- Increased compliance of trachea
- May only be elicited with inspiration (extrathoracic) or expiration (intrathoracic)
- Growing use of dynamic expiratory CT: for suspect dynamic compression of posterior tracheal membrane
- Causes include RP, idiopathic, acute tracheitis, mucopolysaccharidoses, mediastinal lipomatosis

Bronchiectasis

- (1) Congenital
 - = Cystic fibrosis
 - = Primary ciliary dyskinesia

Signet ring

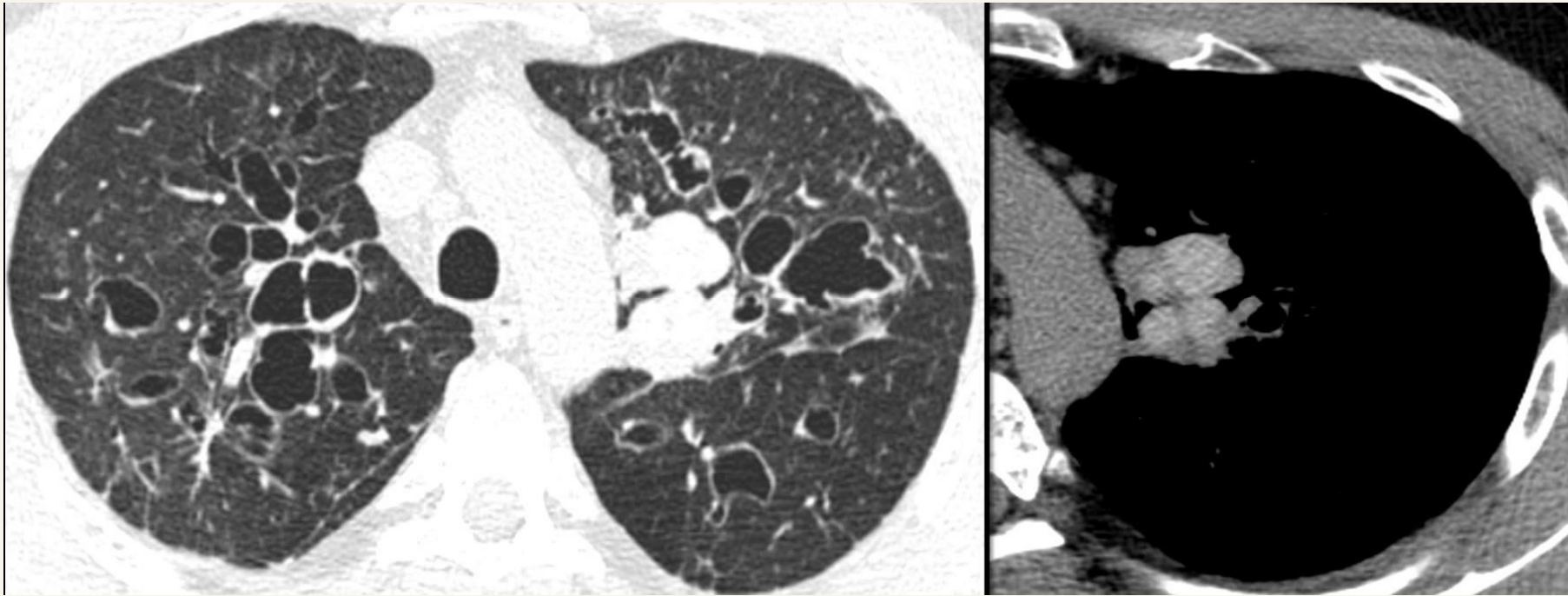


- (2) Acquired
 - = Infection, toxic fume exposure
 - = Recurrent aspiration

Cylindrical

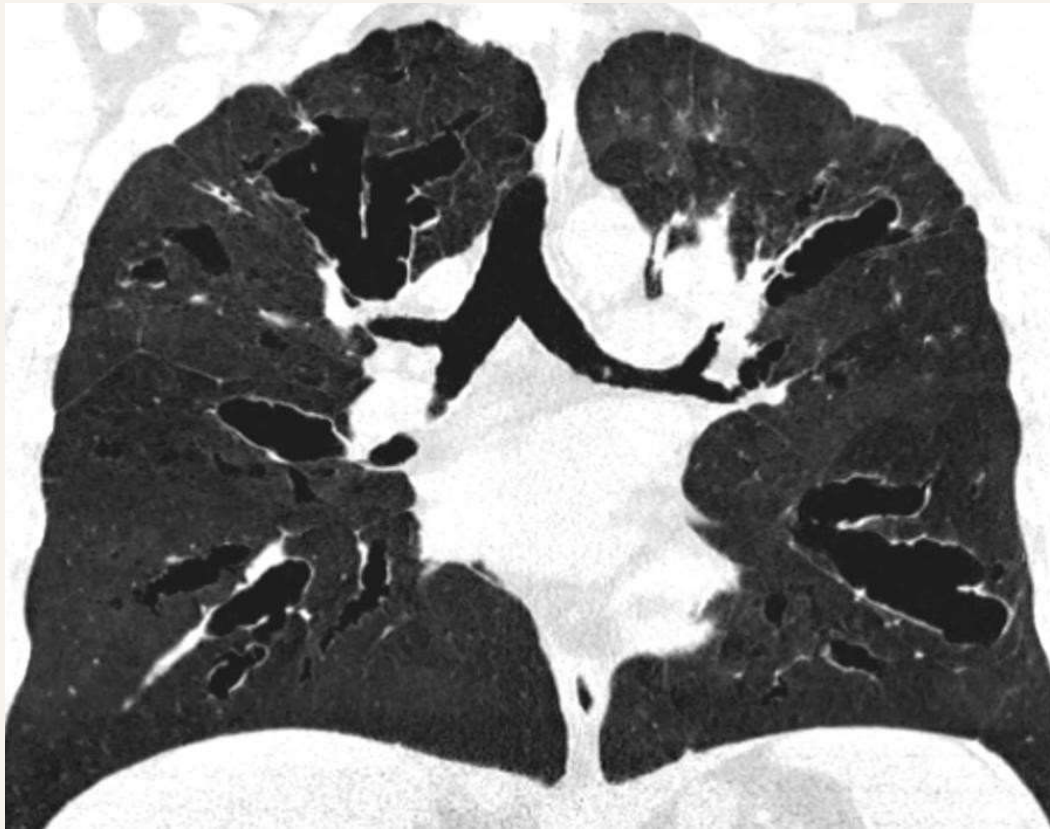


Case:

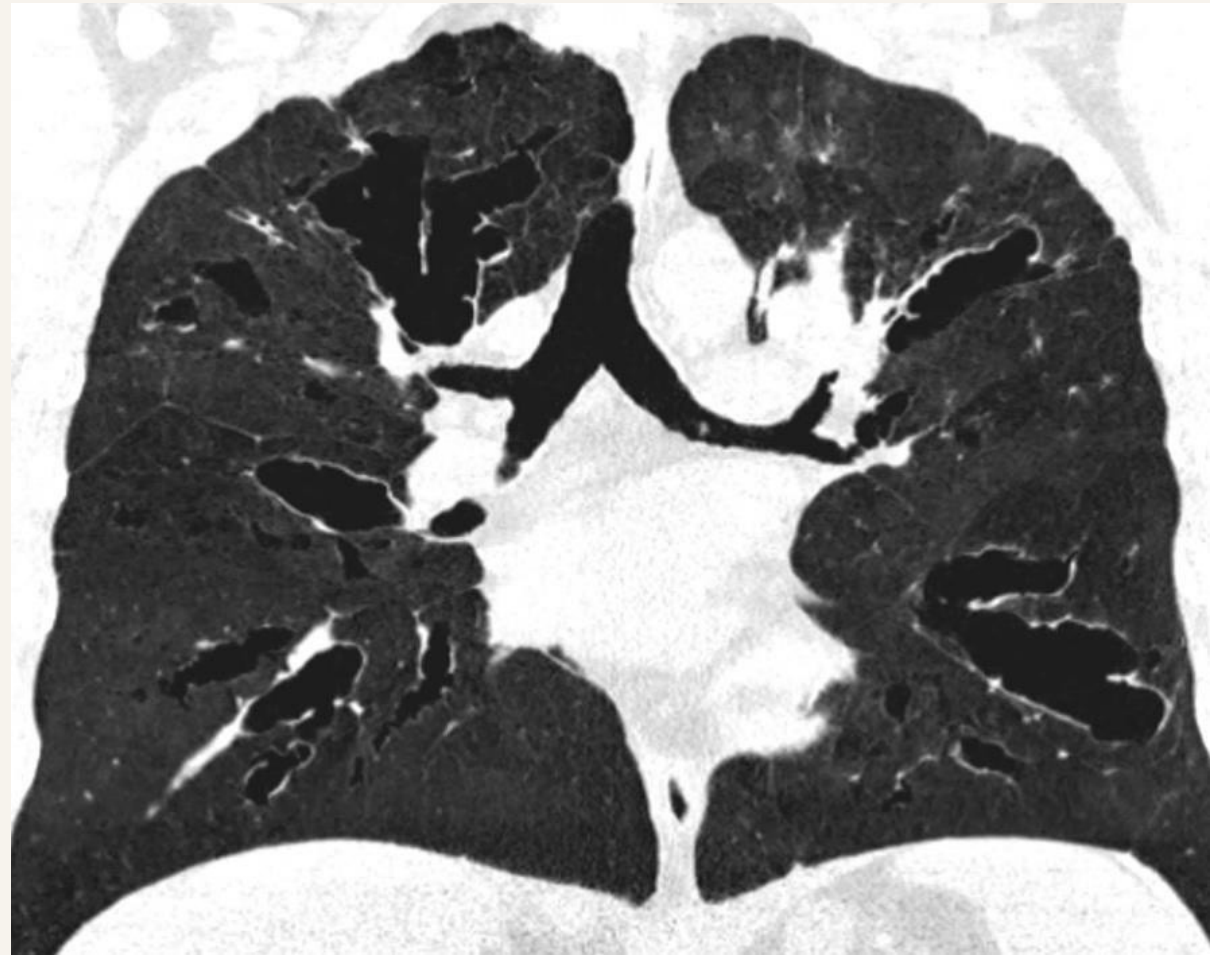


- **54 Y/O Male**
- S/S: asymptomatic
- History of asthma

Case:



- CT chest: **central bronchiectasis**
- Some nodular opacities:dense
- Fingering lobe
- Mucus impaction: high density
- Asthma + central bronchiectasis + mucus plugging (hyper dense)



(2) Large airways disease : Summary

- **MDCT** is the preferred non-invasive tool for imaging large airways
- **Expiratory CT** can be helpful in evaluation of tracheal collapsibility

Take Home Message & 結語



不只看見陰影，更要看見病人

影像學是臨床理學檢查的延伸，永遠將「病患的免疫狀態」與「臨床病史」放在鑑別診斷的第一位。



掌握核心推理法則

Pattern (影像模式) → Distribution (分佈) → Sign (特徵徵象) → Clinical Hx (臨床病史)。



回饋與反思是進步的關鍵

診斷並非終點。持續從經驗性治療的影像回饋中學習，才是累積臨床實力的不二法門。

感謝聆聽
敬請指教！