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

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2026-7-19

Outline

Infectious disease

- Pulmonary tuberculosis/NTM lung disease
- Pulmonary viral pneumonia
- Pulmonary cryptococococosis
- Pneumocystis jirovecii
- Chronic pulmonary aspergillosis

Airway disease

- COPD
- Bronchiectasis

Outline

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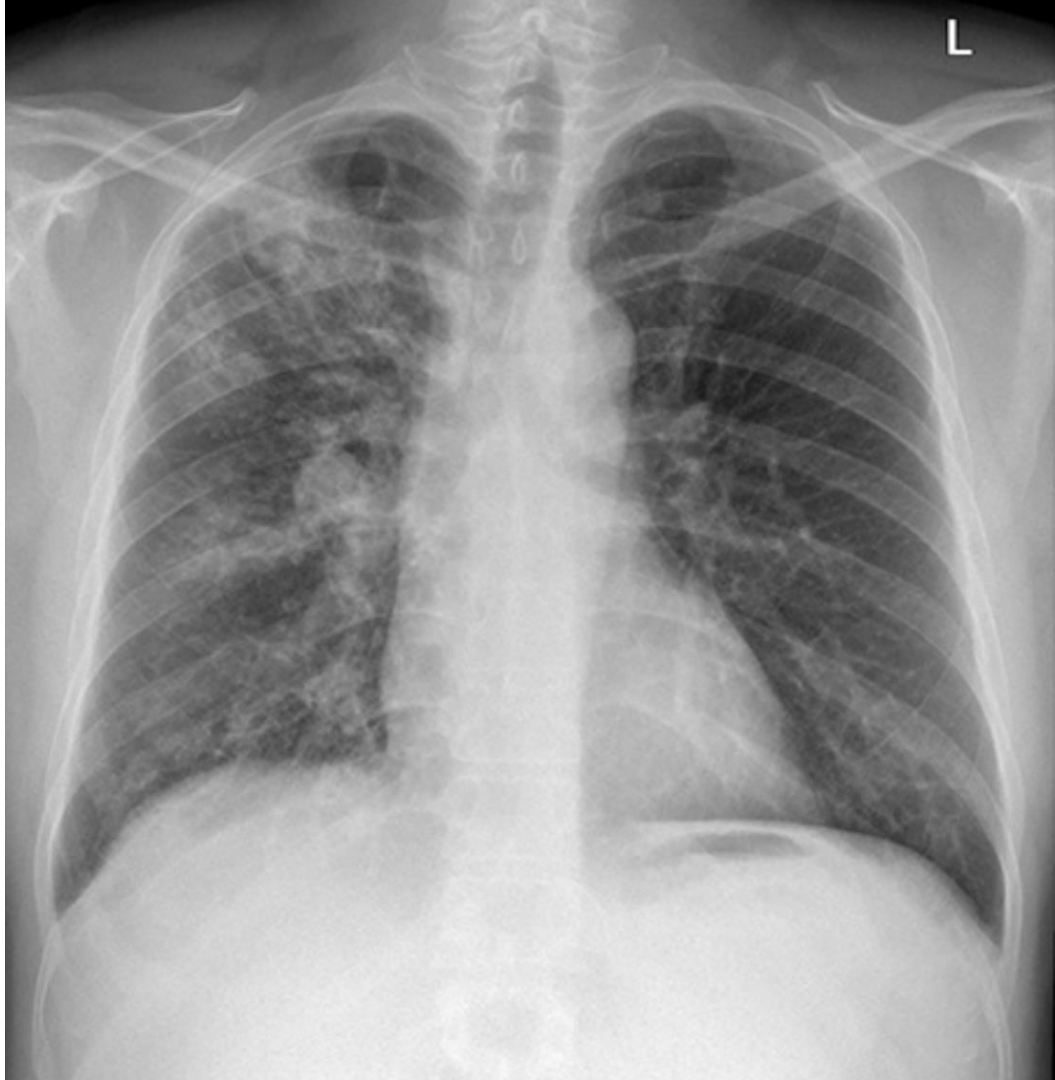
Primary TB

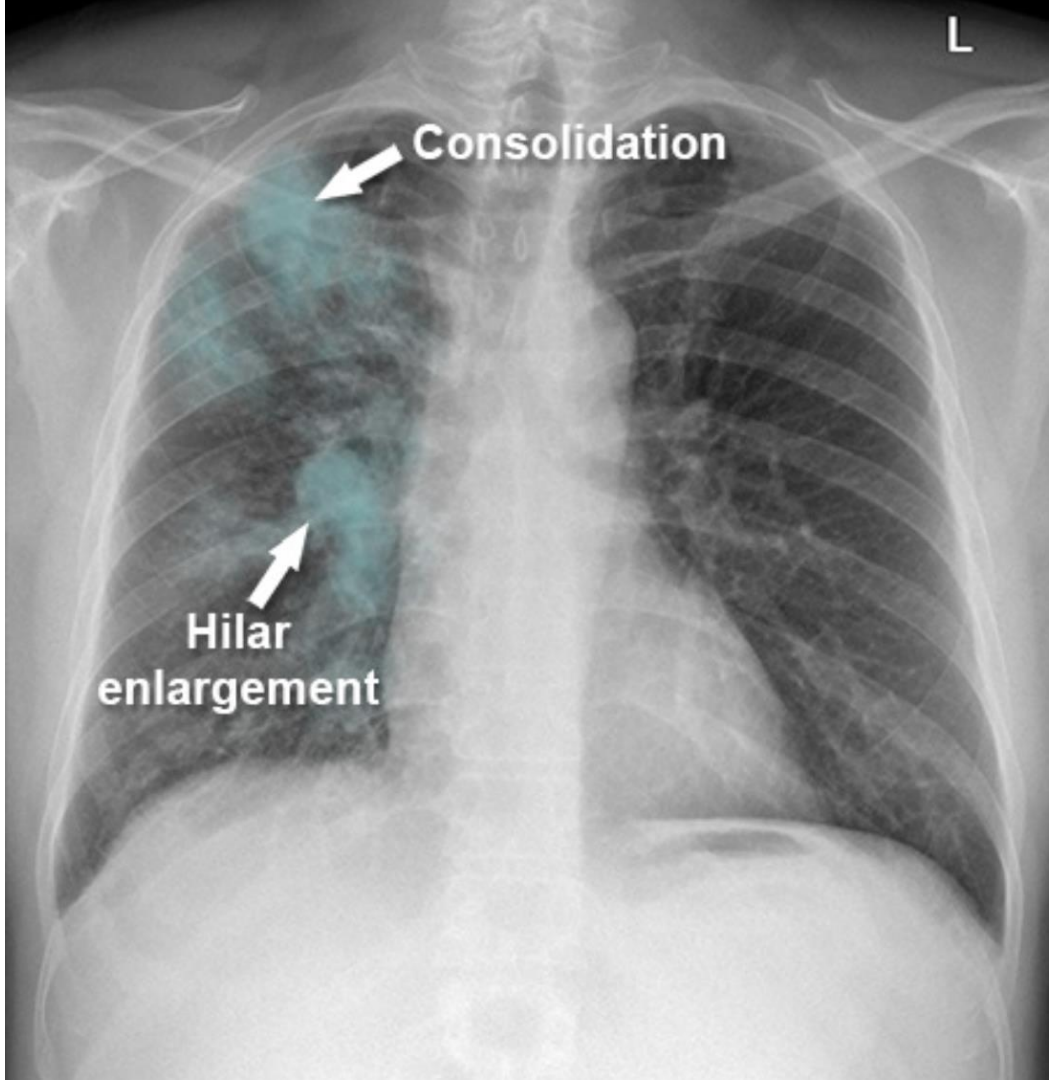


Primary TB

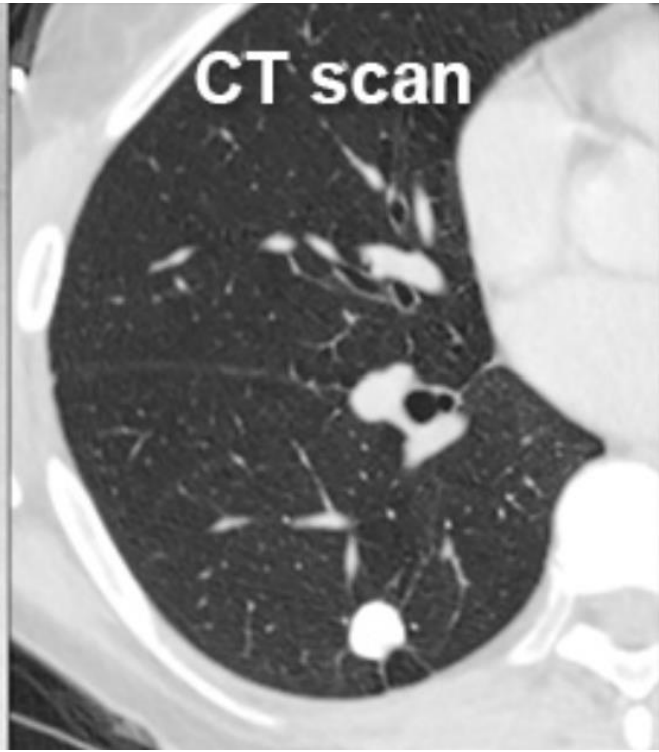
Great mimiker

Consolidation of the **upper zone** with **ipsilateral hilar enlargement** due to lymphadenopathy

Note: **The chest X-ray may be normal in primary TB**, in fact most patients infected are never unwell enough to require a chest X-ray



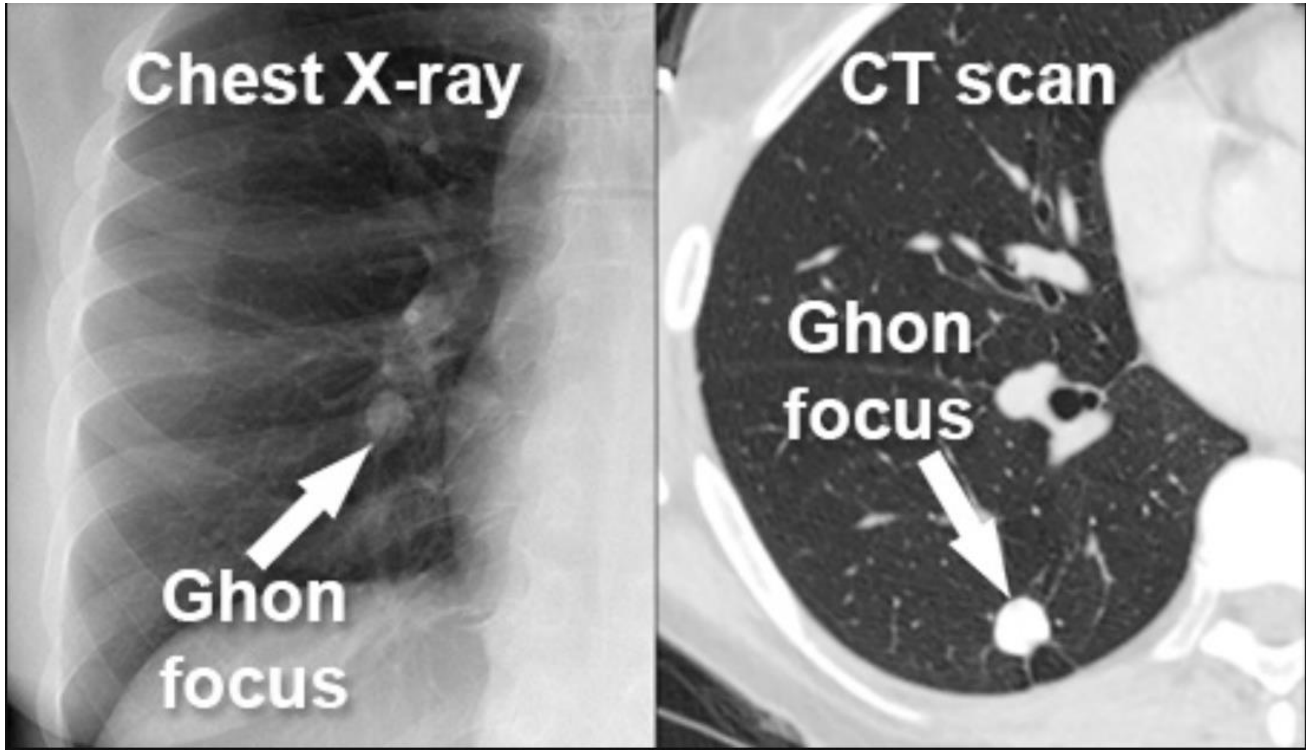
Healed TB



Healed TB

Following an immune response to primary infection, a caseating granuloma forms which **calcifies** over time – this is known as a '**Ghon focus**' – TB has gone!

A Ghon focus is a **rounded, well-defined focus of calcific density** (as dense as bone) usually located in the periphery of the lung



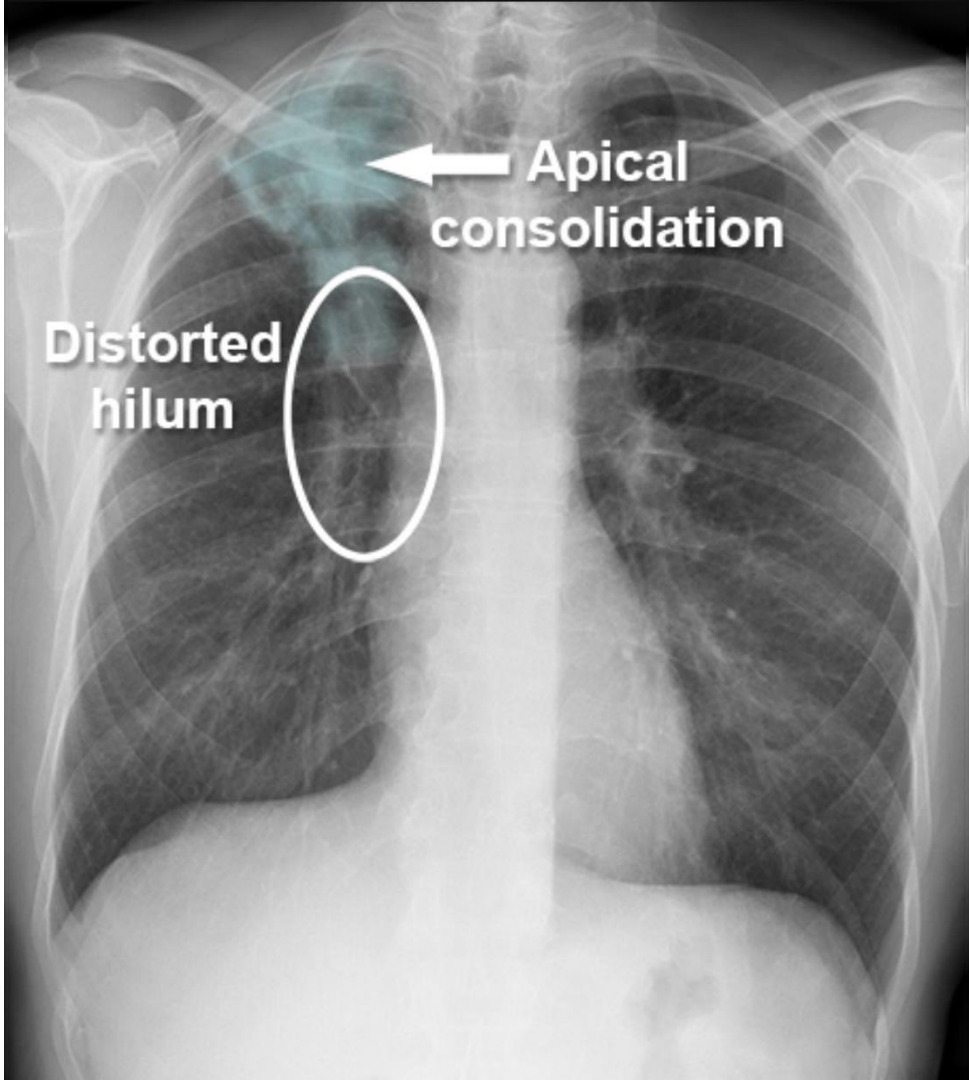
Post Primary TB

Post Primary TB

The upper lobes are more commonly affected

Consolidation often extends to the hilum

The **hilar structures** may be **distorted** due to volume loss of the upper lobe

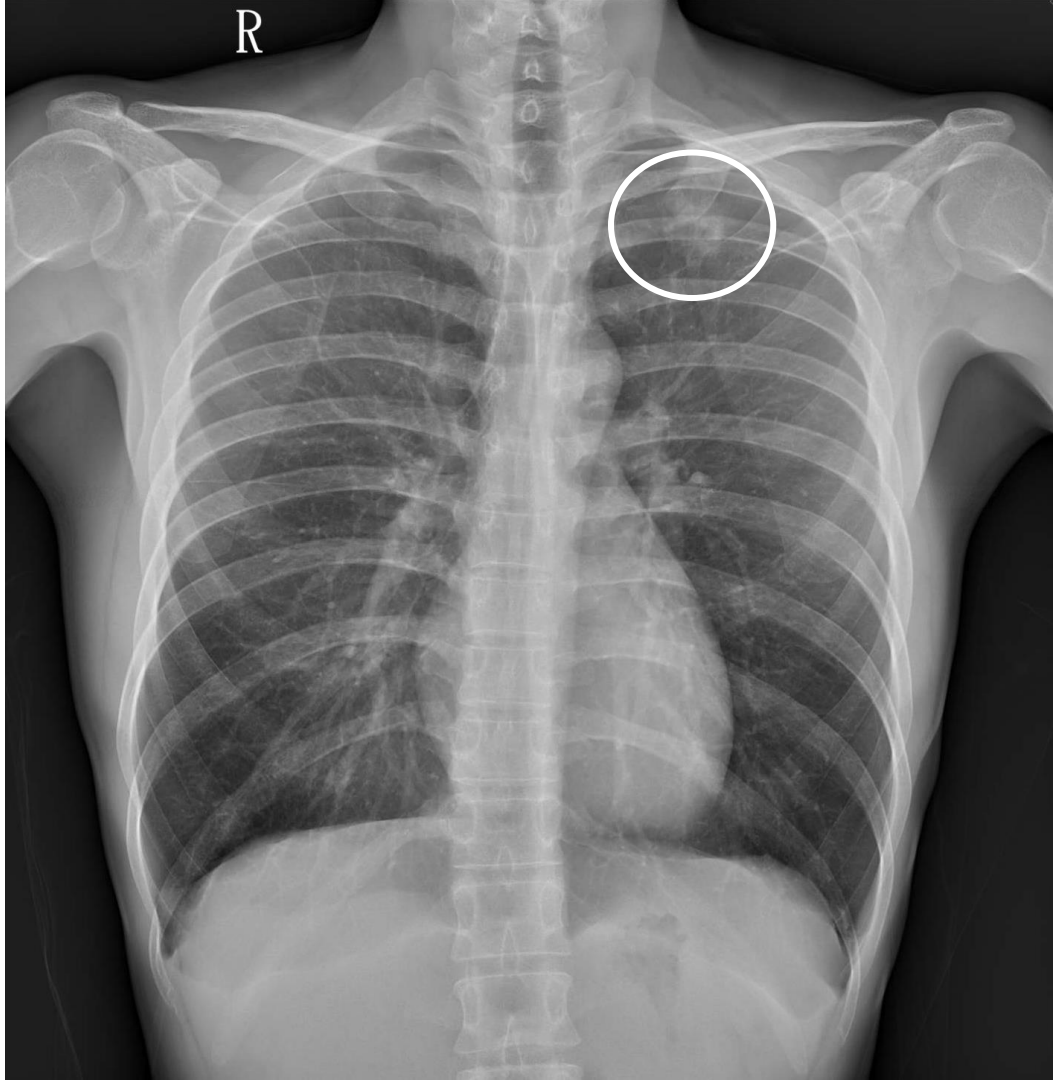


Post Primary TB

Lung Cavity

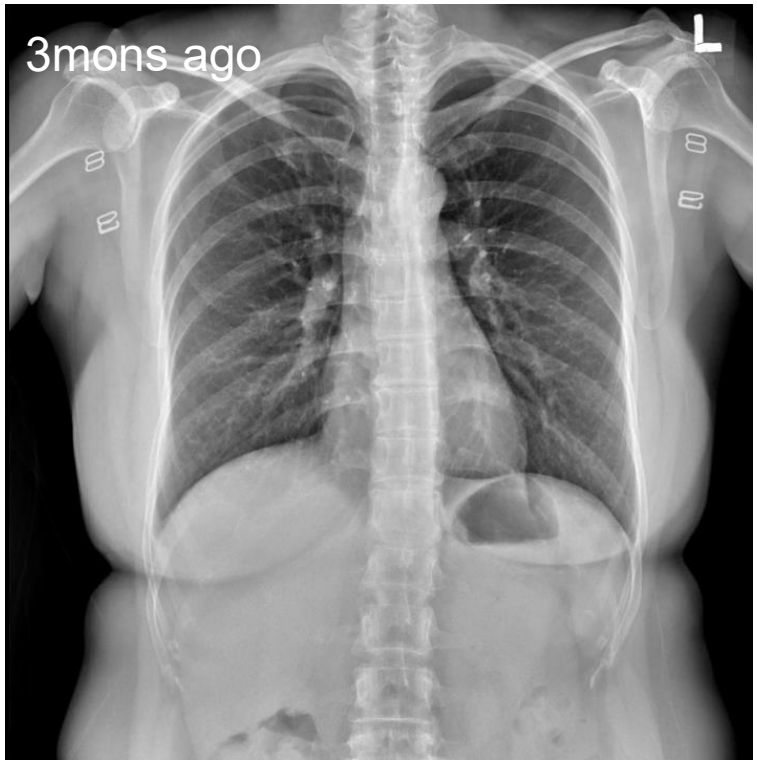
Post Primary TB

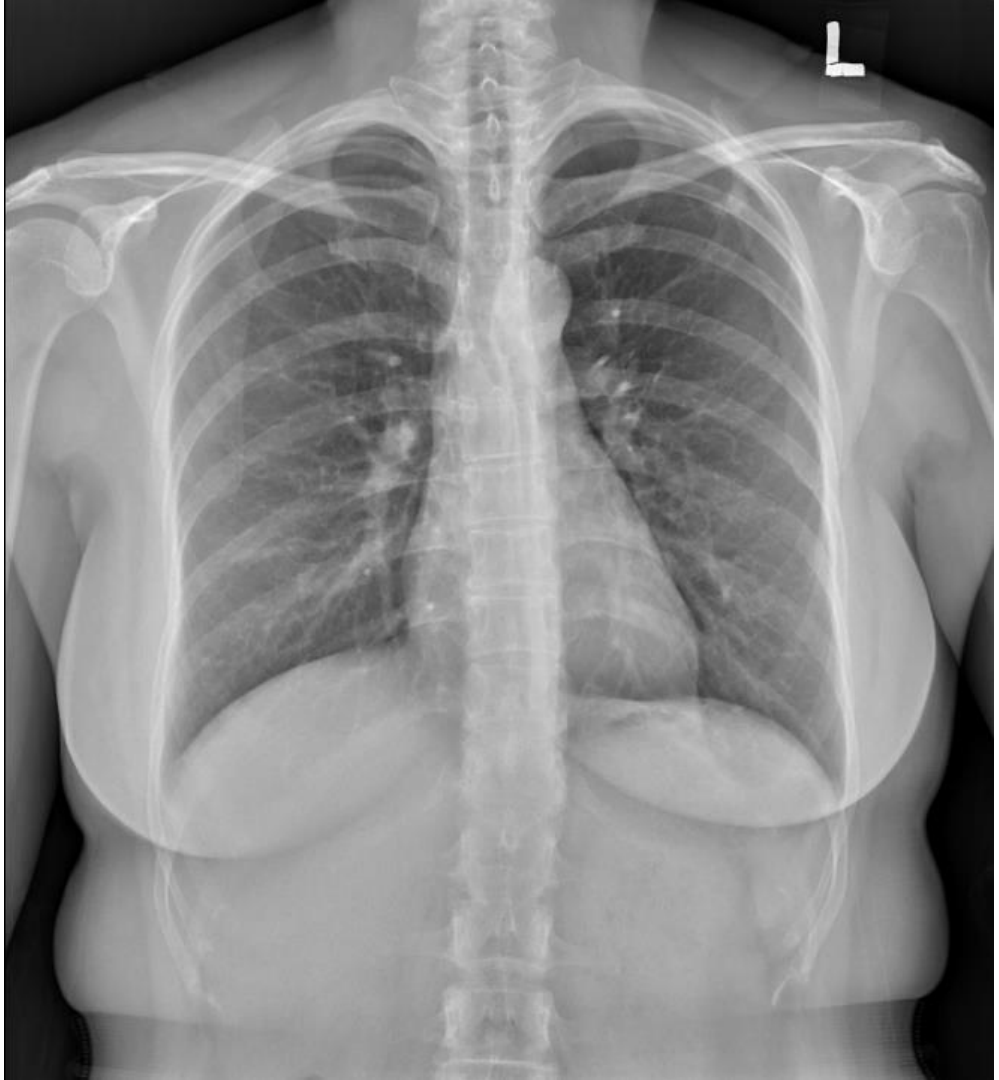
Lung Cavity



Post primary TB

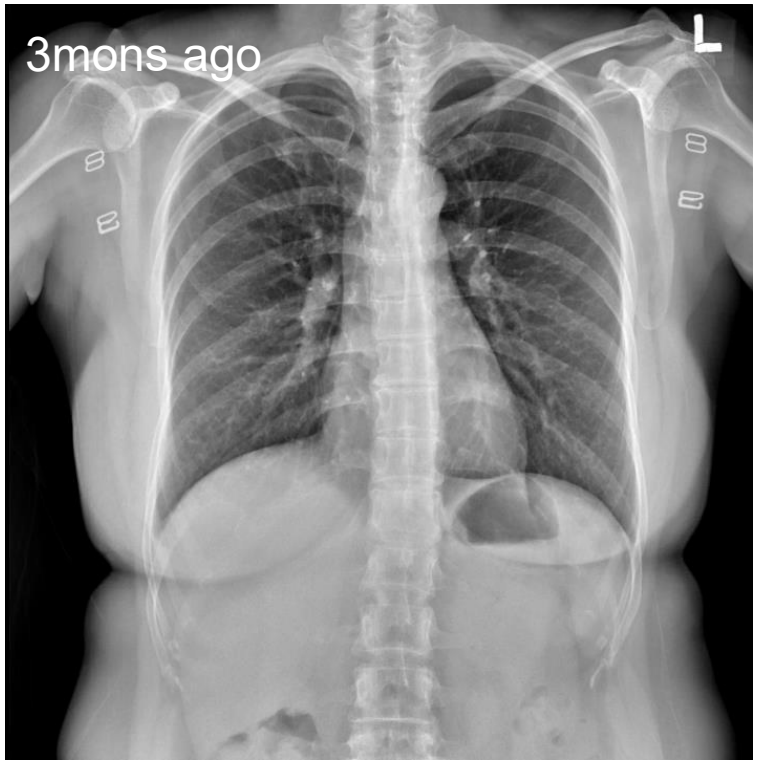
49F husband with active TB

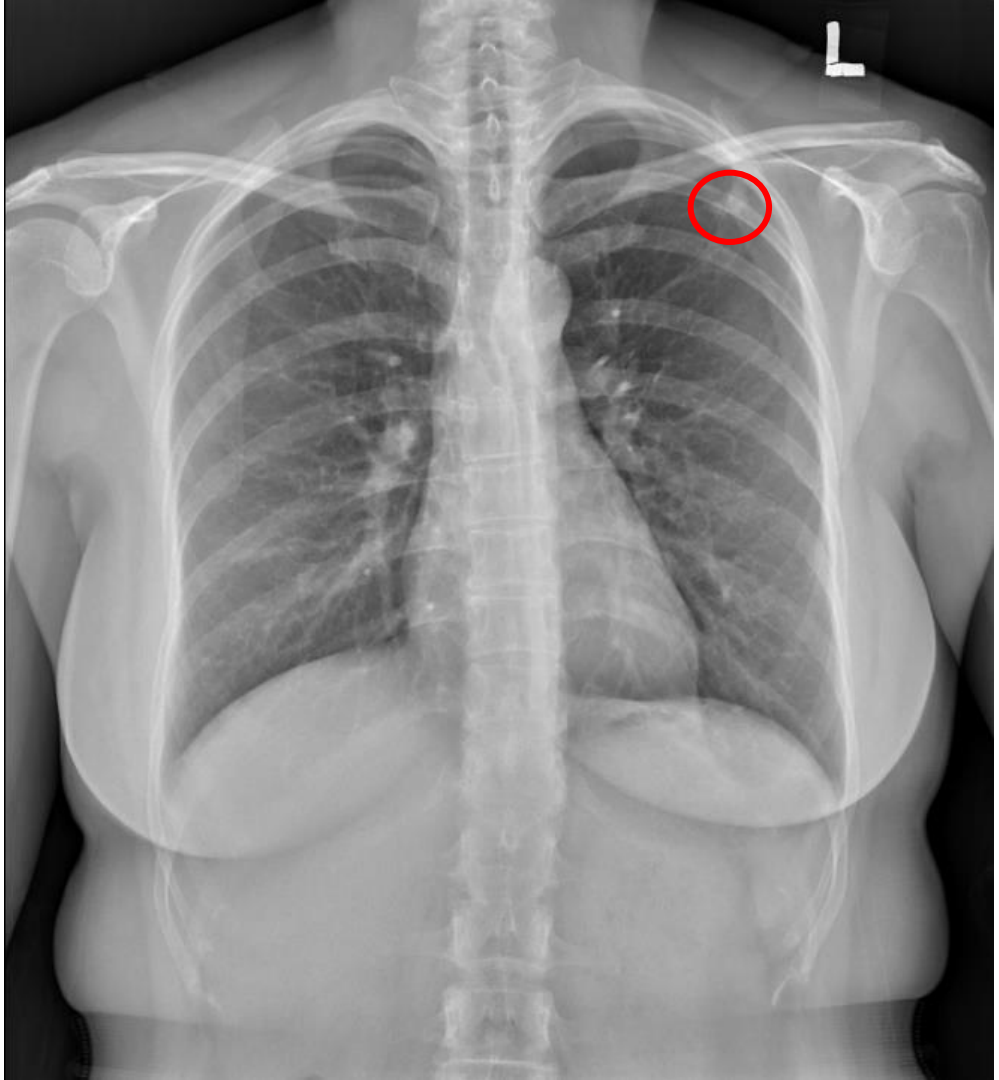




Post primary TB

Nodular lesion





Post primary TB

Lung, left upper, excision:
Granulomatous inflammation with
Mycobacterial infection

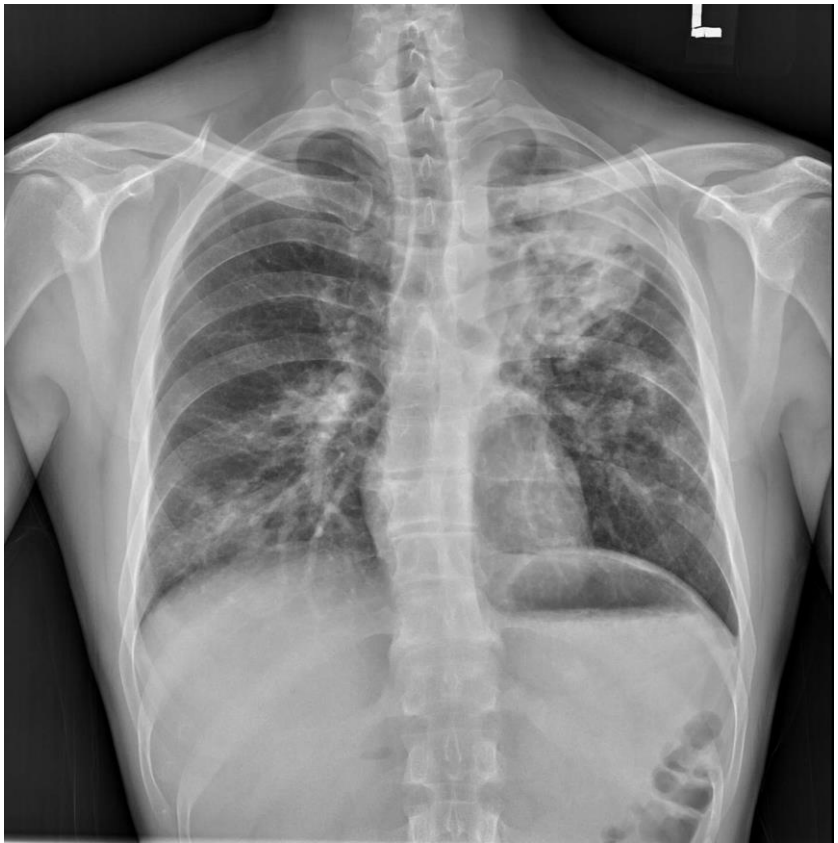
TB culture + (all sensitive)

Healed TB

Following an immune response to post-primary infection, the affected area often becomes scarred (fibrotic) and calcified => '**fibro-calcific change**'

Healed TB (fibro-calcified lesion)

Before treatment



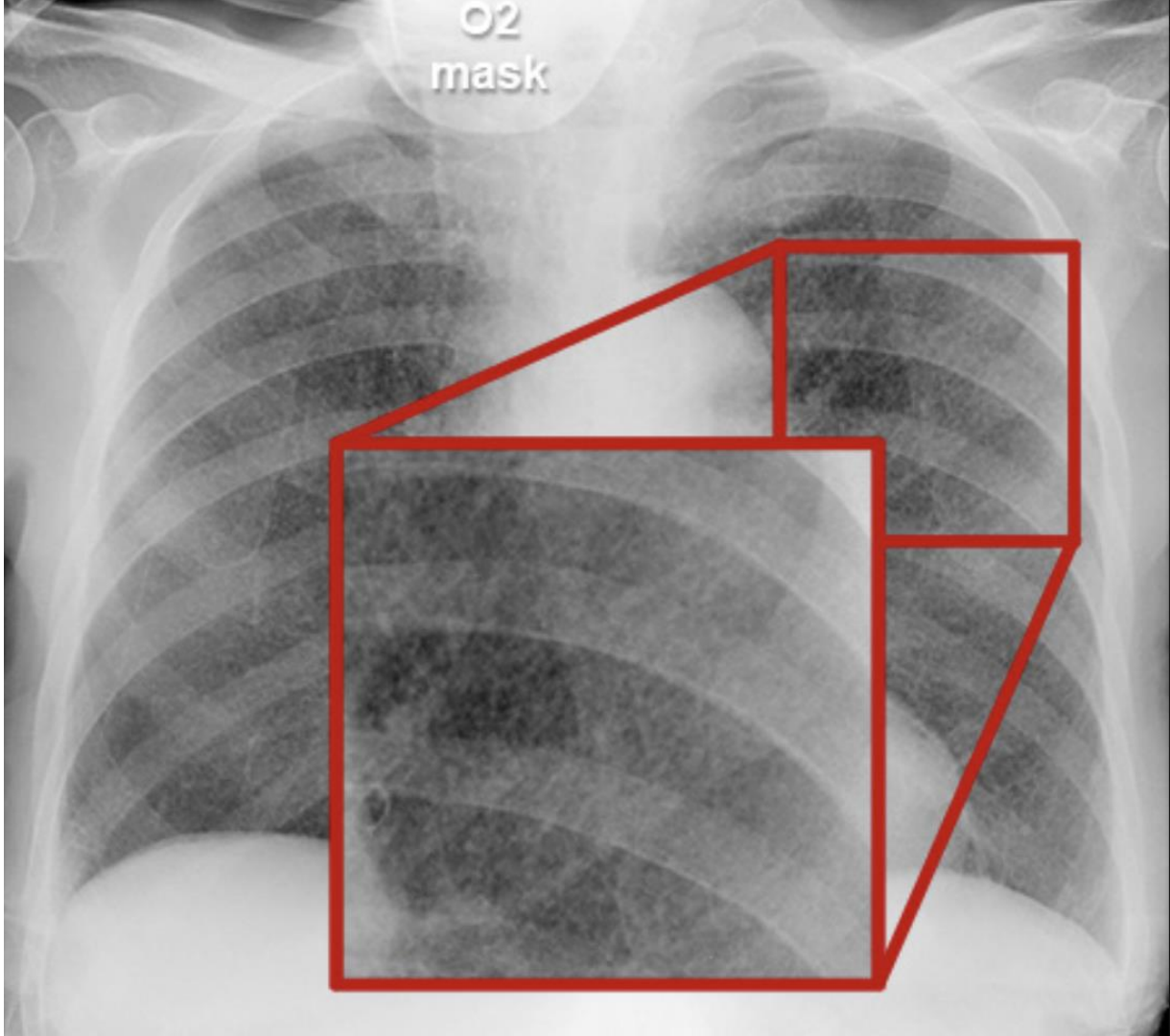
After treatment

Miliary TB

Miliary TB is due to **disseminated spread** of mycobacterial infection

It can occur either at the time of primary infection or on disease reactivation – prognosis is poor

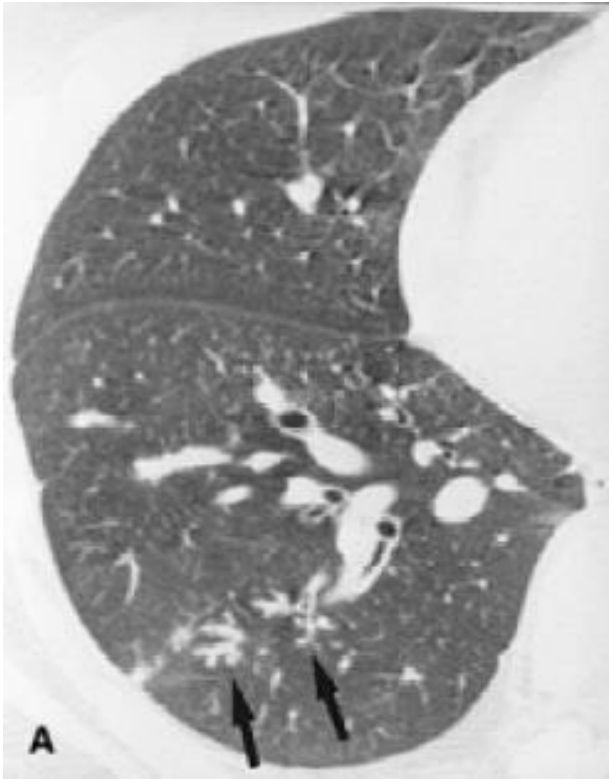
Very fine nodules are typically seen scattered throughout the lungs

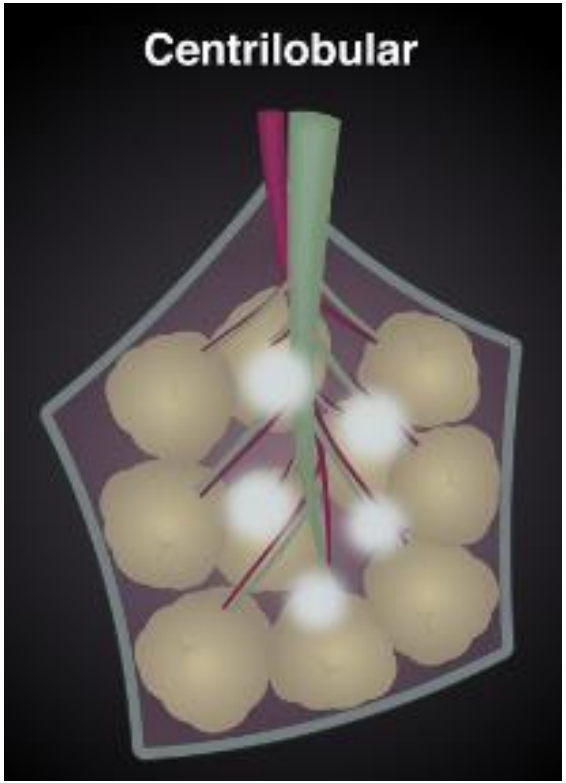


CT Image

Typical TB image

- centrilobular nodules and branching linear structures => tree-in-bud appearance



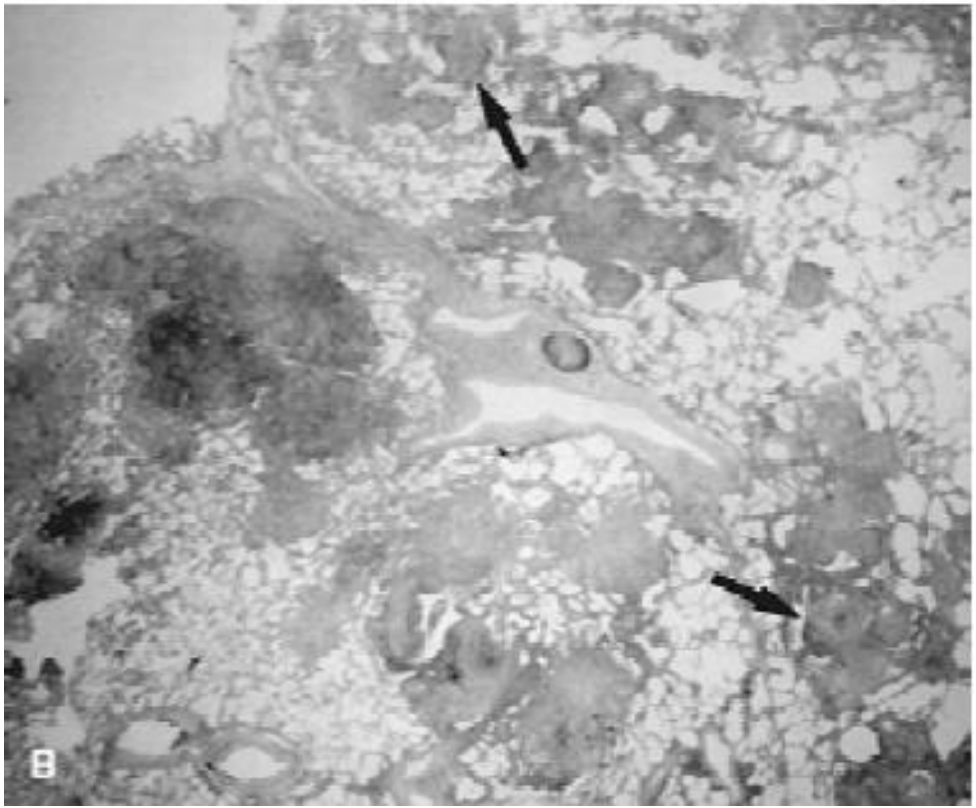


J Comput Assist Tomogr. 2000 Sep-Oct;24(5):691-8. https://radiopaedia.org/articles/centrilobular-lung-nodules-1

CT Image

Typical TB image

- 組織意義: granulomas of various sizes in the peribronchiolar interstitium (centrilobular) and in bronchiolar lumens (branching linear)



J Comput Assist Tomogr. 2000 Sep-Oct;24(5):691-8.

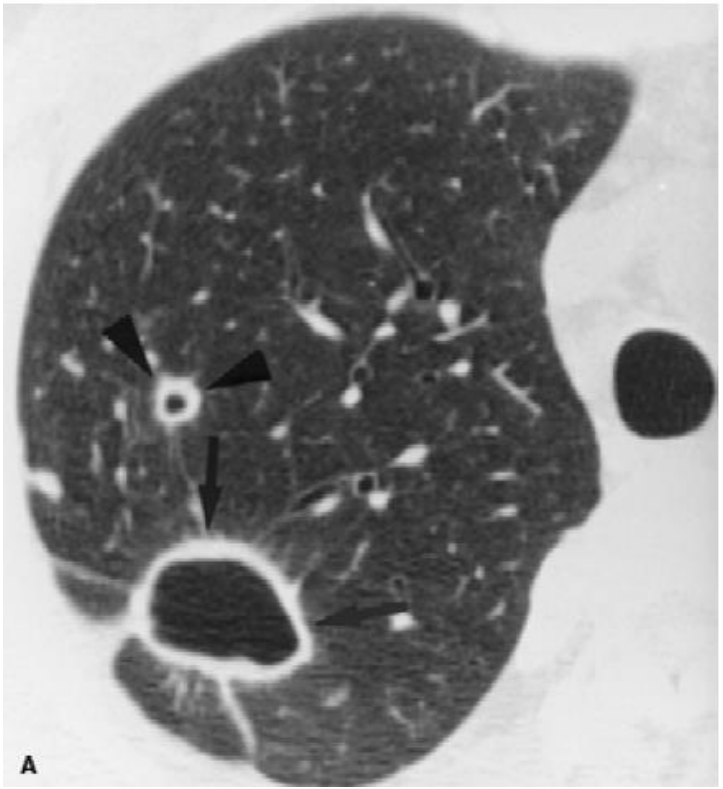
CT Image

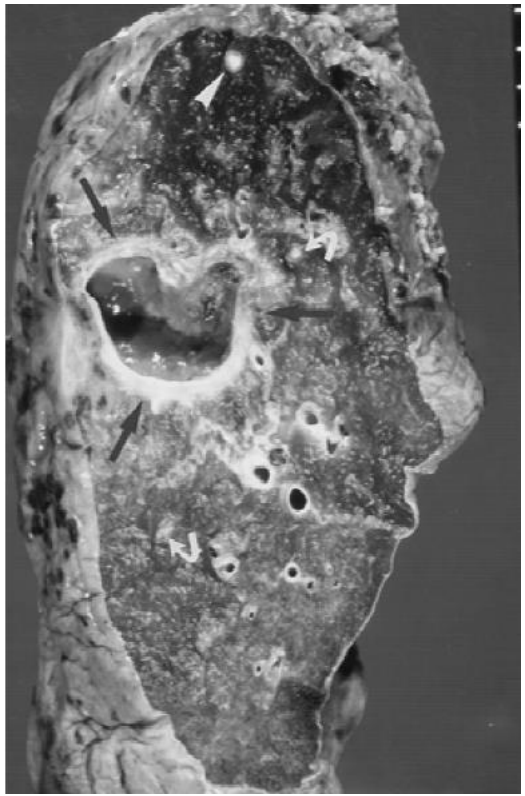
Typical TB image

- cavitation

  (thin walled)

- Satellite lesion (granulomas)



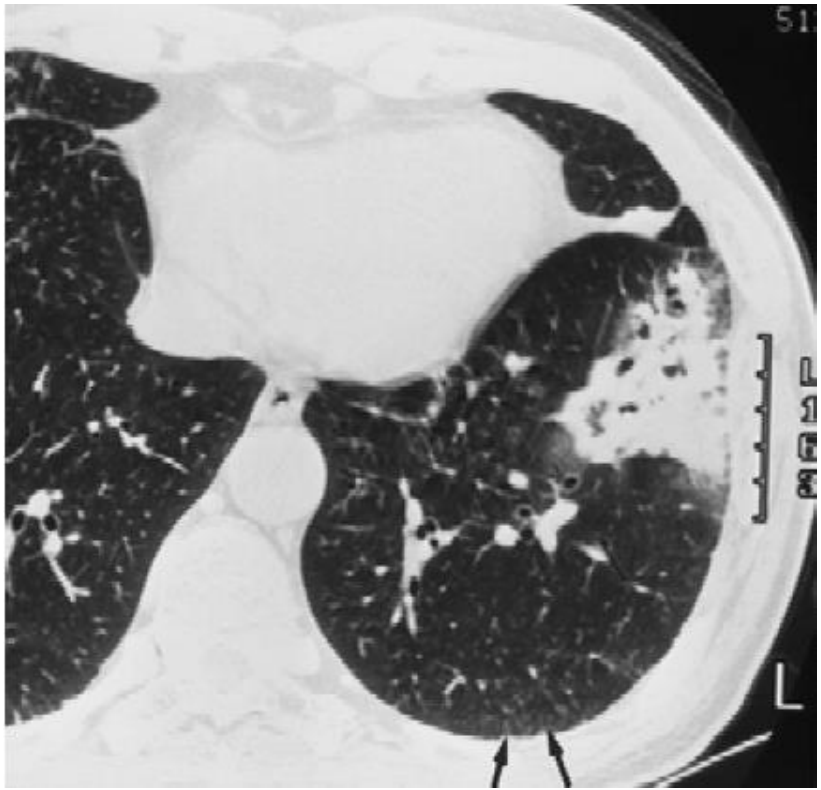


J Comput Assist Tomogr. 2000 Sep-Oct;24(5):691-8.

CT Image

Typical TB image

- **discharge of caseous material** containing tubercle bacilli (from caseous lymph nodes or tuberculous cavities) **into a large airway**

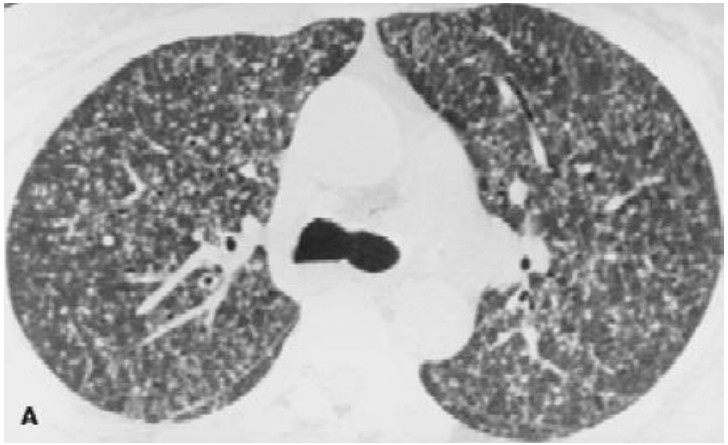


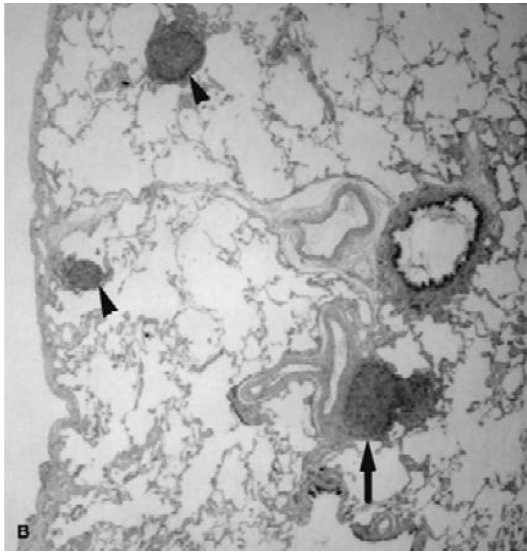
J Comput Assist Tomogr. 2000 Sep-Oct;24(5):691-8.

CT Image

Typical TB image

- Miliary tuberculosis
- 組織意義: granulomas **along arteriole and in alveolar walls**





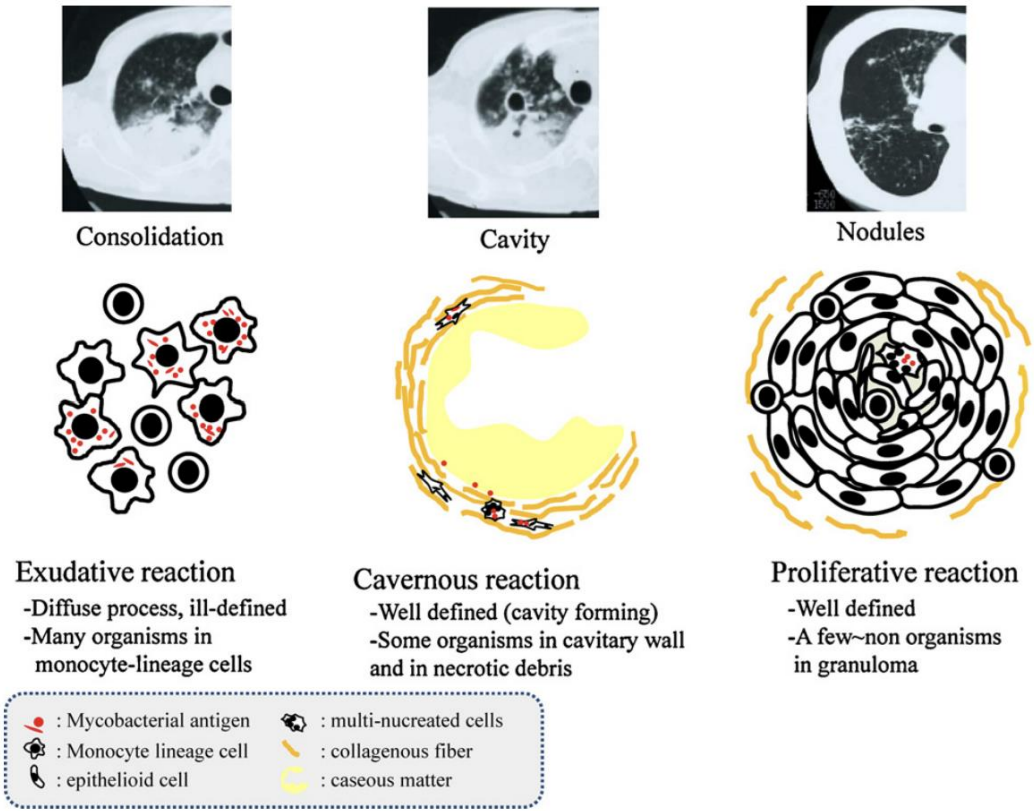
J Comput Assist Tomogr. 2000 Sep-Oct;24(5):691-8.

NTM, very similar with pulmonary TB, also with other features

Image findings	**Histological findings**
Consolidation	**Exudative reaction** (diffuse inflammatory process, numerous mycobacteria in monocyte-lineage cells); **Proliferative reaction**
Cavity	Caseous necrosis resulting from exudative reaction or from proliferative reaction
Nodule	With or without caseous necrosis
Bronchiectasis	Proliferative reaction under intact epithelial layer

Pathol Res Pract. 2012 Jan 15;208(1):53-8.

NTM, very similar with pulmonary TB, also with other features



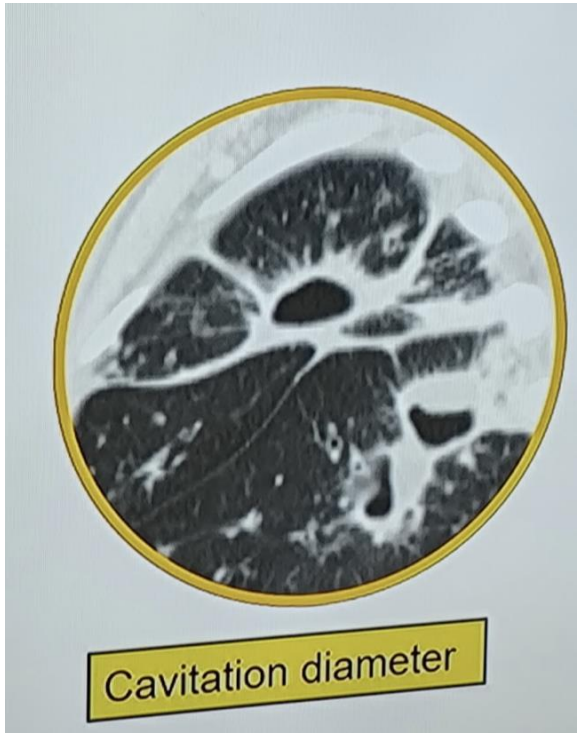
Pathol Res Pract. 2012 Jan 15;208(1):53-8.

NTM, very similar with pulmonary TB, also with other features

Image findings	Mycobacterial antigens/bacteria load
Consolidation	90%
Cavity	60%
Nodule	10-70%
Bronchiectasis	10%

Pathol Res Pract. 2012 Jan 15;208(1):53-8.

NTM, unfavorable prognosis (may prompt treatment)



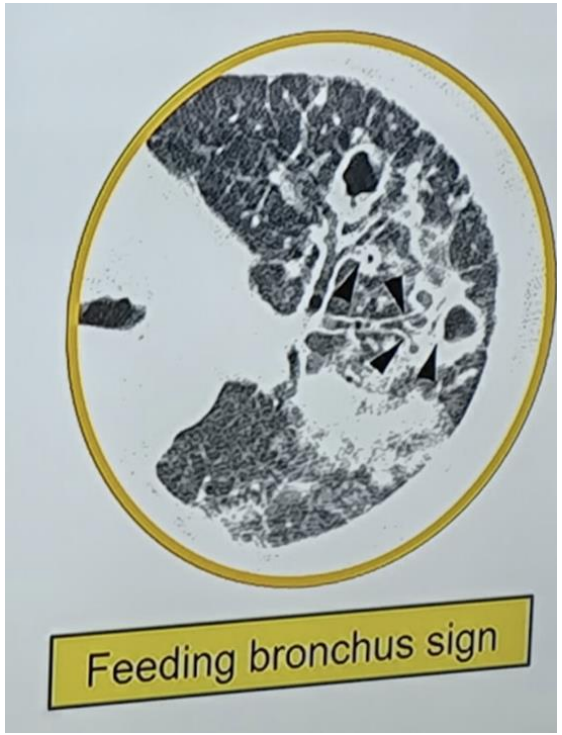
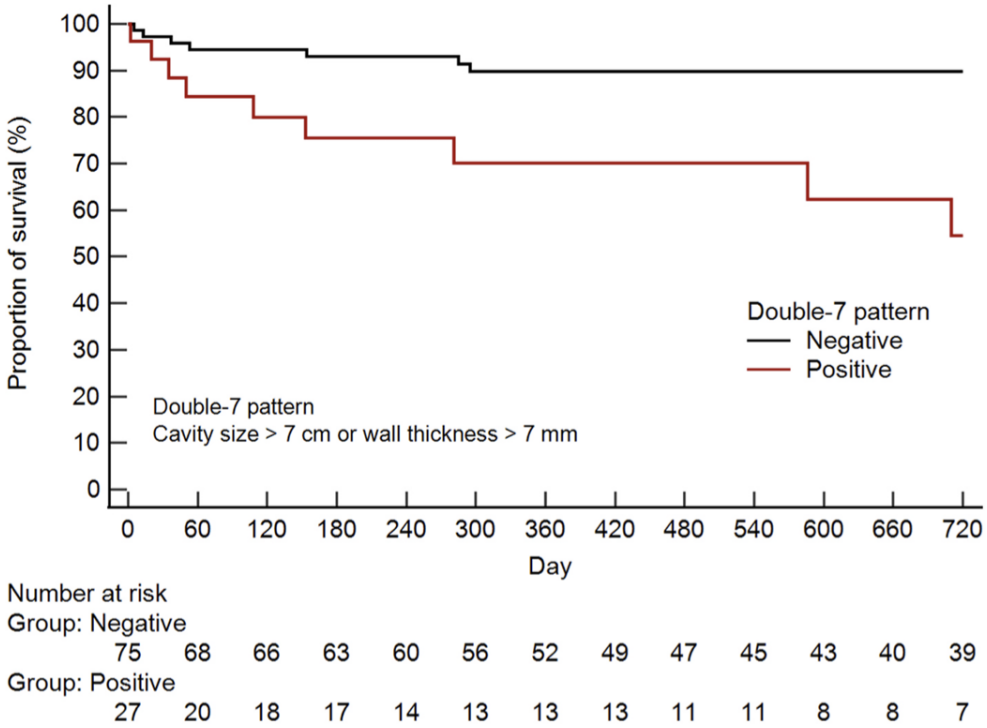


Image from 江品儀醫師新竹台大演講

NTM, wall thickness, larger/thicker=> unfavorable outcome

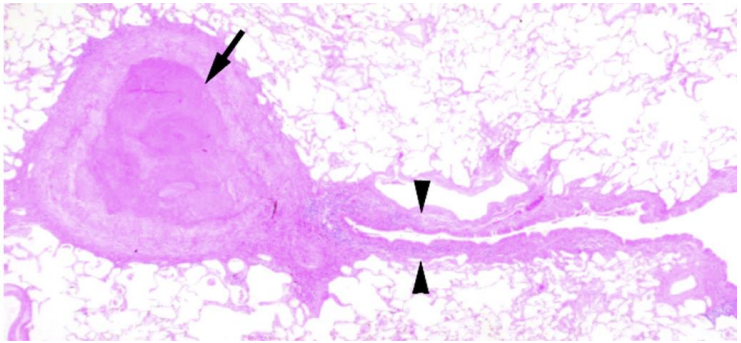
Cavitary size 7cm and 7mm wall thickness (Double-7 cavitary image pattern) => unfavorable outcome

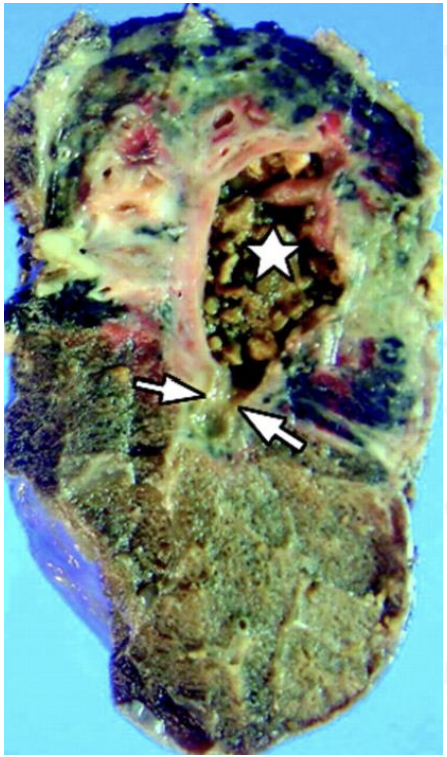


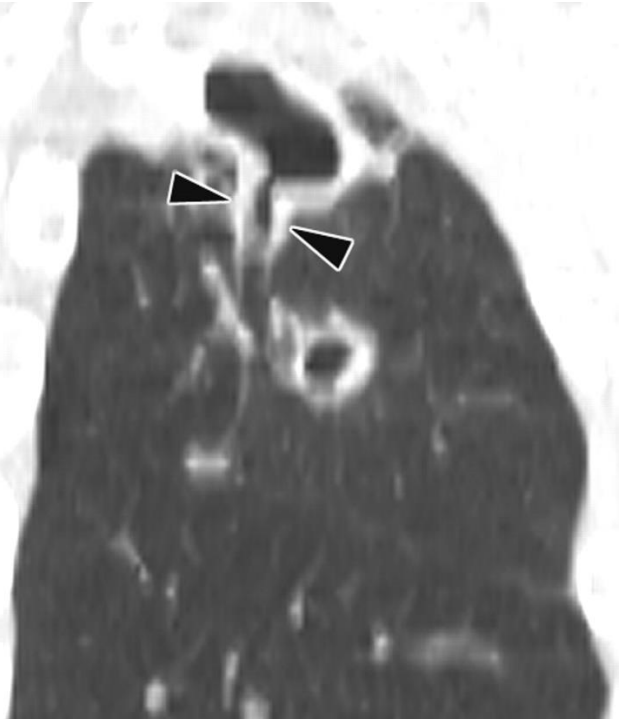
J of Microbiol Immunol Infec.2025Oct;58(5):593-599.

NTM, feeding bronchus sign

Segmental destruction of bronchi forming necrotic cavities or focal cystic bronchiectasis

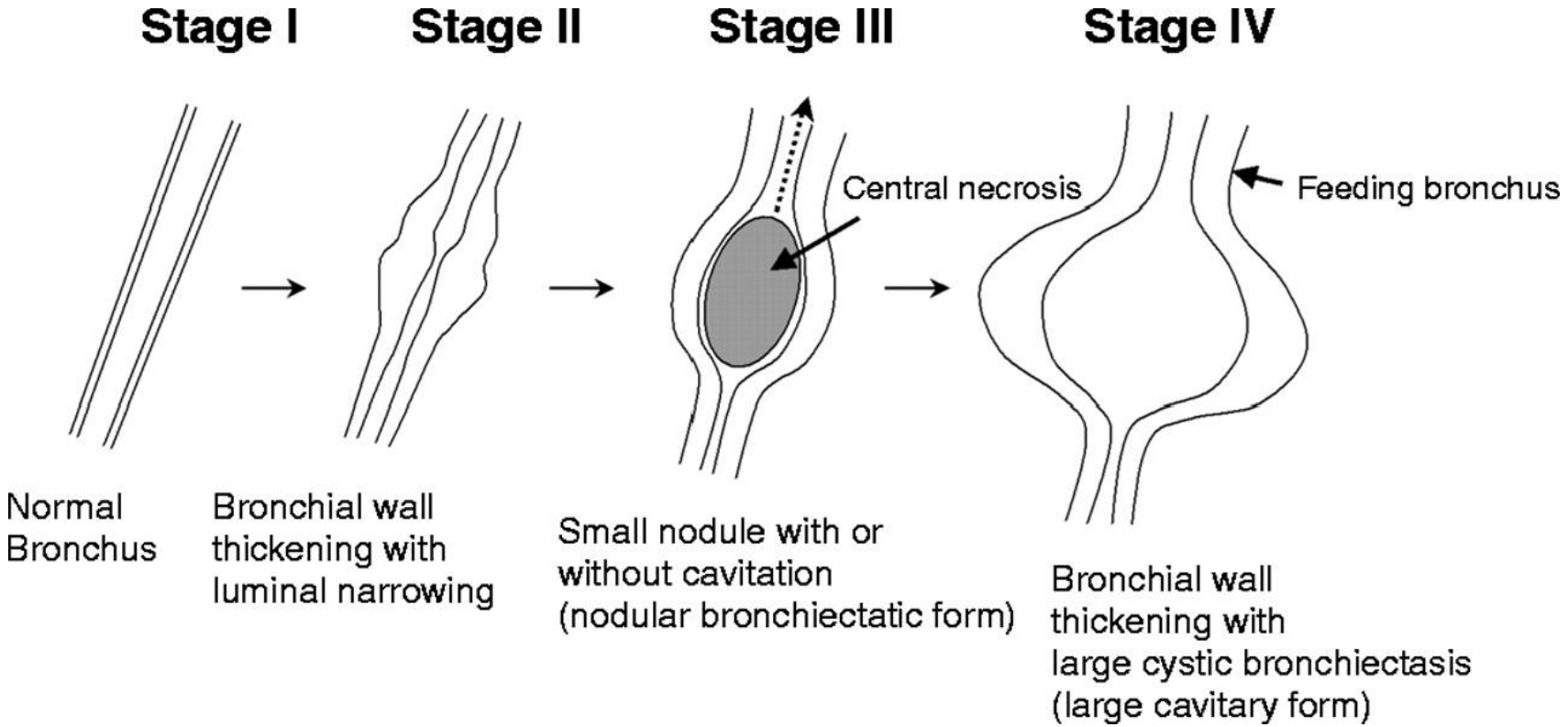






AJR Am J Roentgenol. 2005 Apr;184(4):1247-52.

NTM, feeding bronchus sign, unfavorable outcome



AJR Am J Roentgenol. 2005 Apr;184(4):1247-52.

NTM, cavity with adjacent consolidations=> unfavorable outcome

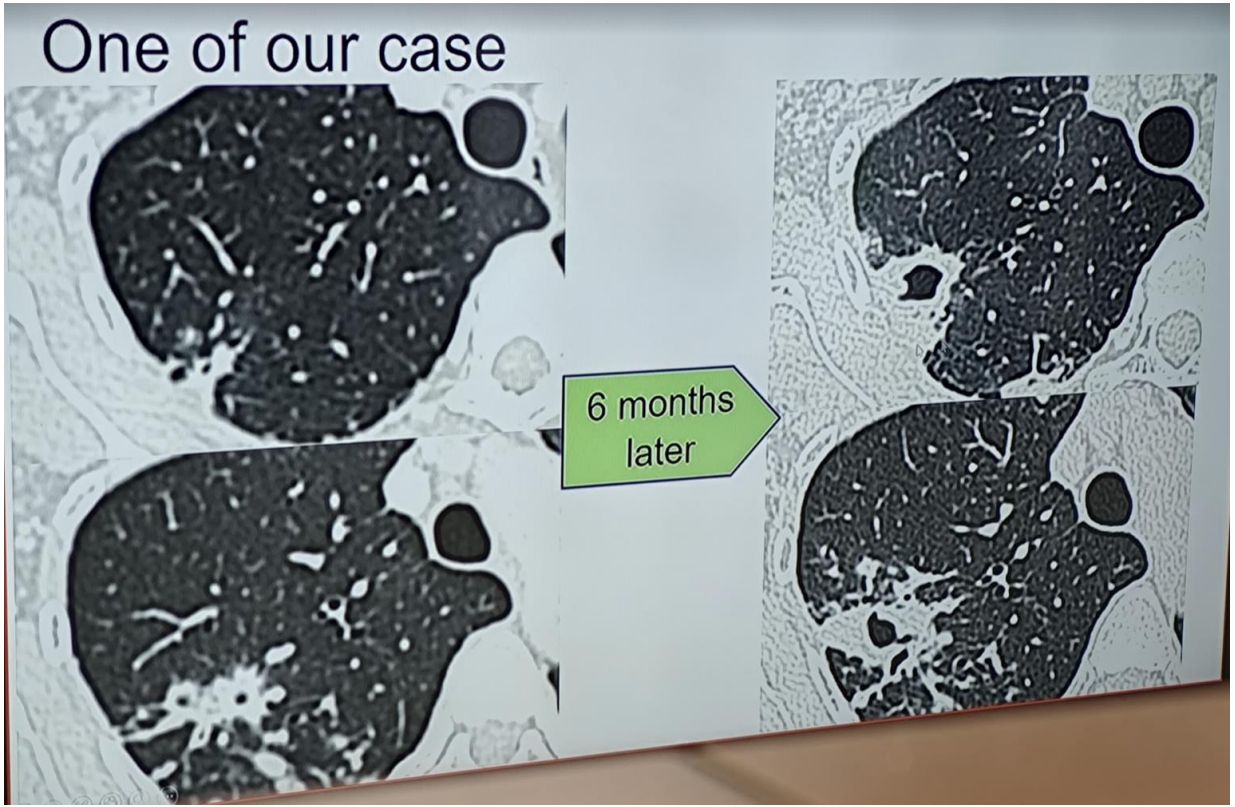


Image from 江品儀醫師新竹台大演講

Infectious disease

- Pulmonary tuberculosis/NTM
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- Chronic pulmonary aspergillosis

Airway disease

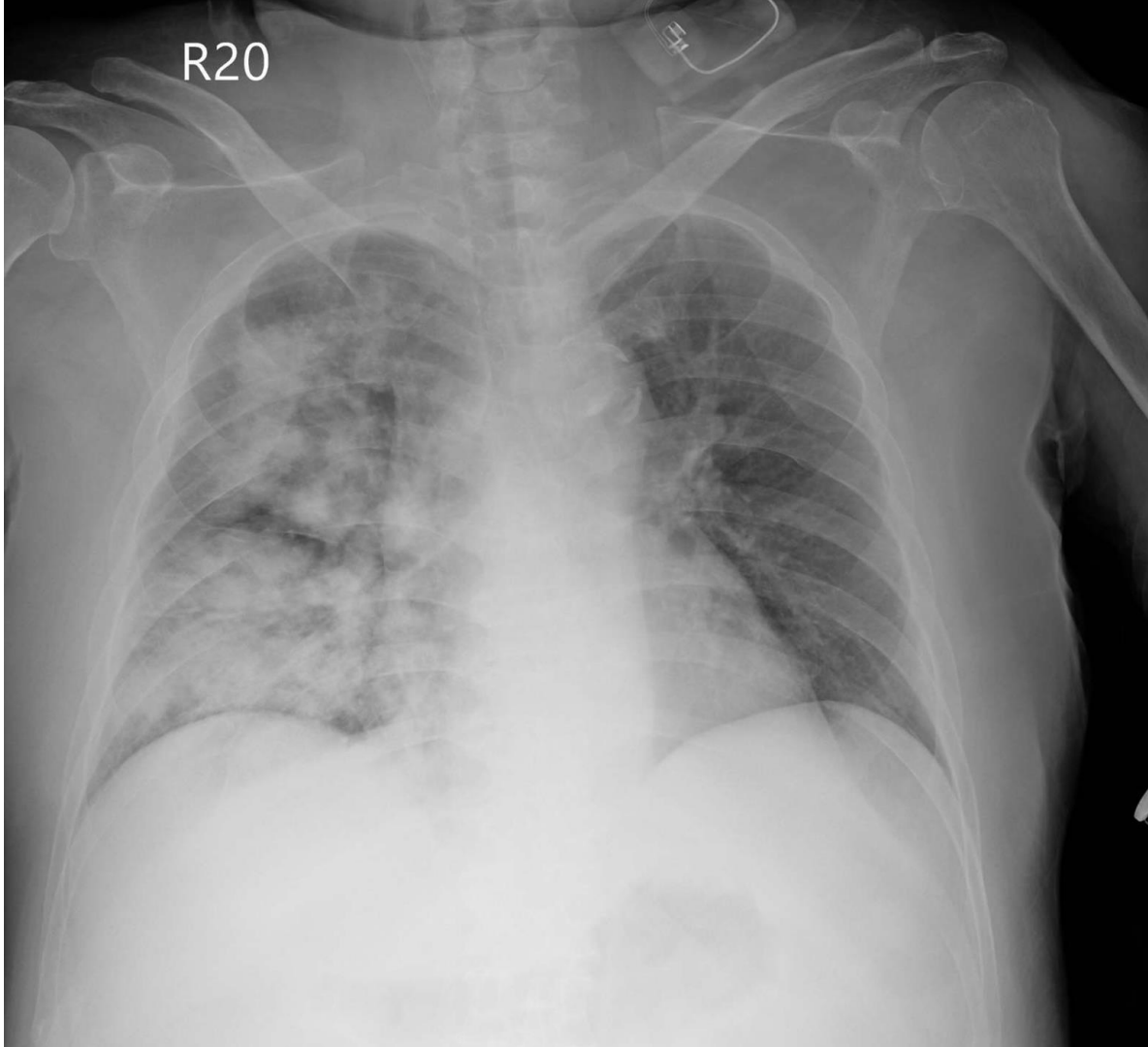
- COPD
- Bronchiectasis

Influenza

68M

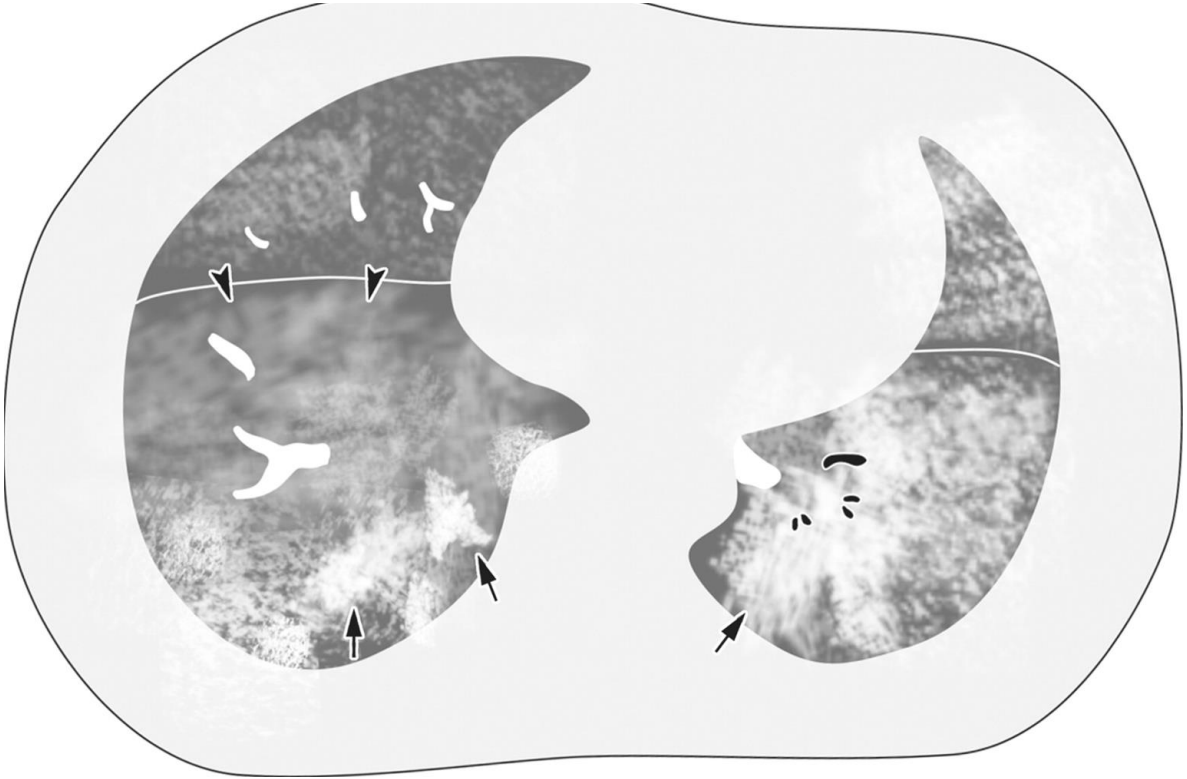
Striking fever, sweating

chest pain



Influenza

Multiple irregular areas of consolidation (arrows) along the bronchovascular bundles and diffuse GGO (arrowheads) with interlobular septal thickening in both lungs



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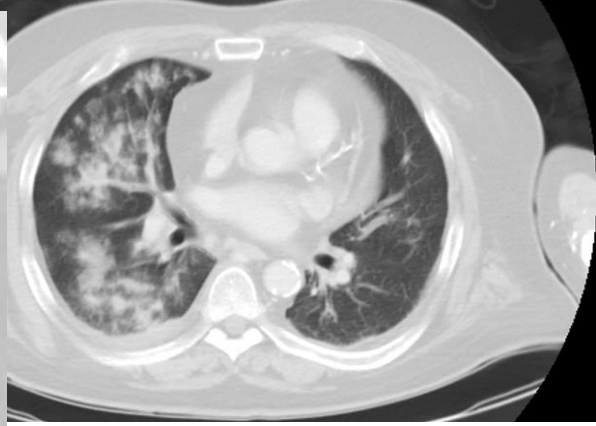
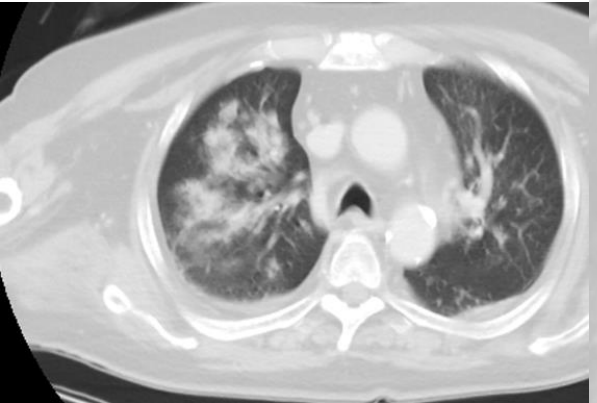
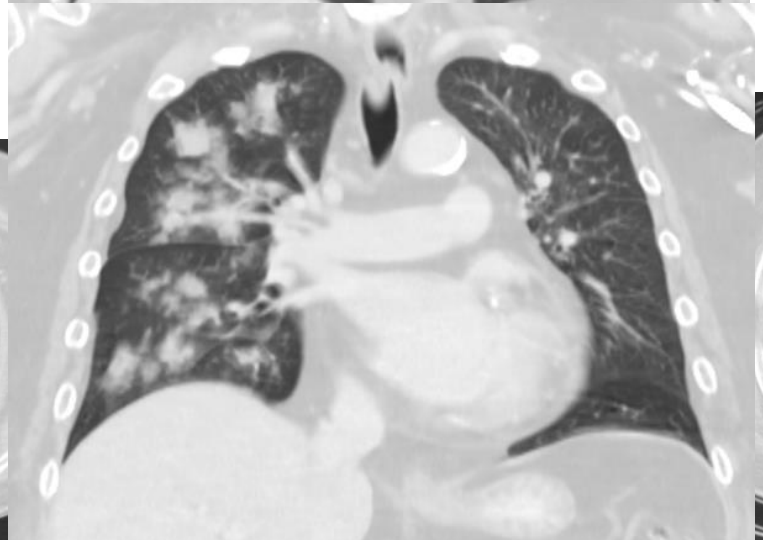
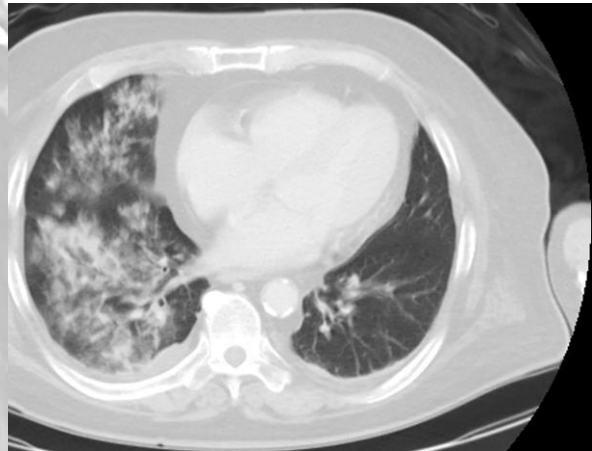
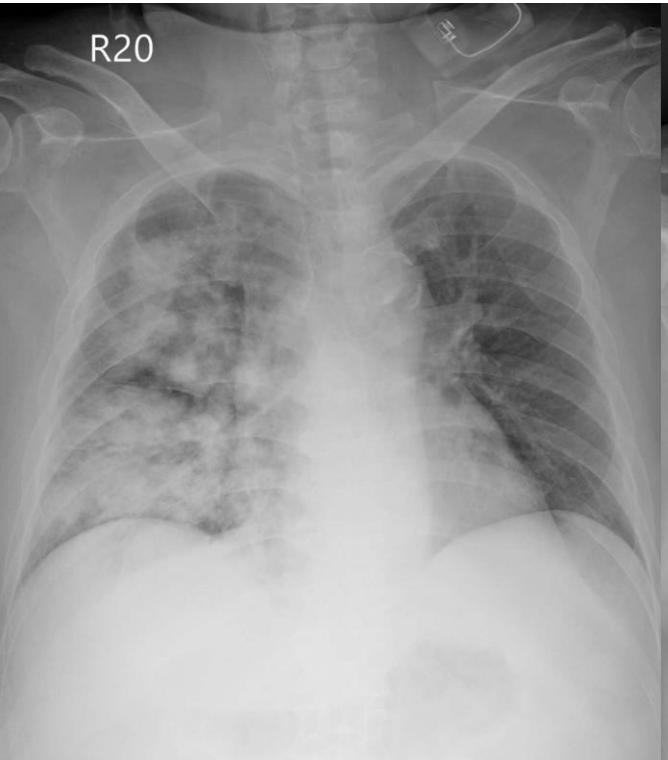





Influenza Pneumonia s/p Tamiflu

D1



D3

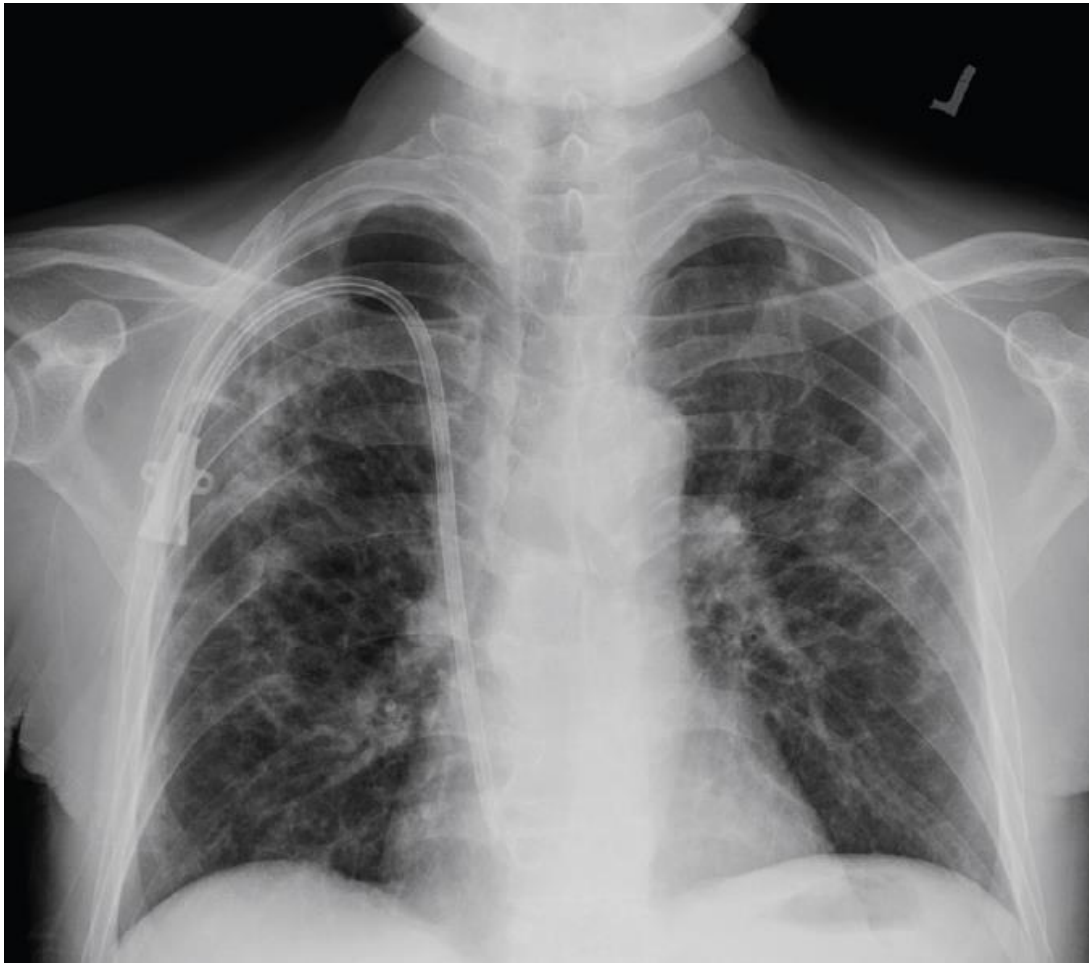
D5

CMV pneumonia

70M under iHD

Fever

Bilateral ill defined GGO



Thorac Med 2021. Vol. 36 No. 1

CMV pneumonia

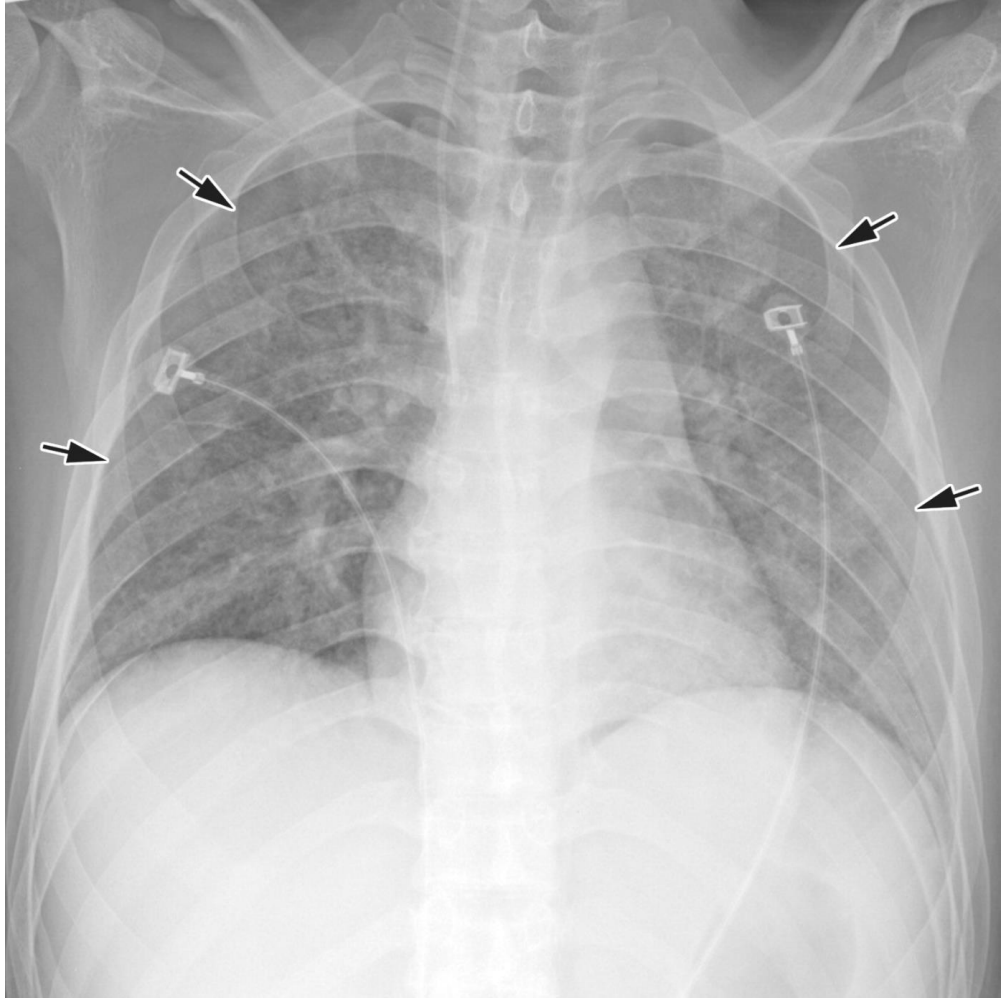
interlobular septal thickening over bilateral lung fields

Immunocompromised host

Thorac Med 2021. Vol. 36 No. 1

CMV pneumonia

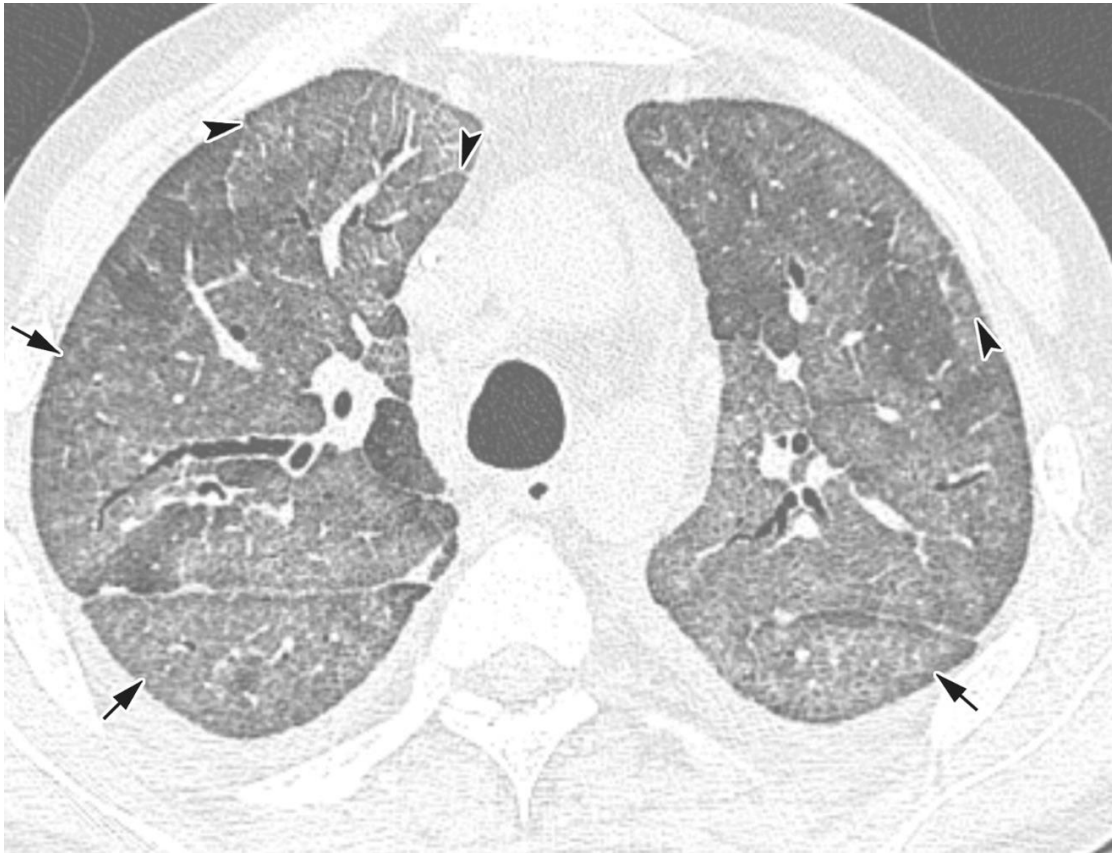
Diffuse illdefined GGO over bilateral lung fields



Radiographics 2018, Volume 38, No.3

CMV pneumonia

ill-defined GGO nodules, interlobular septal thickening (arrowheads), and diffuse GGO (arrows) in both lungs



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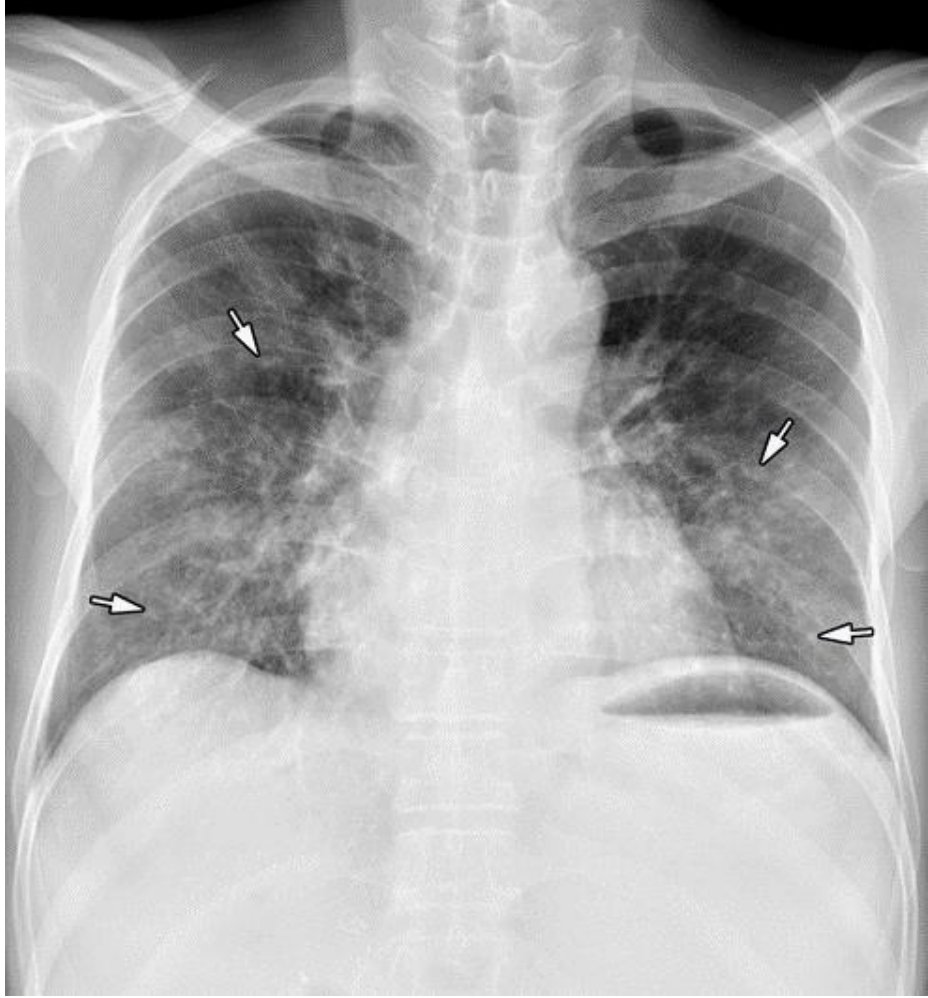
Varicella-zoster virus

53-year-old man who underwent liver transplantation 5 months before contracting the disease

multifocal reticulonodular infiltrations (arrows) in both lungs



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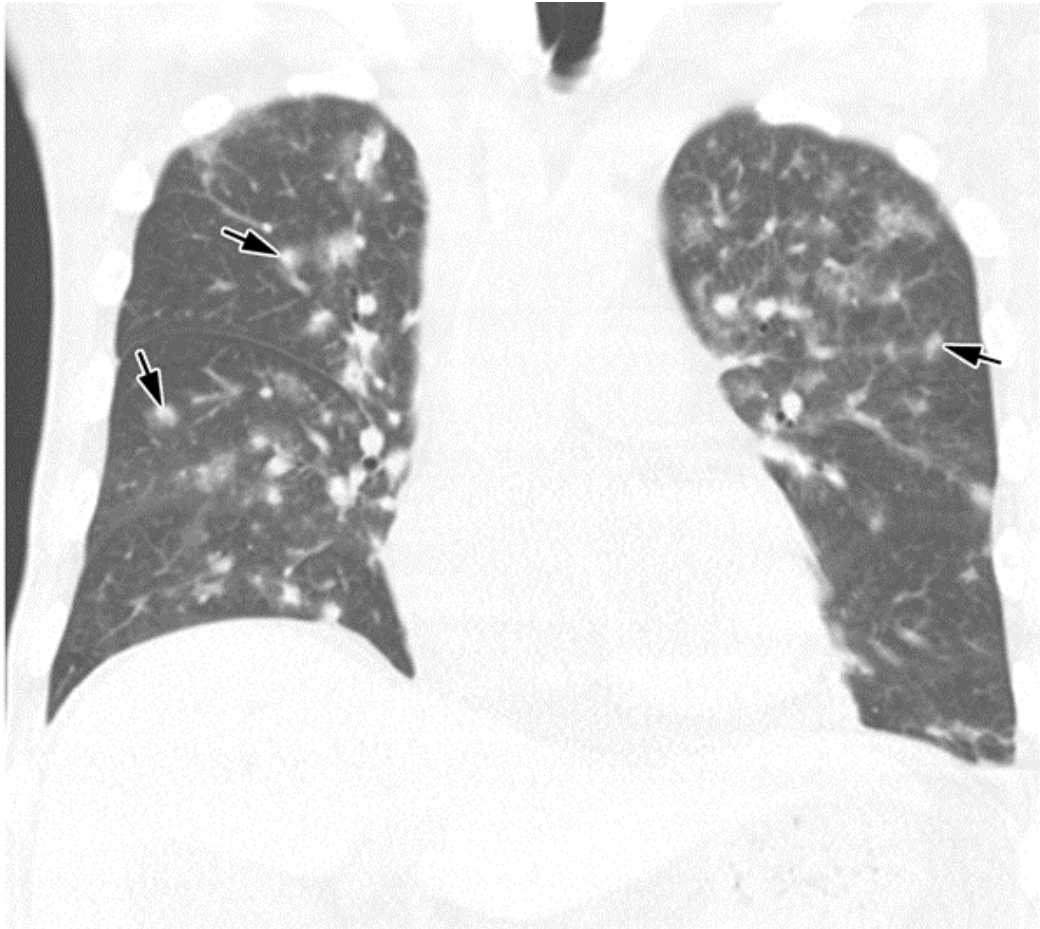
Varicella-zoster virus

Multifocal ill-defined small areas of nodular opacity (arrows) with the **GGO halo sign** in both lungs



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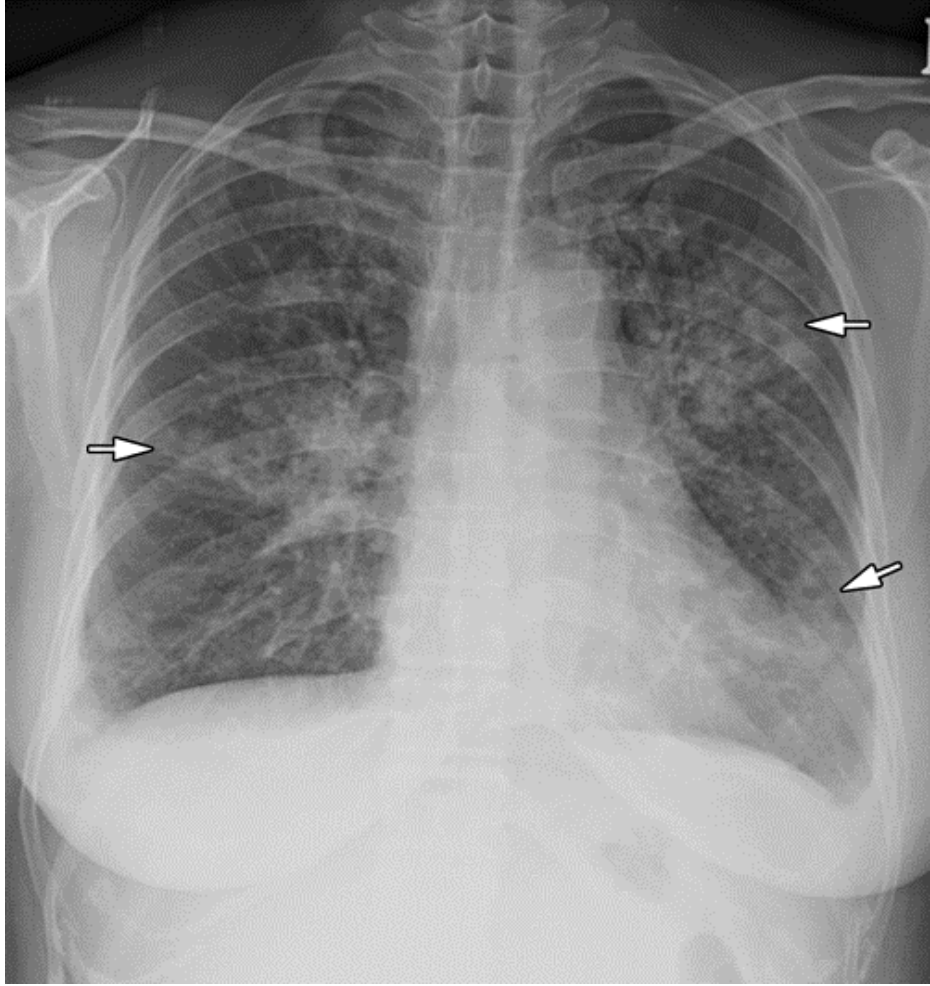
RSV pneumonia

58F acute myeloid leukemia who presented with fever

multiple irregular nodular peribronchial air spaces or GGO (arrows) in both lungs and a small amount of bilateral pleural effusion

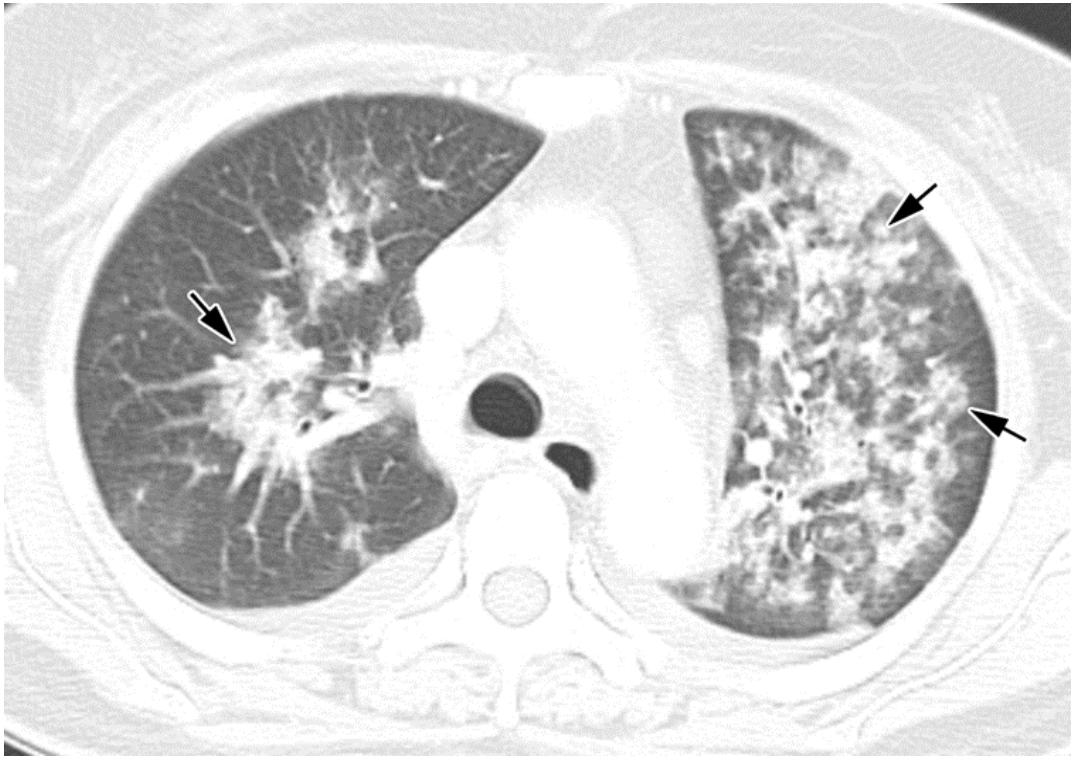


Radiographics 2018, Volume 38, No.3

RSV pneumonia

58F acute myeloid leukemia who presented with fever

multiple irregular areas of nodular tree-in-bud opacity and **patchy consolidations** (arrows) along the bronchovascular bundles and mild bronchial wall thickening



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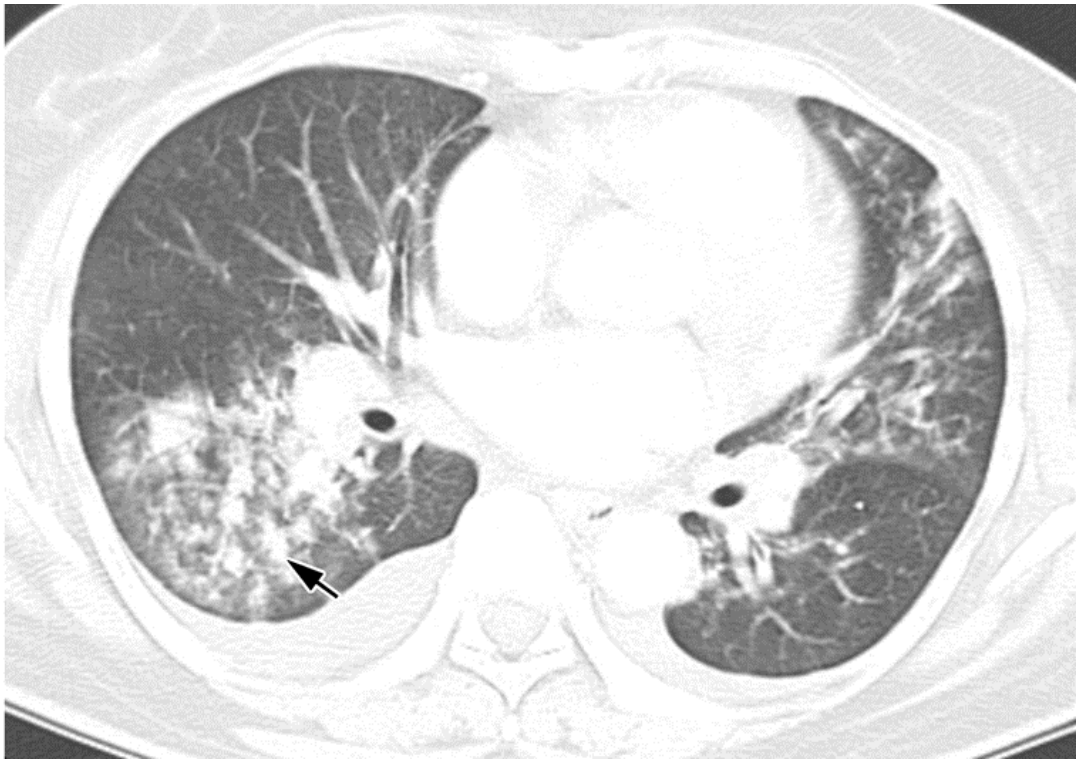

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Infectious disease

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- Pneumocystis jirovecii
- Chronic pulmonary aspergillosis

Airway disease

- COPD
- Bronchiectasis

Cryptococcal pneumonia

46F autoimmune thyroiditis

Fever, with persisted left lower lung pneumonia, no response to curam and azithromycin

Serum Cryptococcus Ag: 1:2 (+)

Cryptococcal pneumonia

Pathology: yeast like fungal organism showing thick cell wall

Repeat serum Cryptococcus Ag 1:2 positive

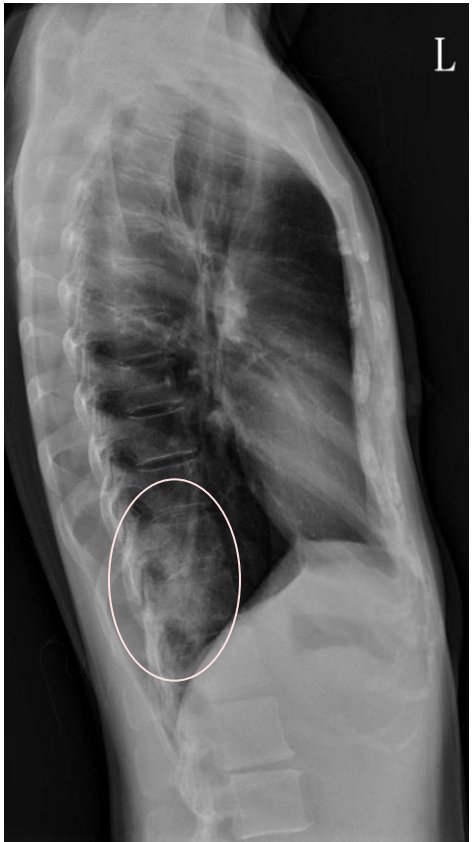
BAL Cryptococcus Ag (-)

Cryptococcal pneumonia

Complete 6 months fluconazole treatment

Cryptococcus Ag turned negative at 3th month

Before treatment



After treatment

Cryptococcal pneumonia

55M Physician of family medicine

Cough

RUL mass lesion with cavity formation

Cryptococcal pneumonia

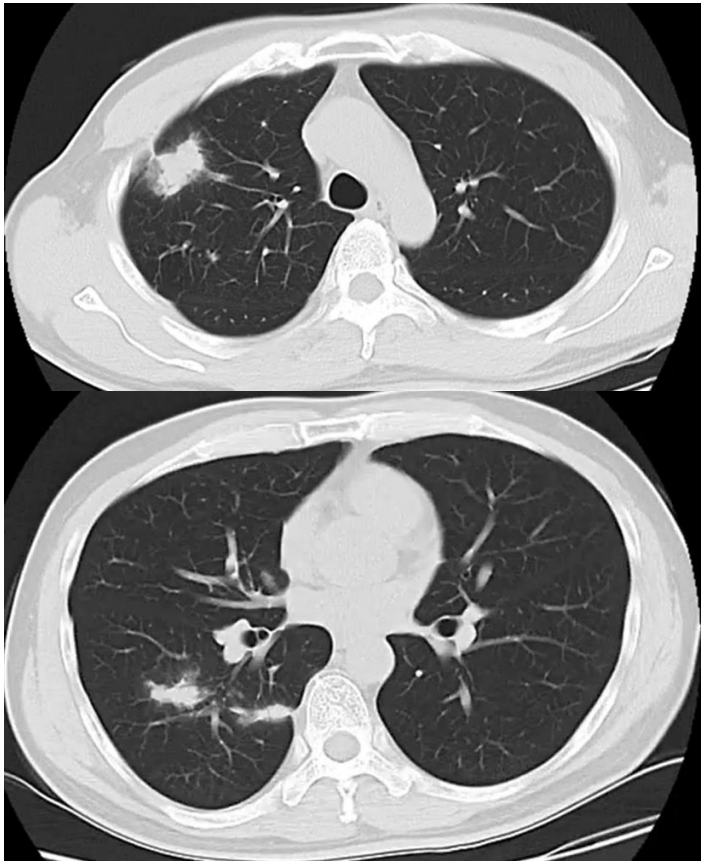
Multiple consolidations over right lung fields

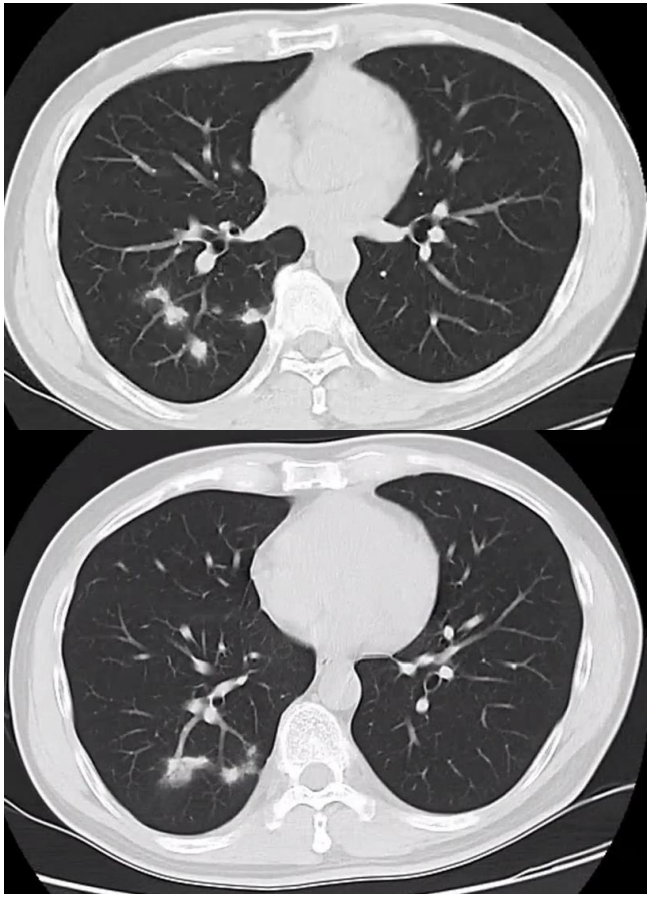
Pathology: Granulomatous inflammation with cryptococcus like microorganisms

Serum Cryptococcus Ag 1:80 (+)

BAL Cryptococcus Ag 1:10 (+)

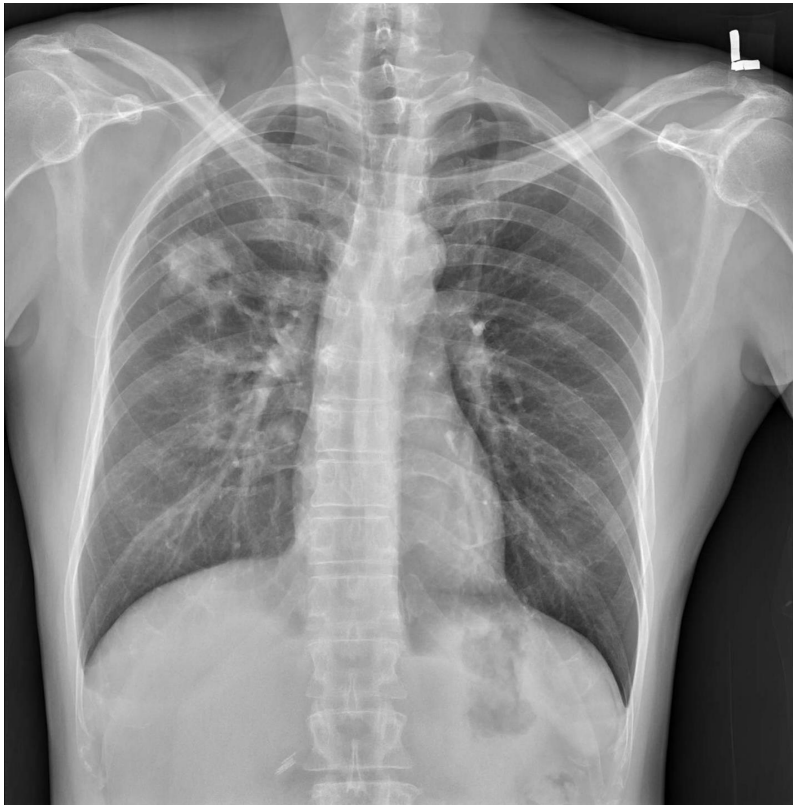
Cryptococcal pneumonia





Cryptococcal pneumonia

Before



After fluconazole 6 months

Cryptococcal pneumonia

Great mimiker

- clustered nodular pattern: most prevalent
- solitary pulmonary nodule or mass with or without cavitation
- scattered nodules
- peribronchovascular consolidation

BJR case reports. 2017 Jan 5;3(2):20150358.

Infectious disease

- Pulmonary tuberculosis
- Pulmonary viral pneumonia
- Pulmonary cryptococococosis
- Pneumocystis jirovecii
- Chronic pulmonary aspergillosis

Airway disease

- COPD
- Bronchiectasis

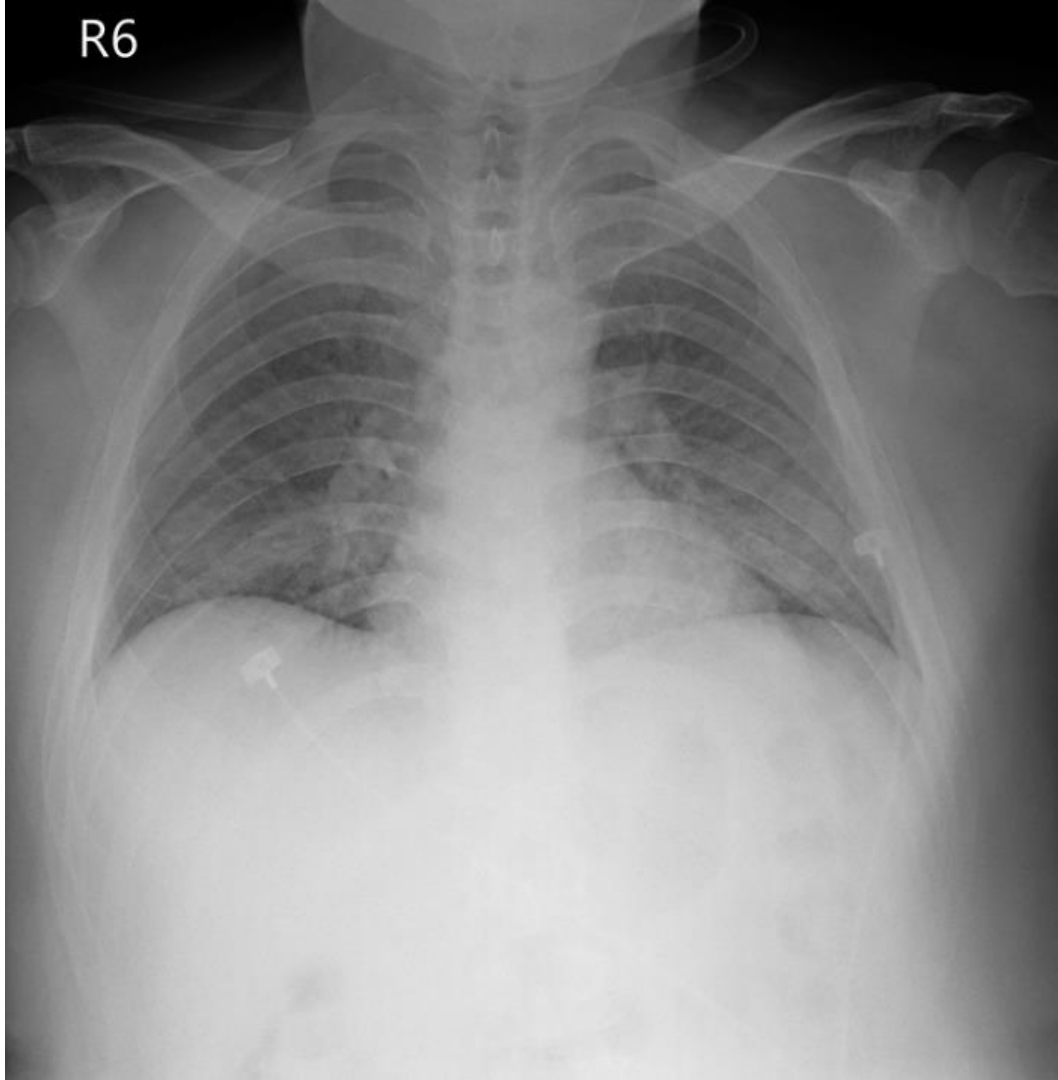
PJP

34M 詐欺犯曾被關，single(曾有過女友)

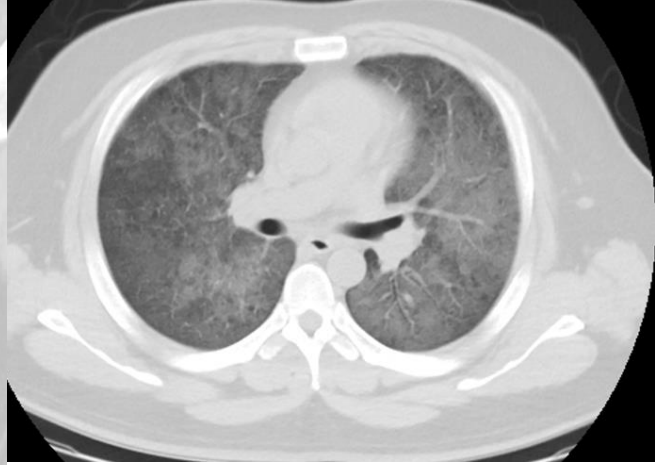
denied underlying disease

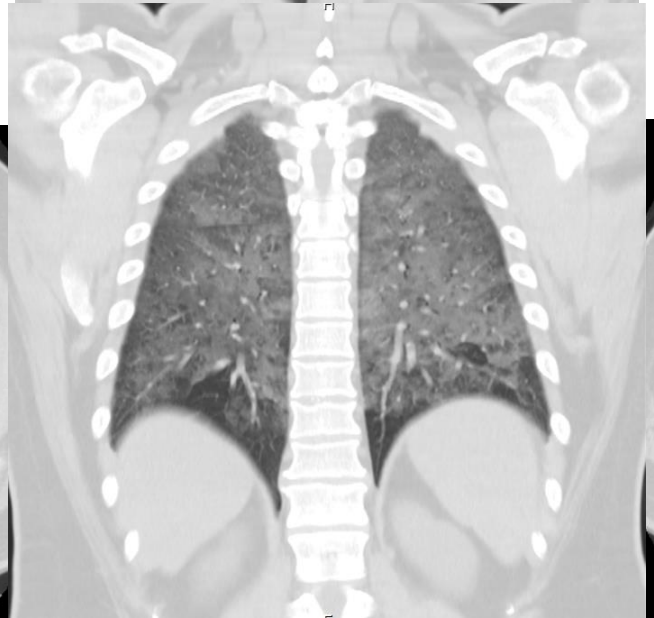
dyspnea on exertion for two weeks, worsen these days

OPD medication: ampicillin, methylprednisolone 4mg BID










PJP

HIV(+)

科室:WM No:260601011094 SPUTUM (EXPECTORATED) 採檢:2026/06/01 08:37 登入:2(

檢驗項目	檢驗值	單位	參考值
Pneumocystis jirovecii DNA PCR	207460	copies/mL	Undetectable。 (備註：本項檢驗屬定量PCR，敏感度1000 copies/mL，分析測量範圍1000-5000000 copies/mL)
DHPS genotype	Wildtype	*	Wildtype

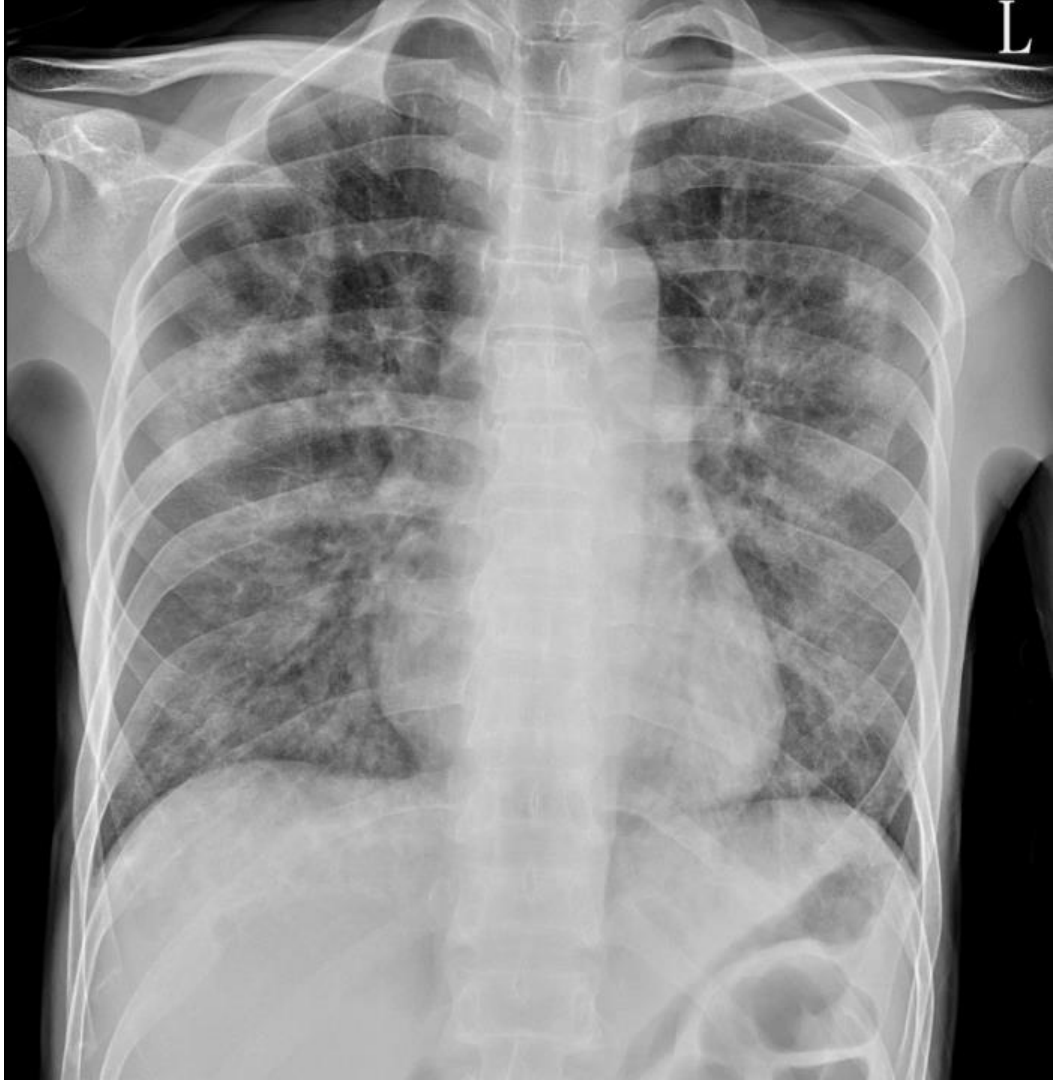
科室:LB No:260603000107 BLOOD 採檢:2026/06/03 05:15 登入:2026/06/03 08:45 最後

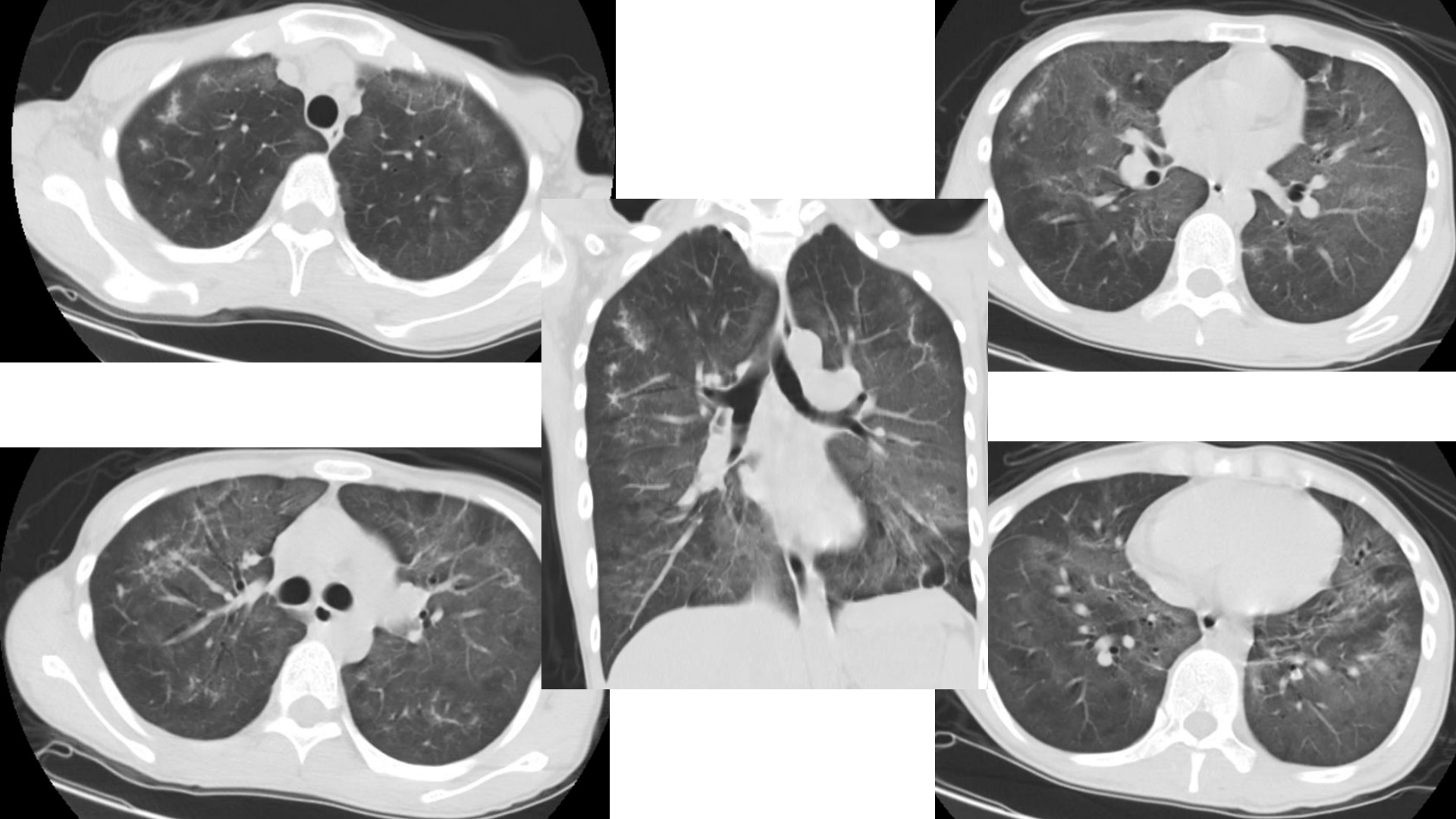
檢驗項目	檢驗值	單位	參考值
Rapid HIV PCR	480000	cp/mL	Undetectable

PJP

29M Single, with boy friend

Dyspnea and cough





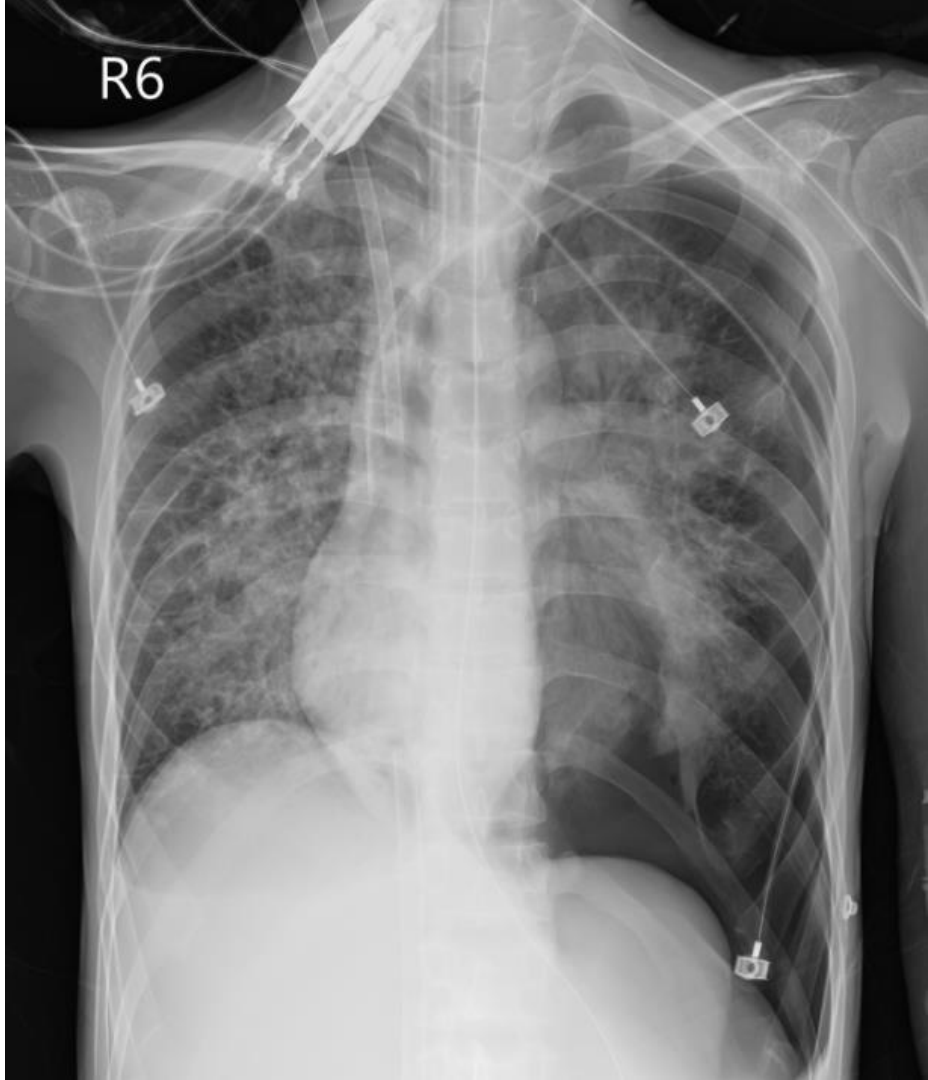
PJP

	Pneumocystis jirovecii DNA PCR (copies/mL)	DHPS genotype(*)
2026/03/20 03:20	126087	Wildtype

HIV Viral Load (cp/mL)
1770000

Bronchial wash

	CMV viral load(IU/mL)
2026/03/19 13:21	50000
2026/03/25 14:52	150000



Pneumothorax, common complication in HIV associated PJP, 5-10%

Infectious disease

- Pulmonary tuberculosis
- Pulmonary viral pneumonia
- Pulmonary cryptococococosis
- Pneumocystis jirovecii
- Aspergillosis

Airway disease

- COPD
- Bronchiectasis

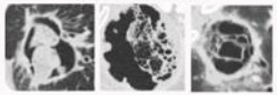
Pulmonary aspergillosis

Different forms

- Invasive aspergillosis (IA)
  - Angio-invasive
  - Airway-invasive
- Allergic broncho-pulmonary aspergillosis (ABPA)
- Chronic pulmonary aspergillosis (CPA)
  - Simple aspergilloma
  - Chronic cavitary pulmonary aspergillosis (CCPA)
  - Chronic fibrosing pulmonary aspergillosis (CFPA)
  - Aspergillus nodule
  - Subacute invasive pulmonary aspergillosis (SAIA), aka chronic necrotising / semi-invasive aspergillosis

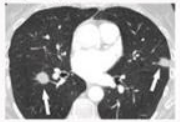
CPA examples

Aspergilloma

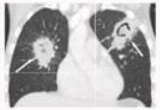


CCPA

Aspergillus nodules

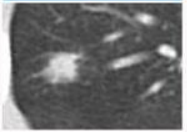


SAIA

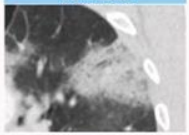


CT findings in IA

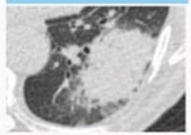
Nodules with halo sign



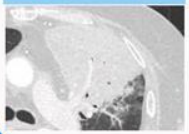
Wedge shaped infiltration



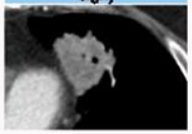
Mass like infiltration



Consolidation



Necrosis (hypodense sign)



Cavitation (with air-crescent sign)

Making the diagnosis: IA

Risk factors

- Chemotherapy
- Prolonged and high-dose corticosteroid therapy
- Prolonged neutropenia
- Transplantation
- Haematological malignancy
- AIDS

- COPD

Fever of unknown origin

Clinical symptoms of lower respiratory tract infection

Unresponsive to broad spectrum antibiotics

HRCT – modality of choice

CTA, MRI

BAL (microscopy, culture), biopsy

Serological tests (galactomannan, B-D-glucan), PCR

CPA

Mild immunosuppression/ normal immune status + Underlying lung disease

CT/ MRI + Microscopy/culture/ immunological tests + Duration of symptoms

Pulmonary aspergillosis, allergic or infected?

69F CC: chronic cough with sputum, aggravated dyspea and cough in recent months, increased wheezing frequency since 2025

PH:

1. smoking (+): 0.5 ppd x 50+ yrs, quit since 2024-3
2. Asthma childhood
3. NPC s/p R/T

case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?

69F

- Intermittent AE with wheezing, s/p ICS/LABA and then ICS/LABA/LAMA, but with persisted chronic sputum production (culture: Pseudomonas)
- 2024 smoking cessation with improvement of cough, dyspnea

case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?

	Pre-Bronch			Post-Bronch		
	Pred	Actual	%Pred	Actual	%Pred	%Chng
--- SPIROMETRY ---						
FVC (L)	1.86	1.48	79	1.57	84	+6
FEV1 (L)	1.47	1.08	73	1.14	77	+5
FEV1/FVC (%)	82	73	89	73	88	+0
FEF 25-75% (L/sec)	2.28	0.77	33	0.94	41	+22
FEF 75-85% (L/sec)		0.23		0.28		+17
FEF 25% (L/sec)	4.52	2.33	51	3.03	67	+30
FEF 50% (L/sec)	3.01	0.94	31	1.31	43	+39
FEF 75% (L/sec)	0.42	0.35	84	0.35	83	+0
PEF (L/sec)	4.91	3.29	66	3.64	74	+10
Expiratory Time (sec)		6.82		6.89		+1

case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?

2024-11-1
Suspect scattered few tiny nodules

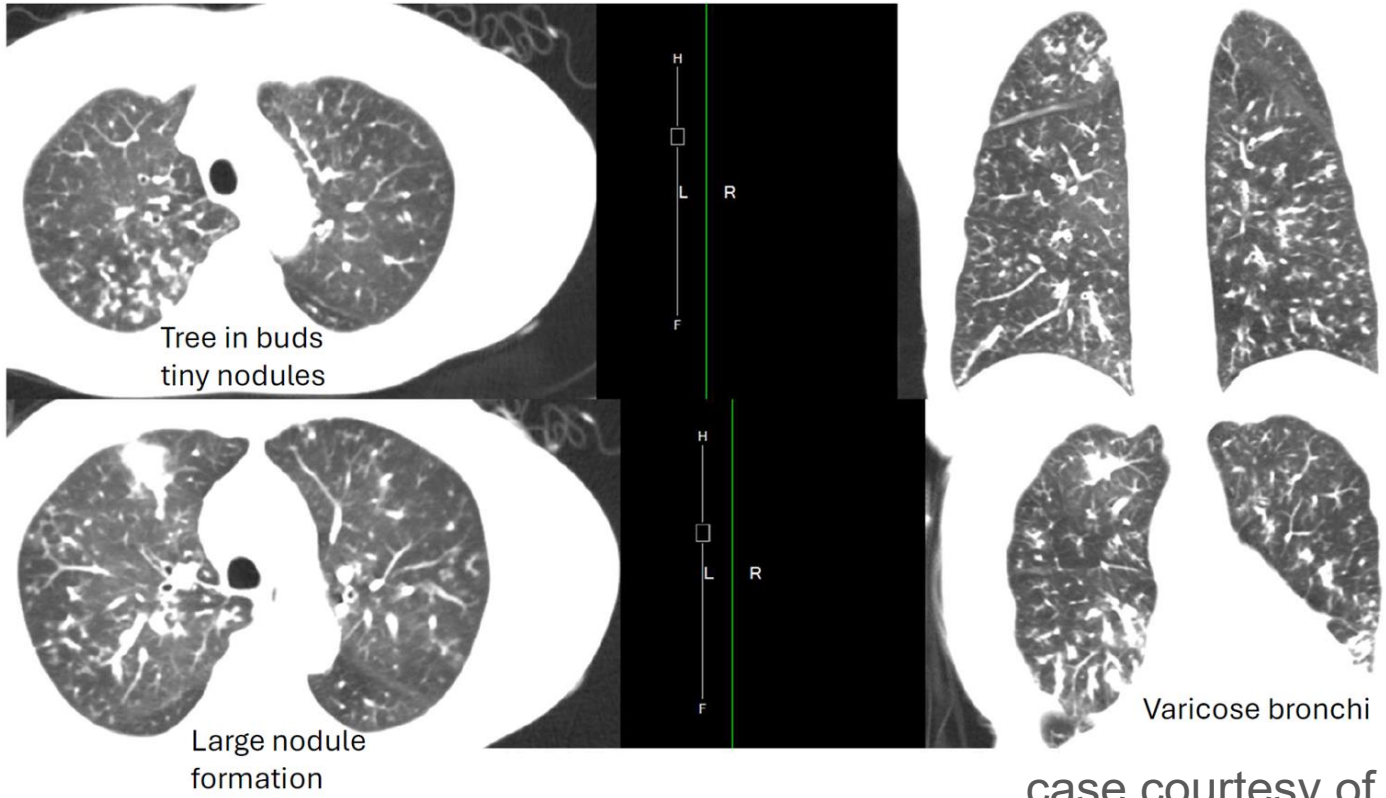
2025-2-1
Bil diffuse tiny nodules

2025-10-27

case courtesy of Dr. 張建仁

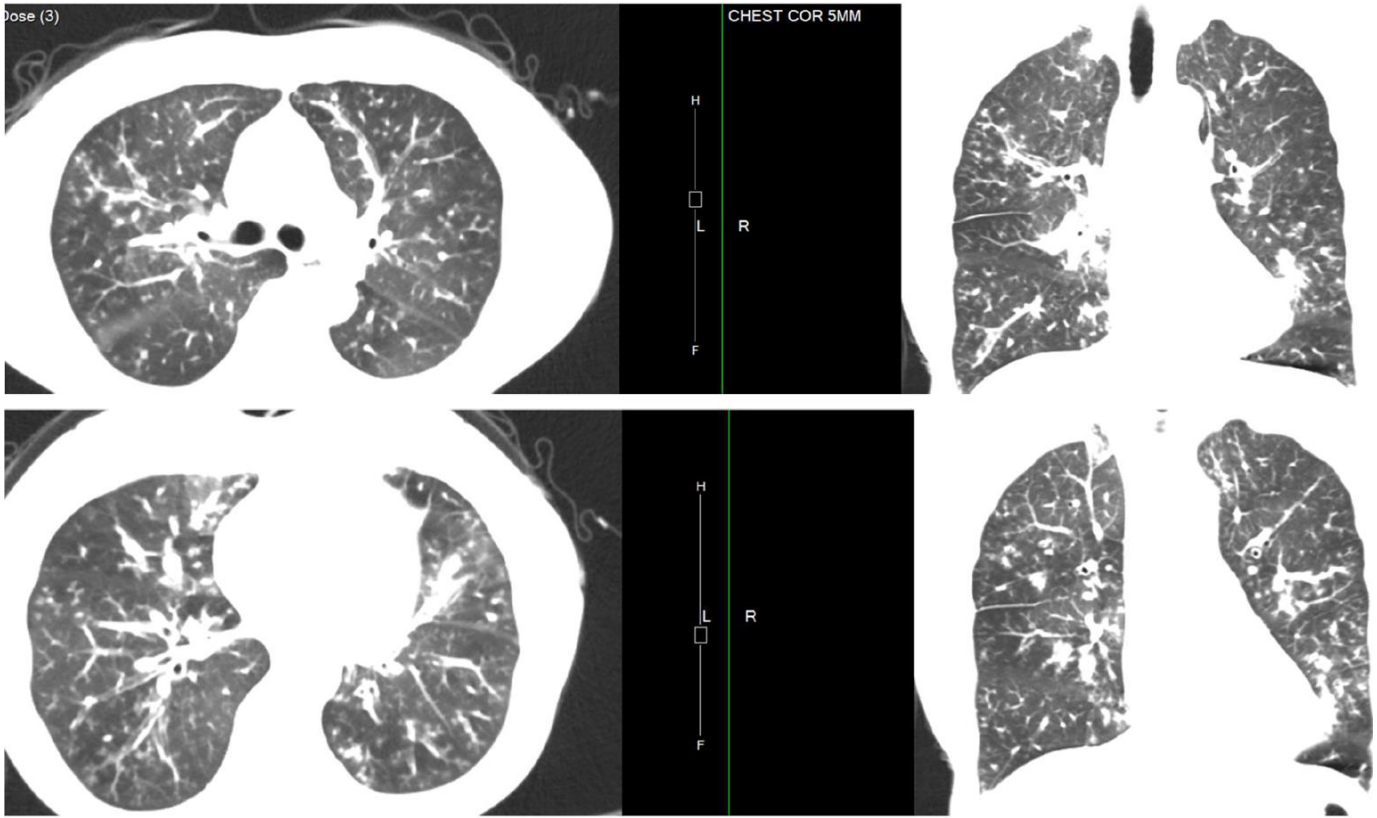
Pulmonary aspergillosis, allergic or infected?

2026-2 chest CT



case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?



case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?

Bronchial wash

- Aspergillus Ag(*): positive
- Aspergillus diff. PCR(*): Asp. fumigatus and Asp. terreus Detected
- Fungus culture: Aspergillus fumigatus, Aspergillus terreus
- TB: PCR(-), Culture: no growth
- Bacteria: • Acinetobacter species 2+

Blood

- Aspergillus Ag +
- Aspergillus niger IgG 120mg/L; Aspergillus fumigatus IgG >200mg/dL
- WBC: 11.94K; Eos: 33.5%, BEC: 3999cells/uL
- Total IgE >5000 IU/ml

case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?

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- Total IgE >5000 IU/ml

case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?

CPA?

- One or more pulmonary cavities +/- aspergilloma on CT imaging
- **Serological or microbiological evidence of Aspergillus (positive IgG antibody or culture/PCR from respiratory samples)**
- Exclusion of alternative diagnoses
- **Duration >=3 months of symptoms or radiological progression**

case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?

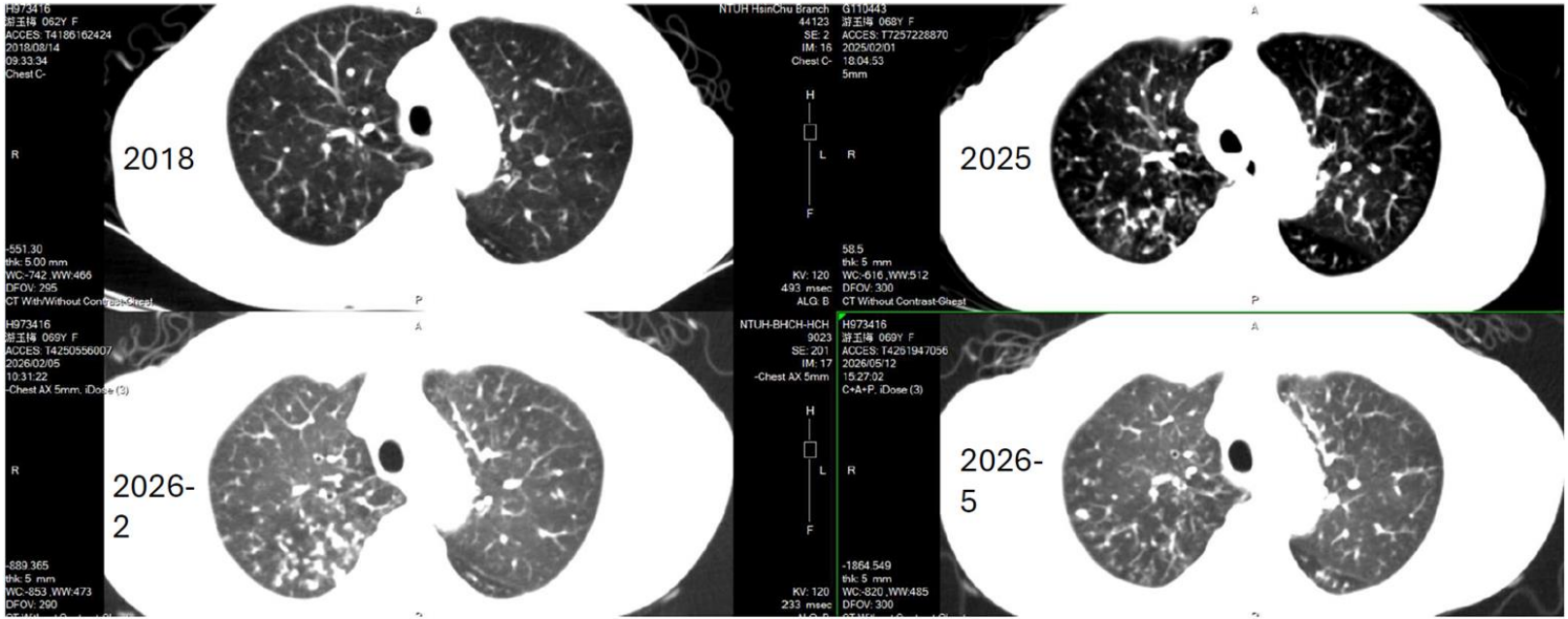
ABPA?

- Mandatory criteria:
  - Predisposing condition (**asthma** or CF)
  - A fumigatus sensitization (specific IgE > 0.35 KUA/L)
  - **Total IgE >=500 IU/ml**
- Plus 2 of the following:
  - **A fumigatus-specific IgG elevated**
  - **Peripheral eosinophil >= 500 cells/uL**
  - Suggestive imaging (**bronchiectasis**, mucus plugging, fleeting infiltrates)

case courtesy of Dr. 張建仁

Pulmonary aspergillosis, allergic or infected?

Before (2018, 2025, 2026-2) and After (2026-5), antifungal+ICS+OCS when attack



c/w chronic airway spreading(colonization ? Or invasion, infection) with response to antifungal treatment

case courtesy of Dr. 張建仁

Infectious disease

- Pulmonary tuberculosis
- Pulmonary viral pneumonia
- Pulmonary cryptococococosis
- Pneumocystis jirovecii
- Chronic pulmonary aspergillosis

Airway disease

- COPD
- Bronchiectasis

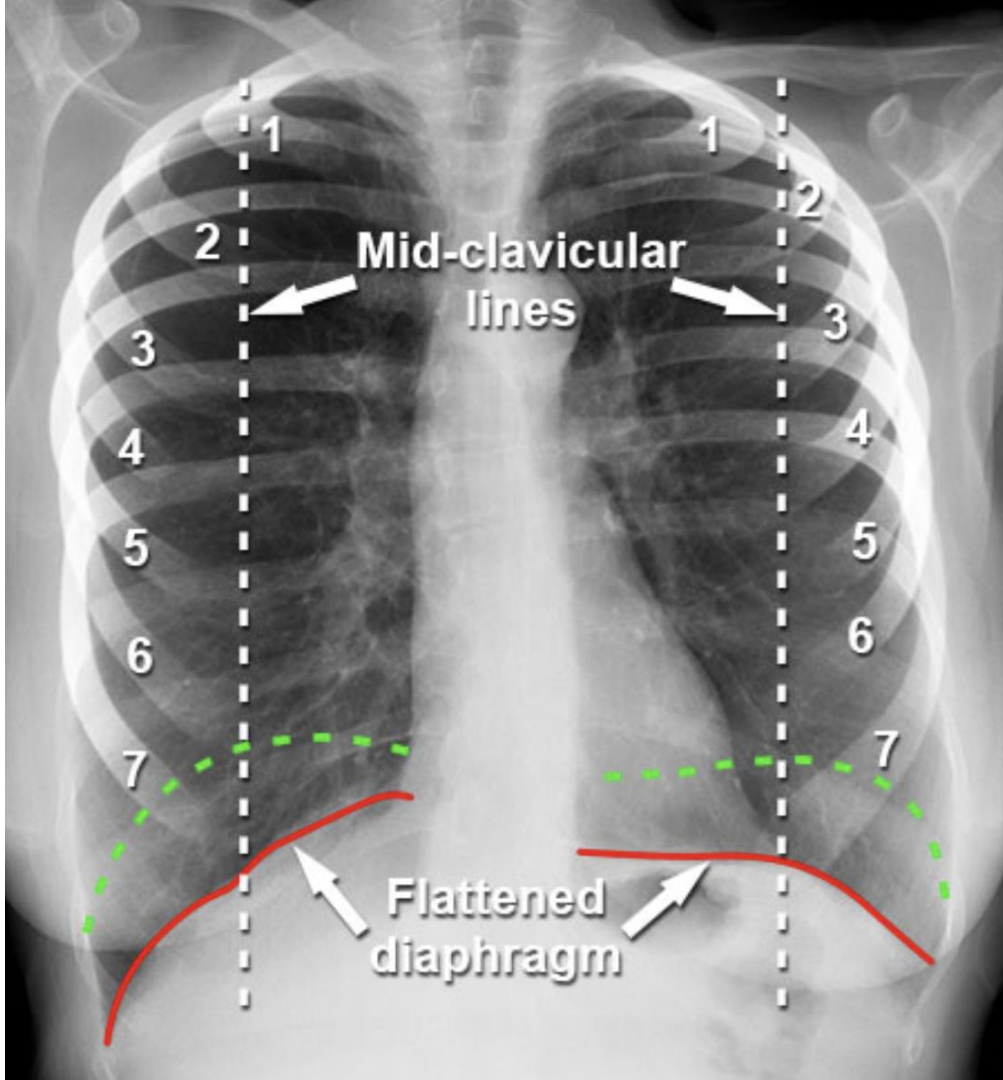
COPD/Emphysema

Hyperextension

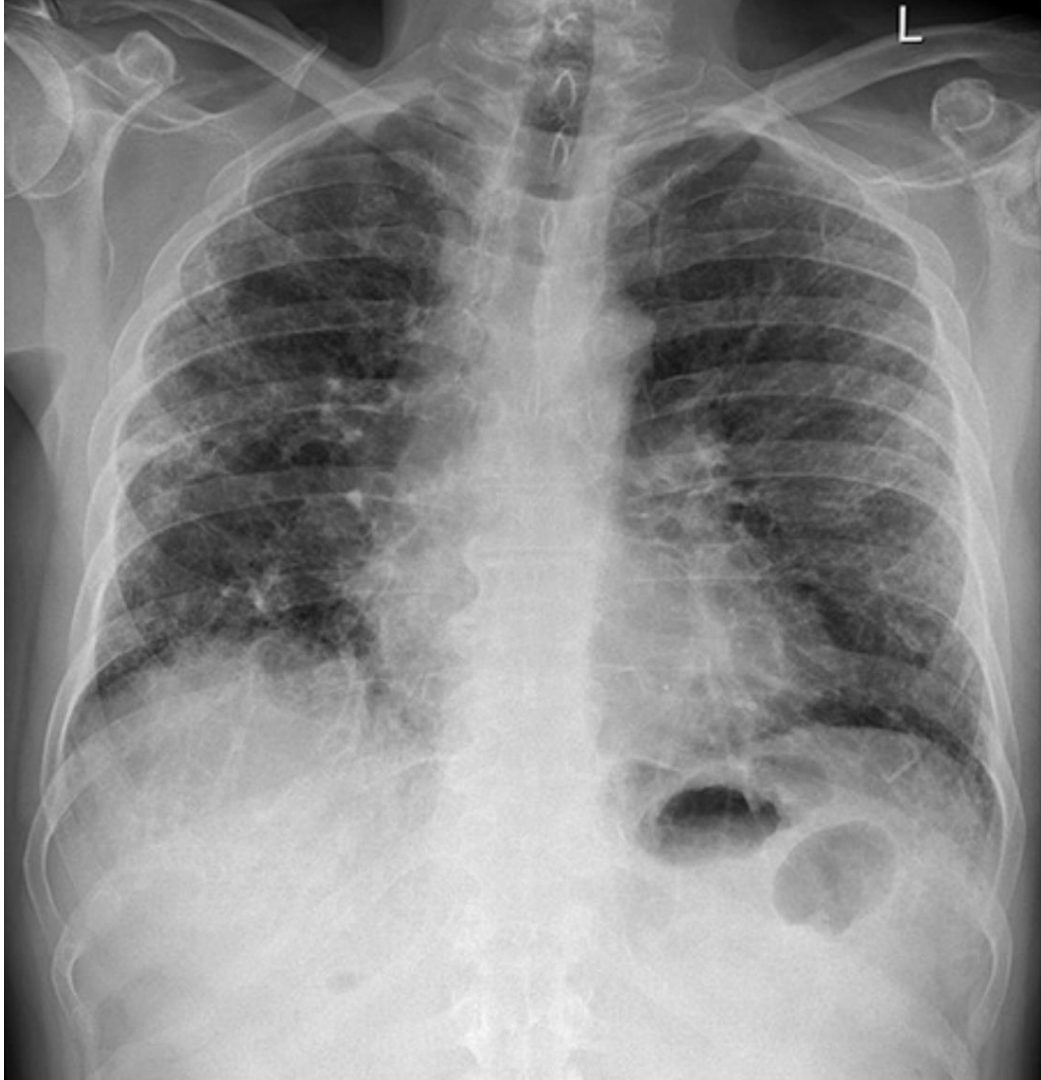
COPD/Emphysema

Hyperextension

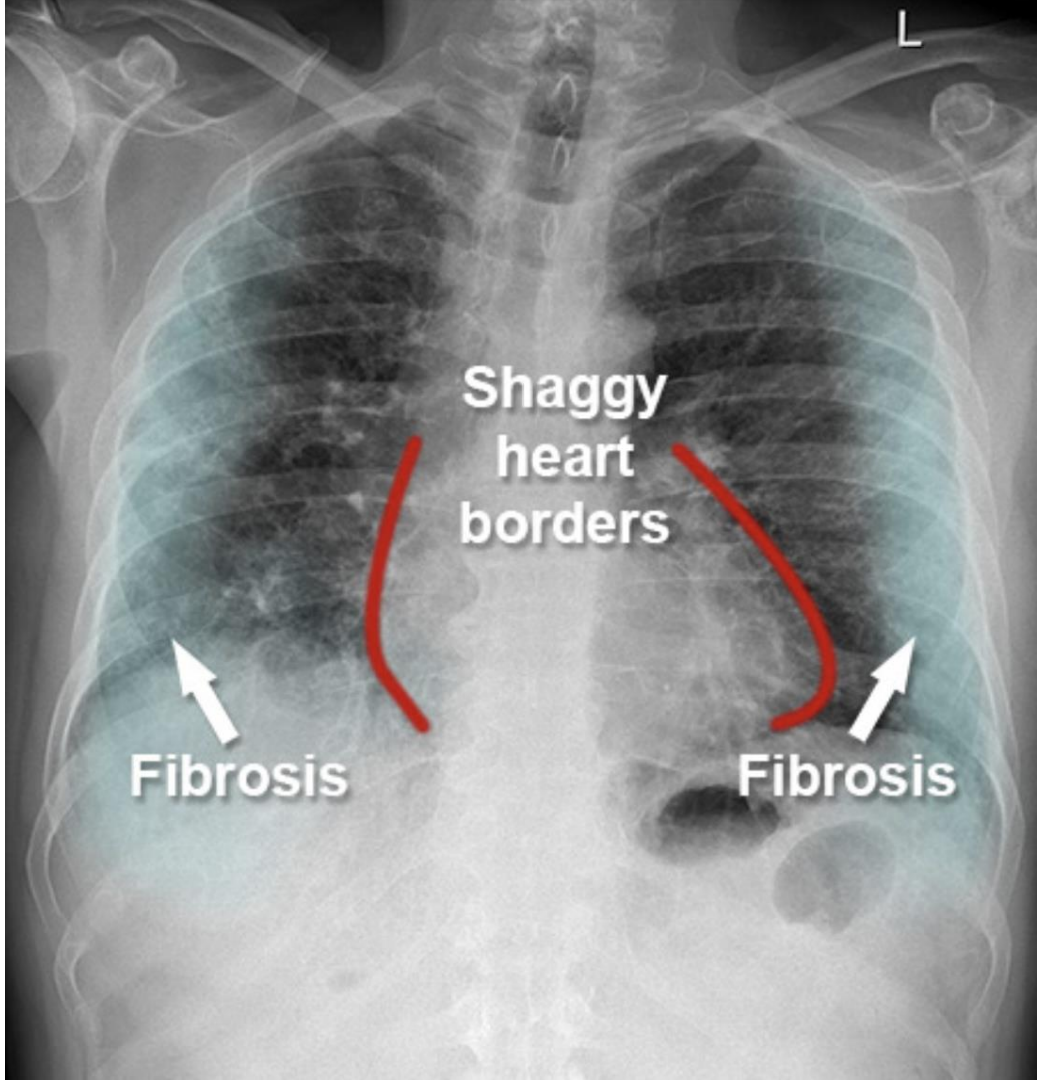
- 正常 5th to 7th anterior ribs in the mid-clavicular line (綠虛線)
- 這位病人diaphragm (**red lines**) level with the mid-clavicular line比第7根還低
- Flattening of the diaphragm (**紅線**)



比較: pulmonary fibrosis



比較: pulmonary fibrosis

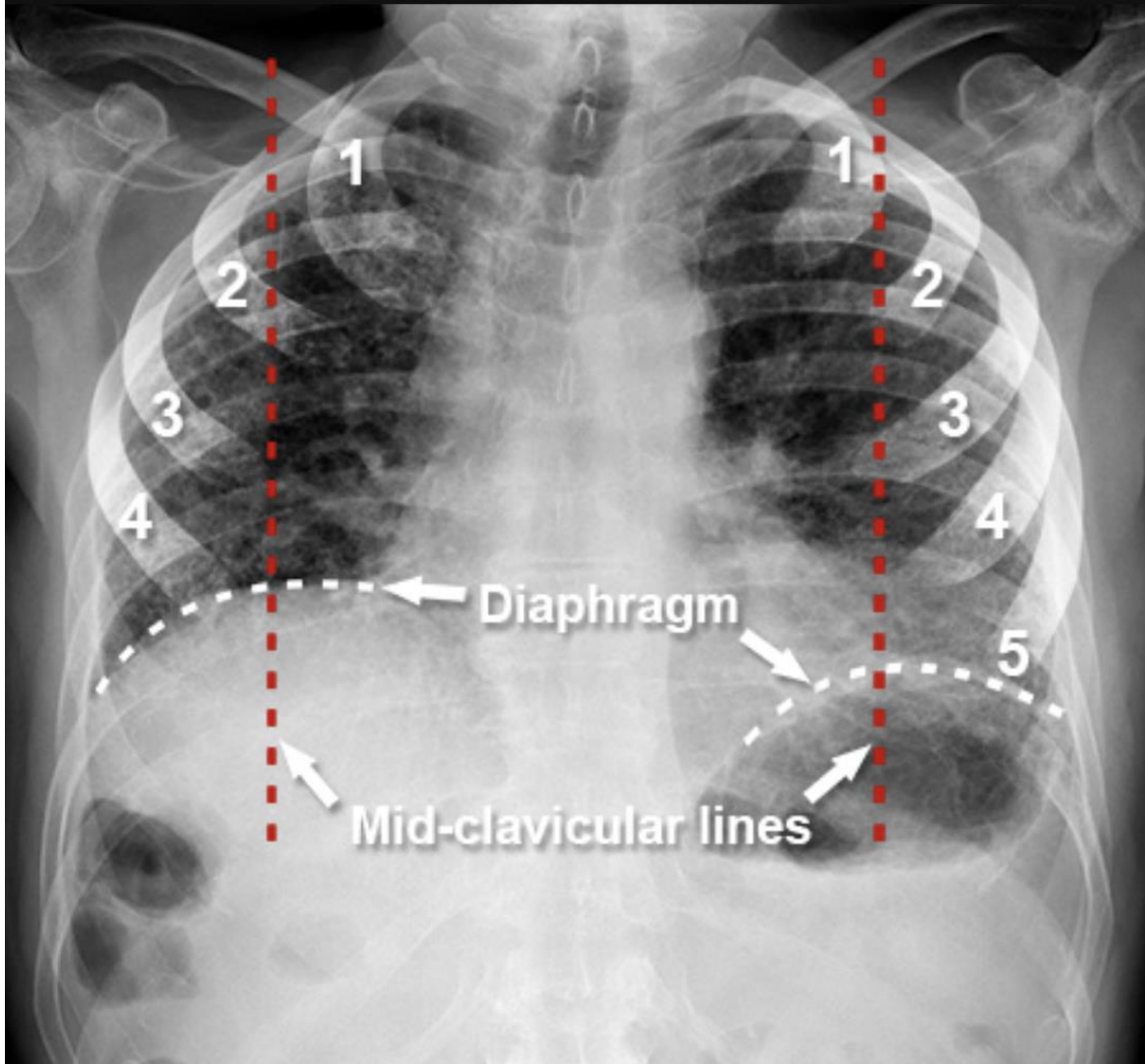


Radiology Masterclass Website

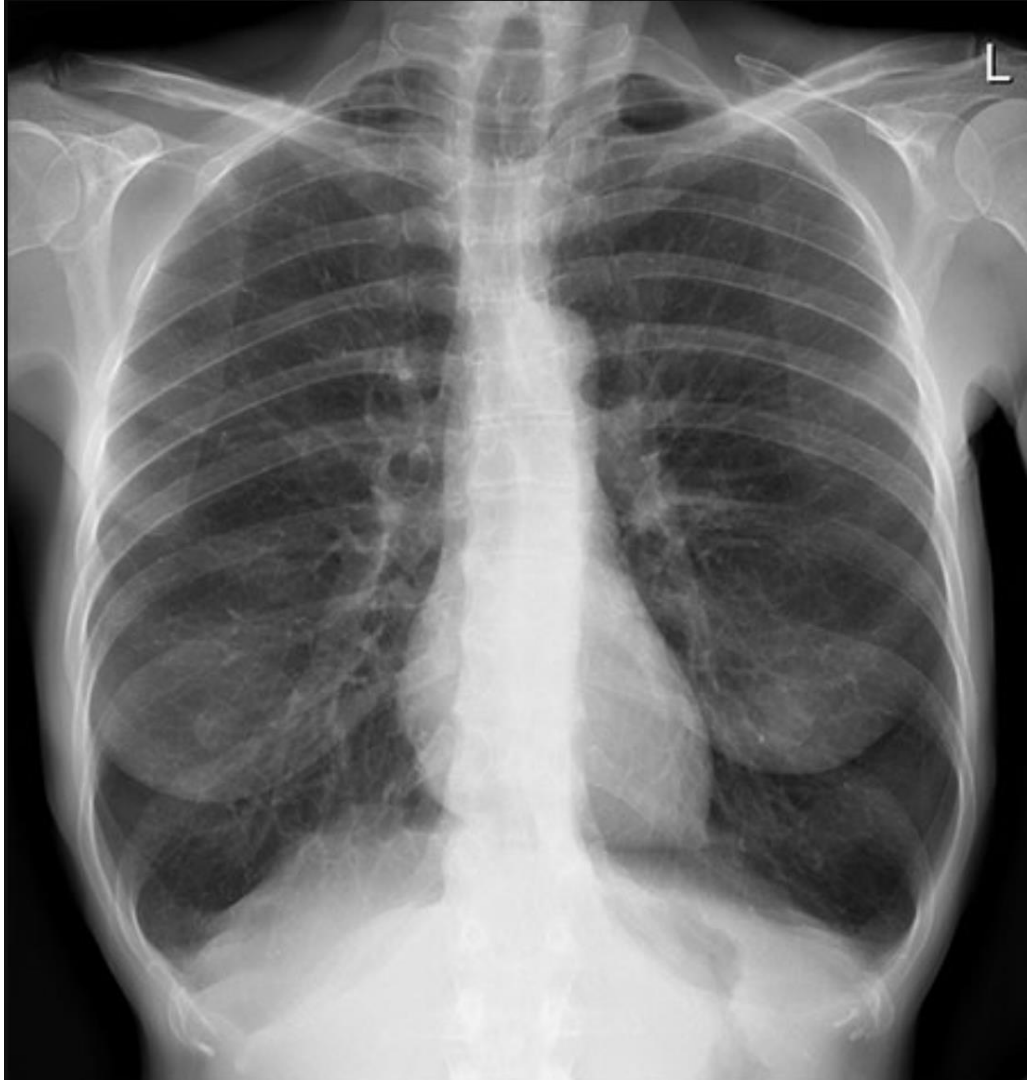
比較: pulmonary fibrosis

比較: pulmonary fibrosi

lung volume ↓



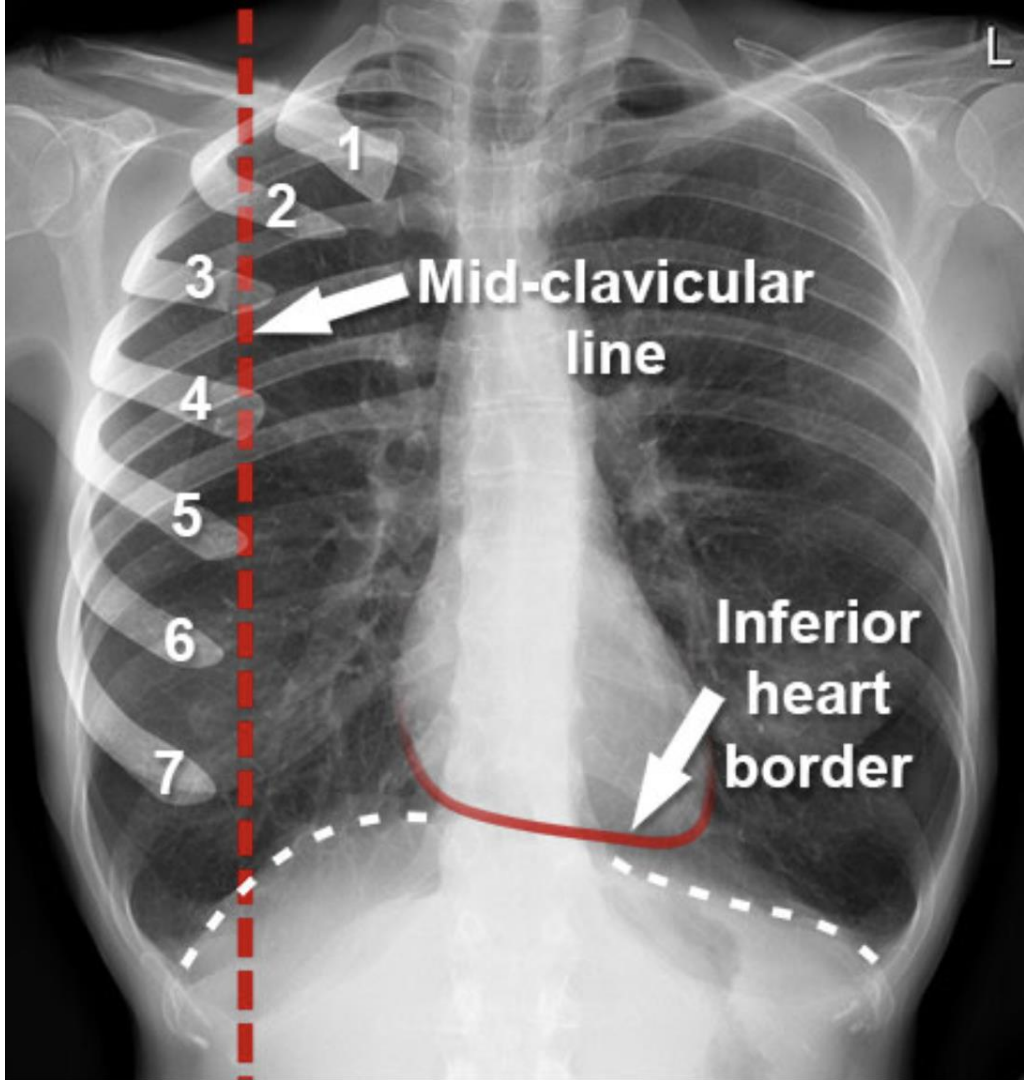
Floating heart sign



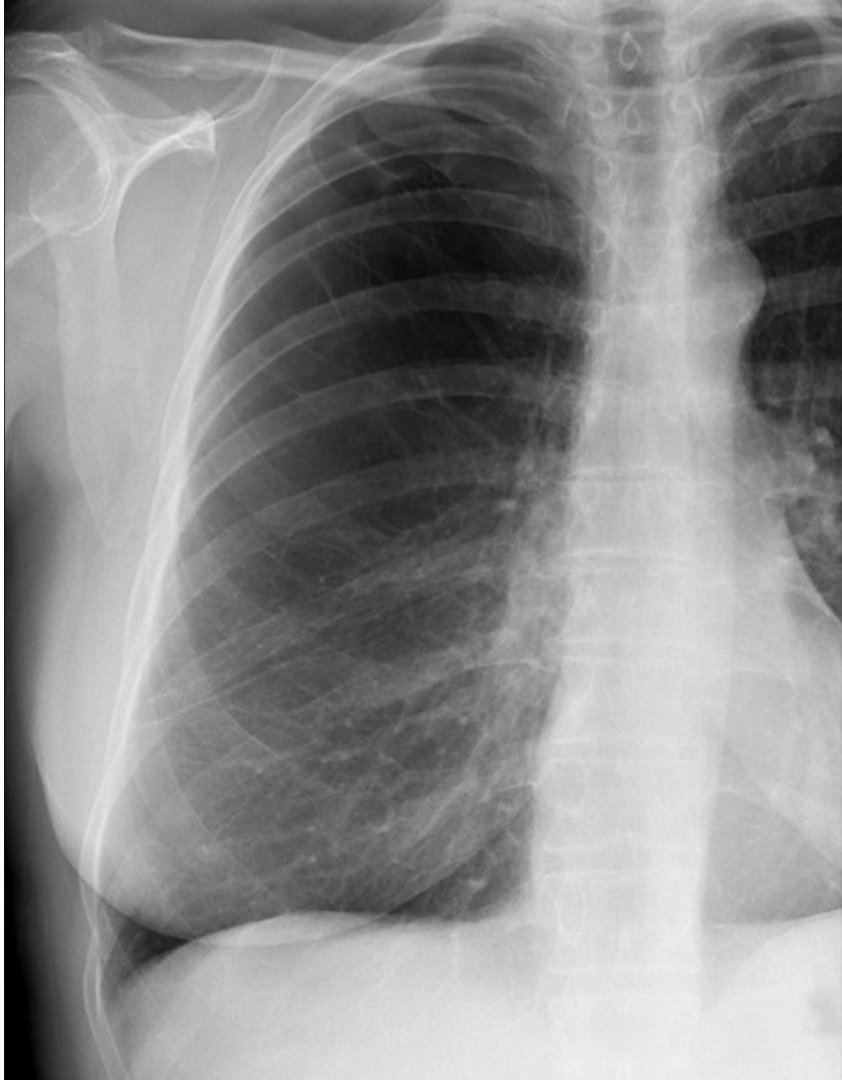
Floating heart sign

Inferior border of the heart becomes visible – the heart appears to float above the diaphragm

Note the flattened hemidiaphragms (white dotted lines)



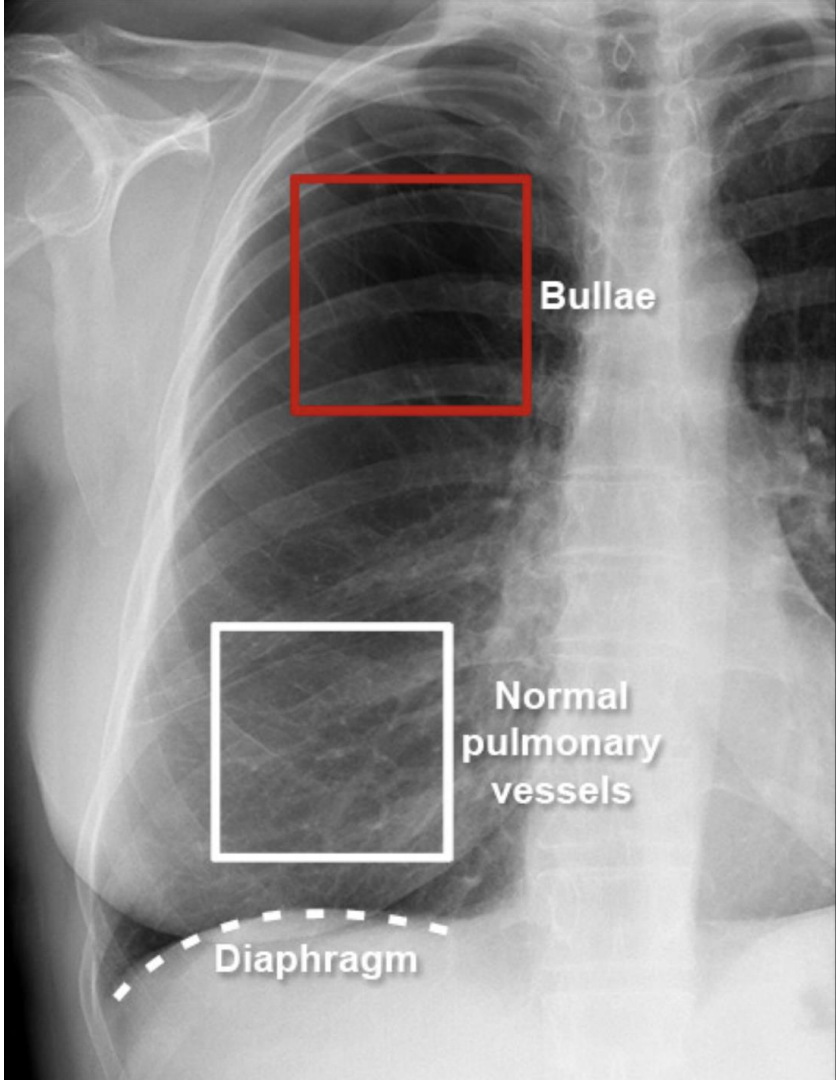
bullous emphysema



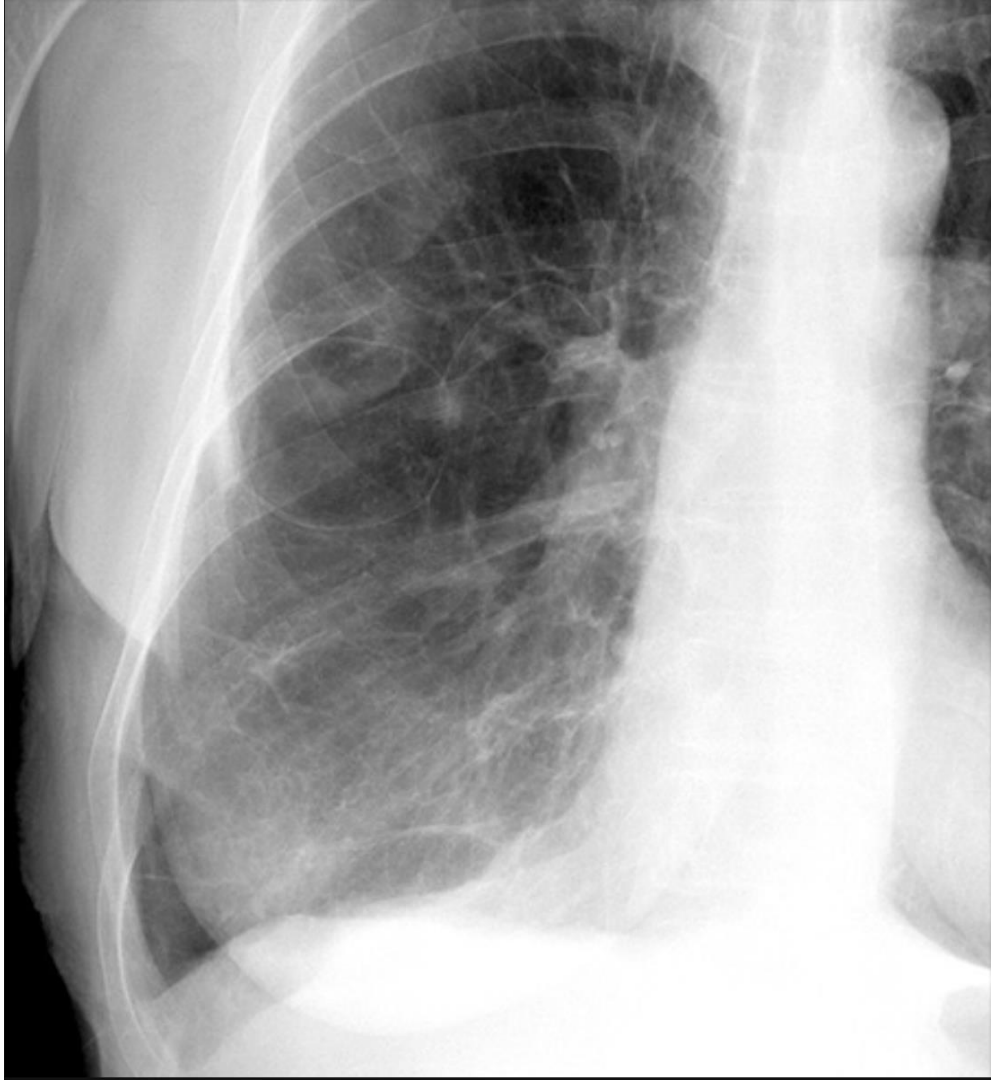
bullous emphysema

Areas of low density (black) with thinning of the pulmonary vessels, predominantly affecting the upper zones

The lower part of the lungs may appear denser (whiter) in normal subjects because of overlying breast tissue

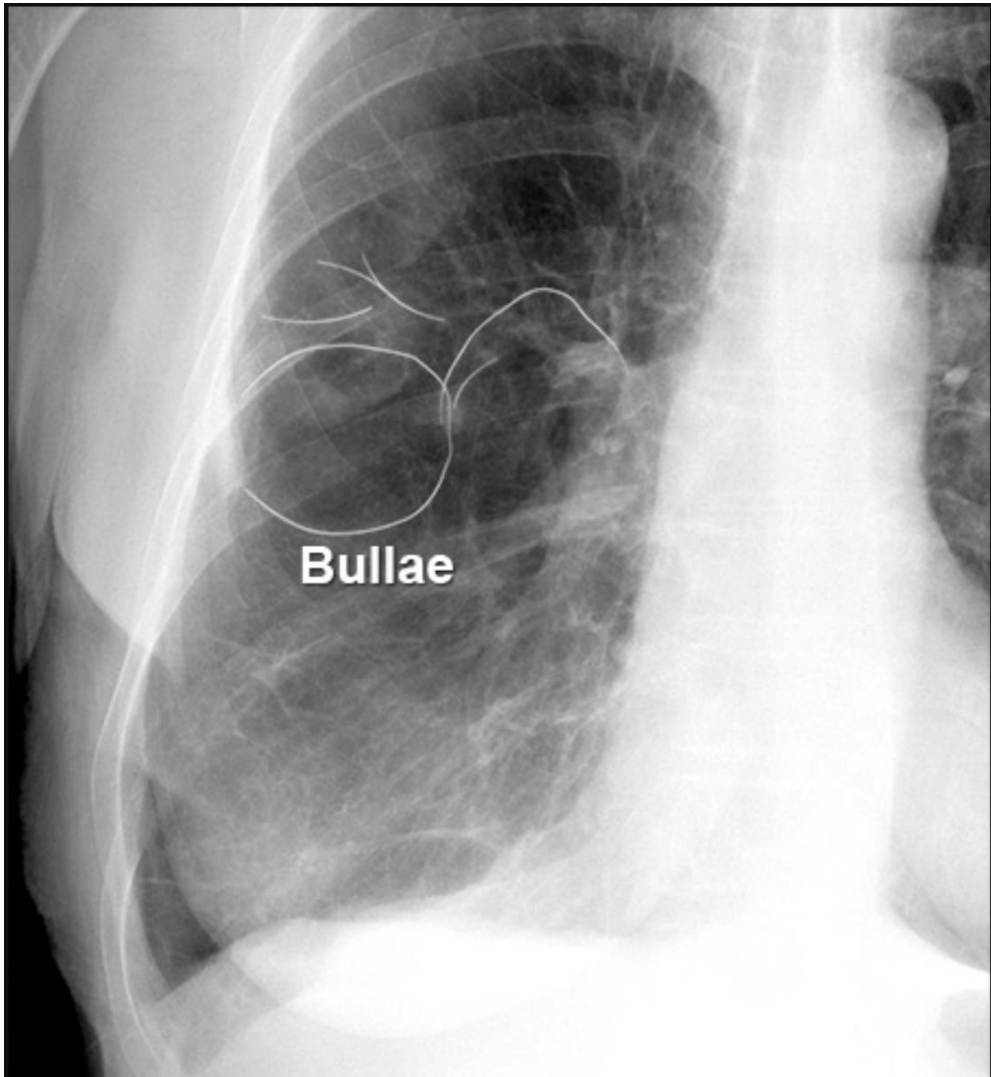


bullous emphysema

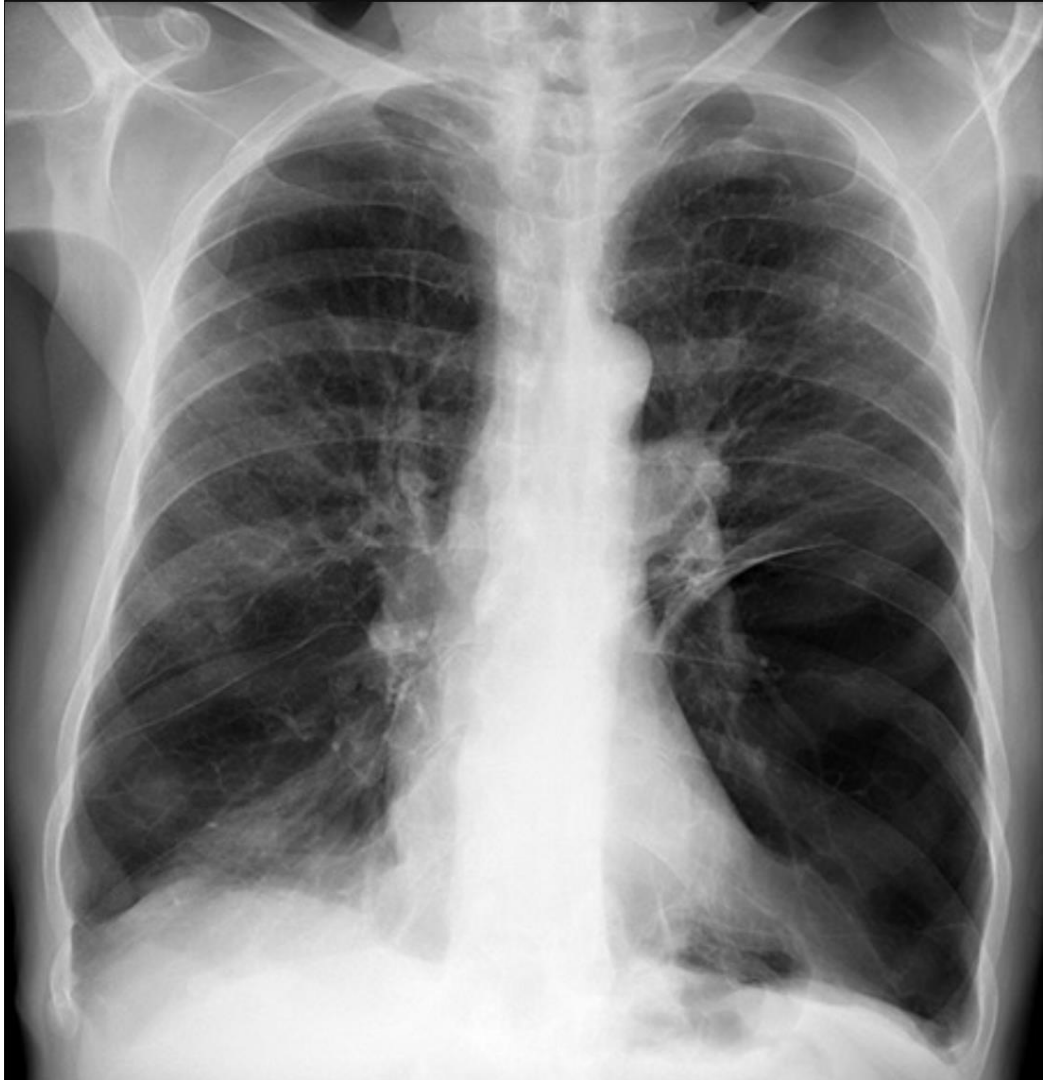


bullous emphysema

Occasionally bullae are seen as discretely outlined holes in the lungs which **resemble bubbles**

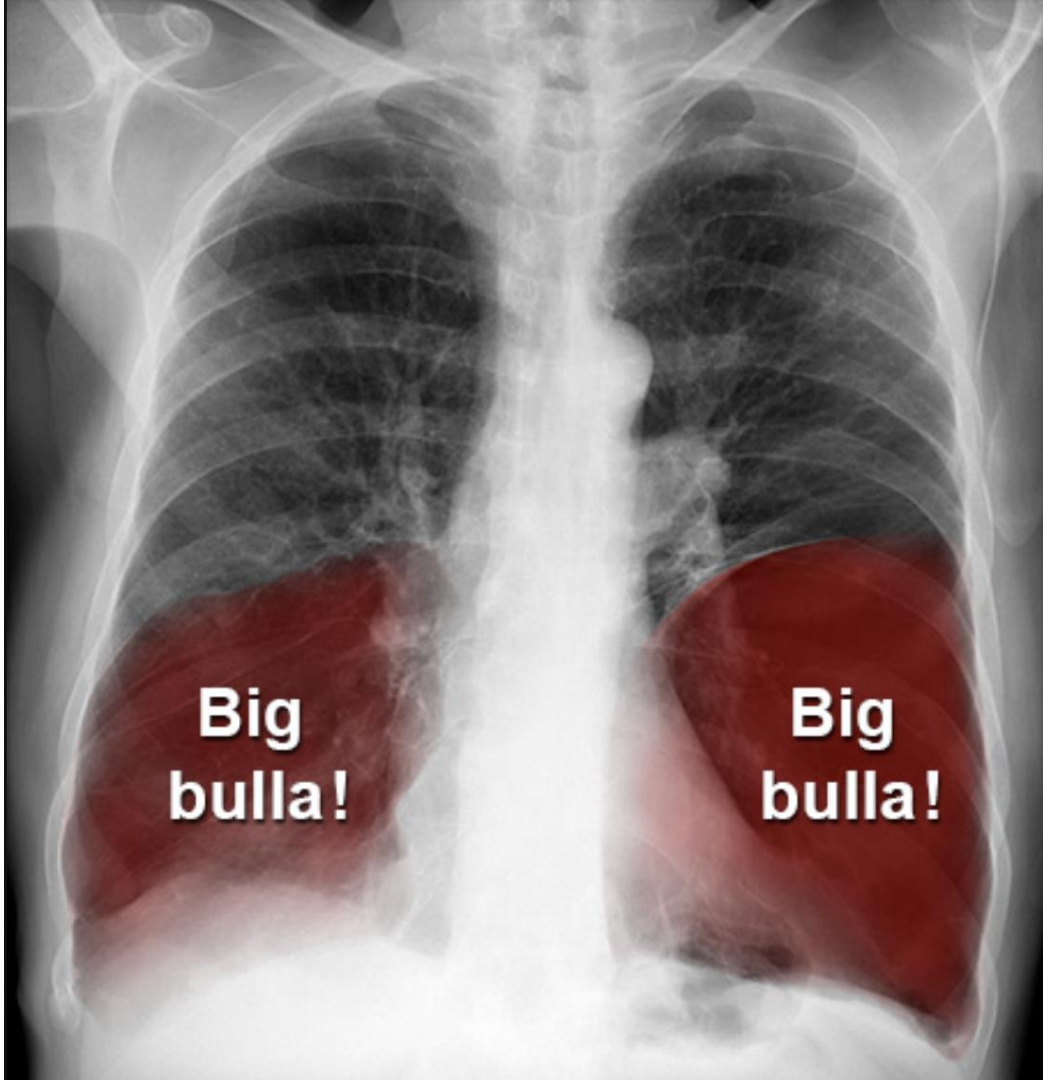


Large bullae



Large bullae

大bulla需與pneumothorax做鑑別診斷(絕不可以放chest tube)



Radiology Masterclass Website

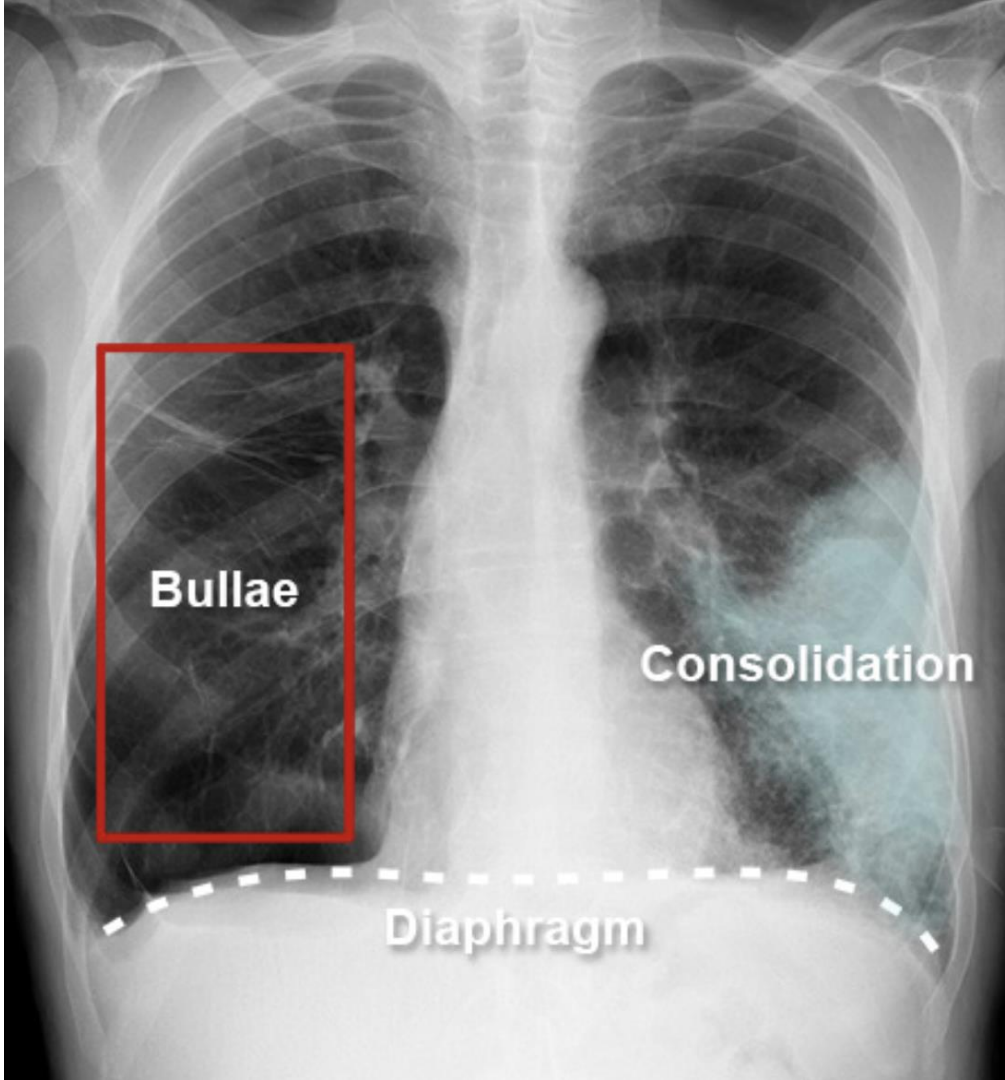
Infective exacerbation

Infective exacerbation

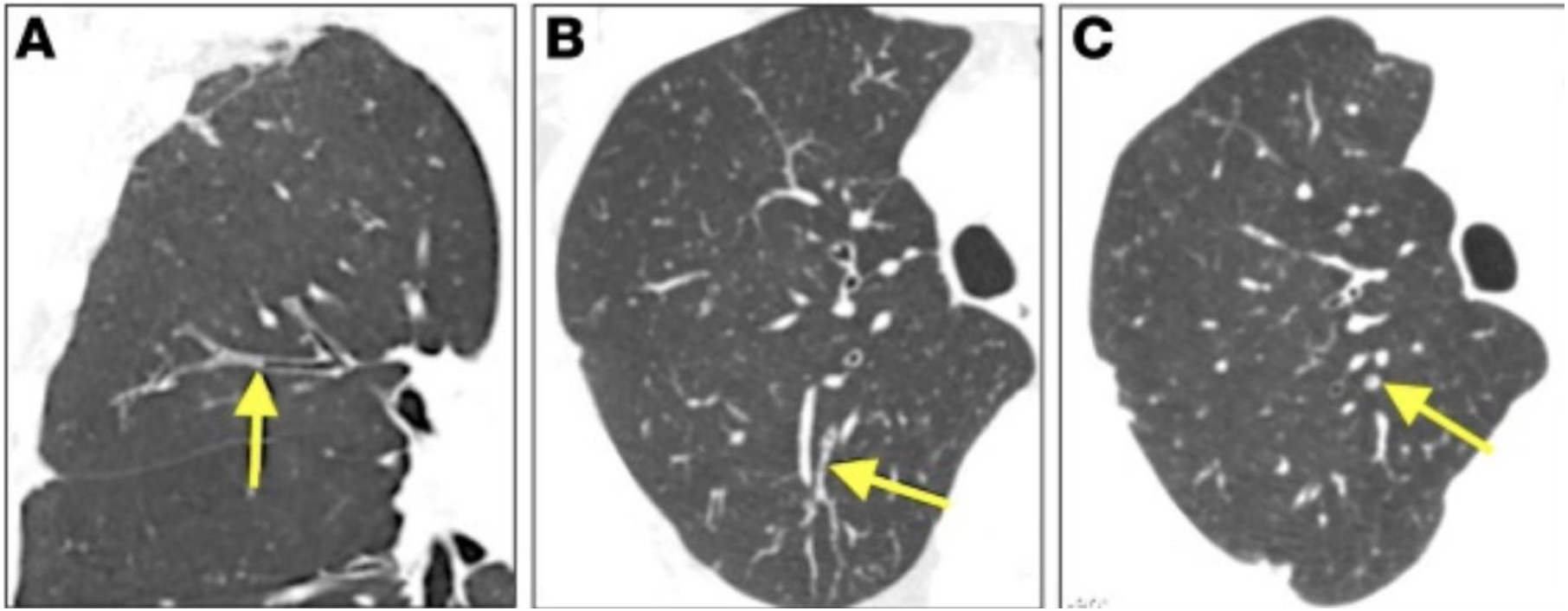
The lungs are hyper-expanded – the diaphragm is flattened and too low

There are large areas of black due to bullae

A large area of consolidation in the left lung is due to pneumonia



如何探討mucus plugs呢? CT Mucus Score by MDCT



Frontal Plane

Transverse Plane

Transverse Plane

Journal of Clinlical Investigation 2018 Feb 5;128(3):997–1009.

如何探討mucus plugs呢? CT Mucus Score by MDCT

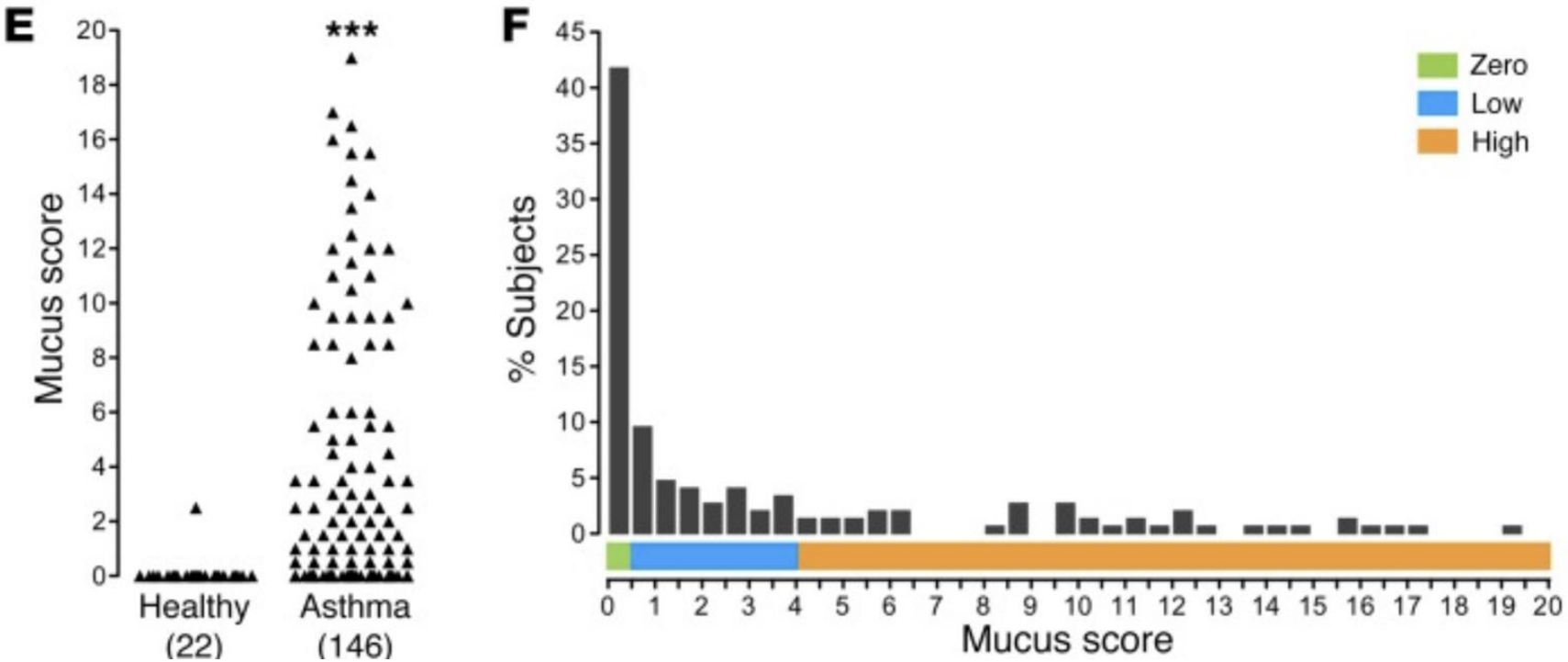
D

CT evaluation	Mucus plugging	Mucus score
Define area of evalution	Indentify mucus plugs	Examine each bronchopulmonary segment for mucus plugs
		
CT axial plane	Plugged airway in cross-section	Bronchopulmonary segments
Exclude peripheral lung ≤ 2 cm from the costal or diaphragmatic pleura from midline anteriorly to the mediastinal interface posteriorly	Mucus plug defined as complete occlusion of airway by mucus Partial occlusion by mucus is not scored	Count the bronchopulmonary segments with ≥ 1 mucus plug(s) to generate the mucus score

Journal of Clinlical Investigation 2018 Feb 5;128(3):997–1009.

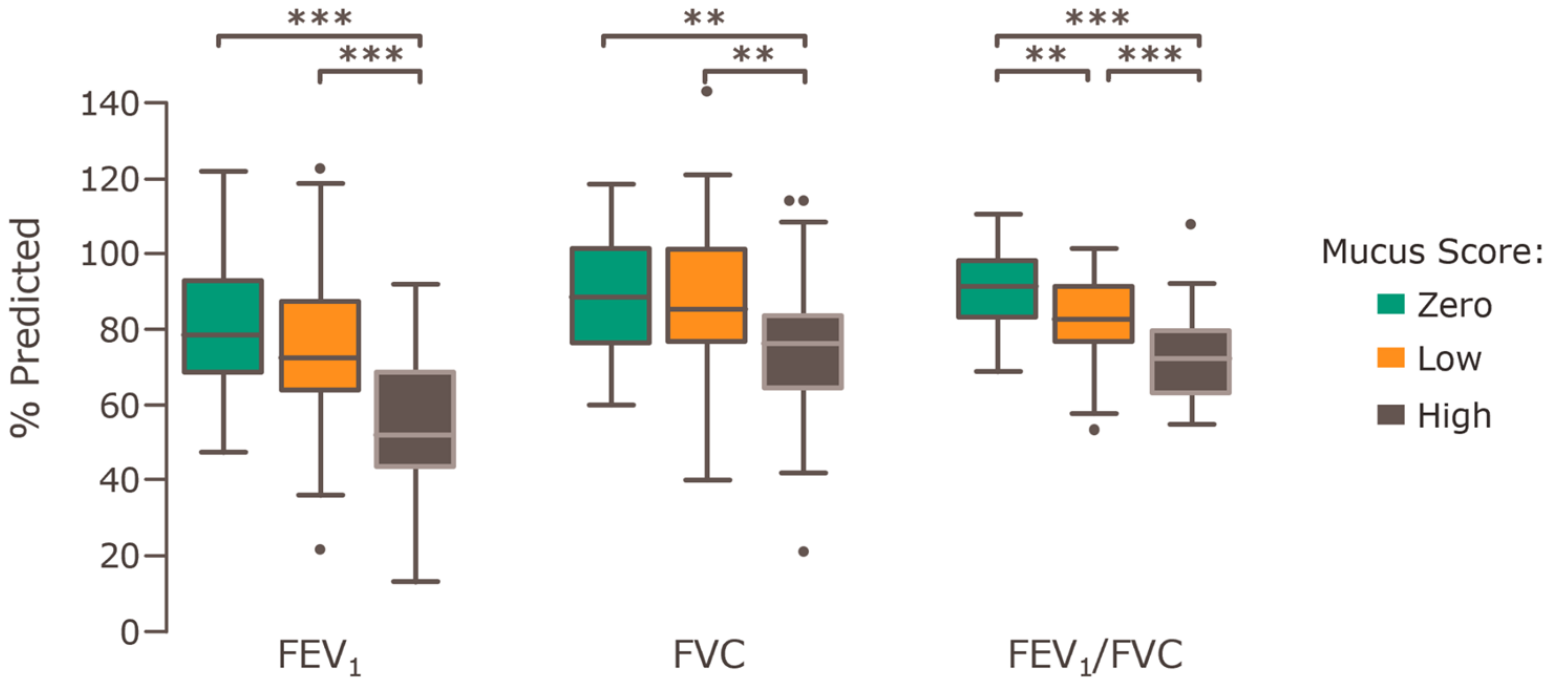
Mucus score 分數越高越不好... Asthma病人有不少low to high mucus score

如何探討mucus plugs呢? CT Mucus Score by MDCT



Journal of Clinlical Investigation 2018 Feb 5;128(3):997–1009.

Mucus Plugging Is Associated With Poor Lung Function and Airflow Obstruction



***P < 0.001; **P < 0.01

FEV_1=forced expiratory volume in 1 second; FVC= forced vital capacity; SARP=Severe Asthma Research Program.

N=146 adults with asthma.

Dunican EM, et al. J Clin Invest. 2018 Mar 1;128(3):997-1009.

Infectious disease

- Pulmonary tuberculosis
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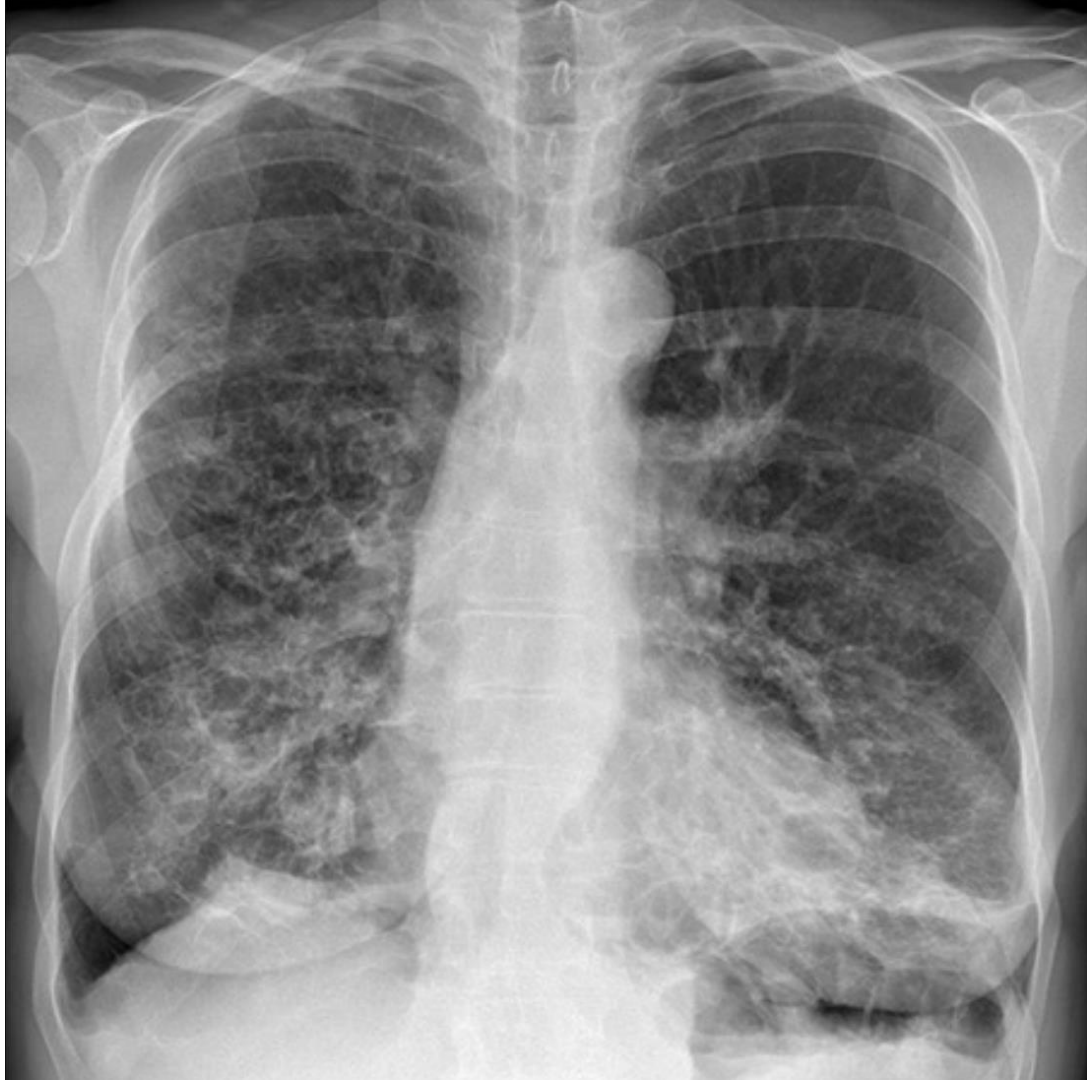
- Pneumocystis jirovecii
- Chronic pulmonary aspergillosis

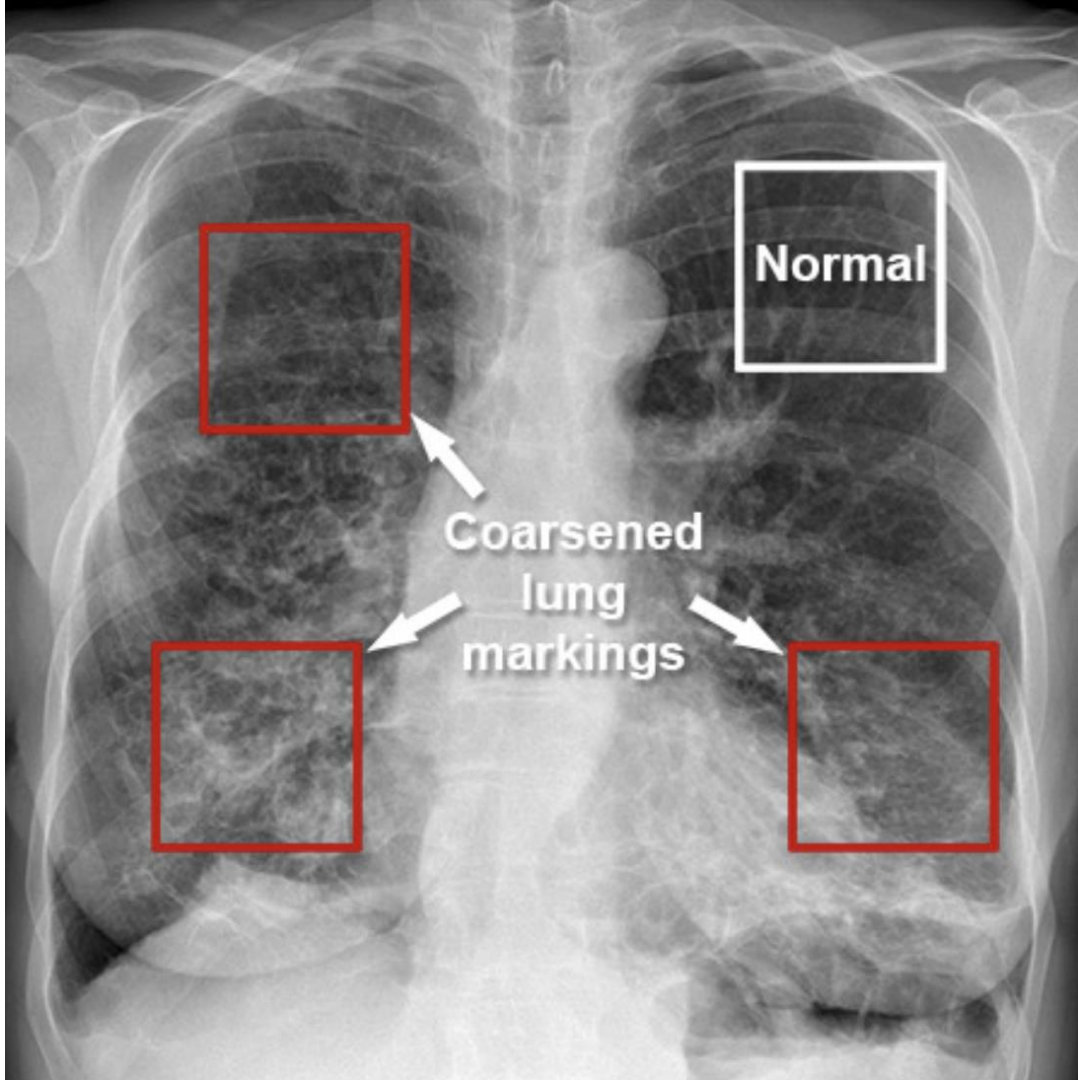
Airway disease

- COPD
- **Bronchiectasis**

Bronchiectasis

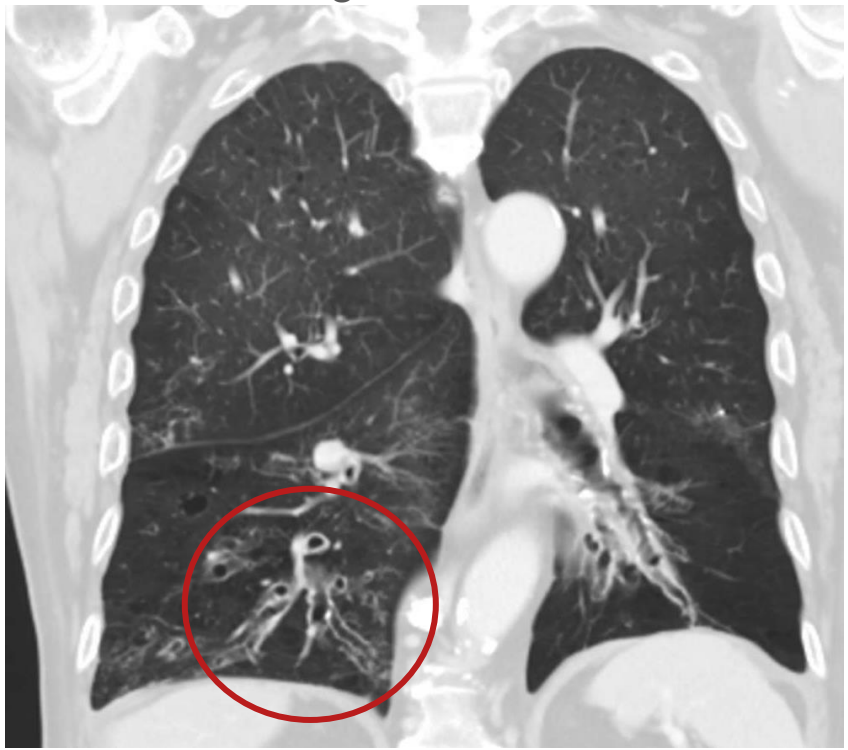


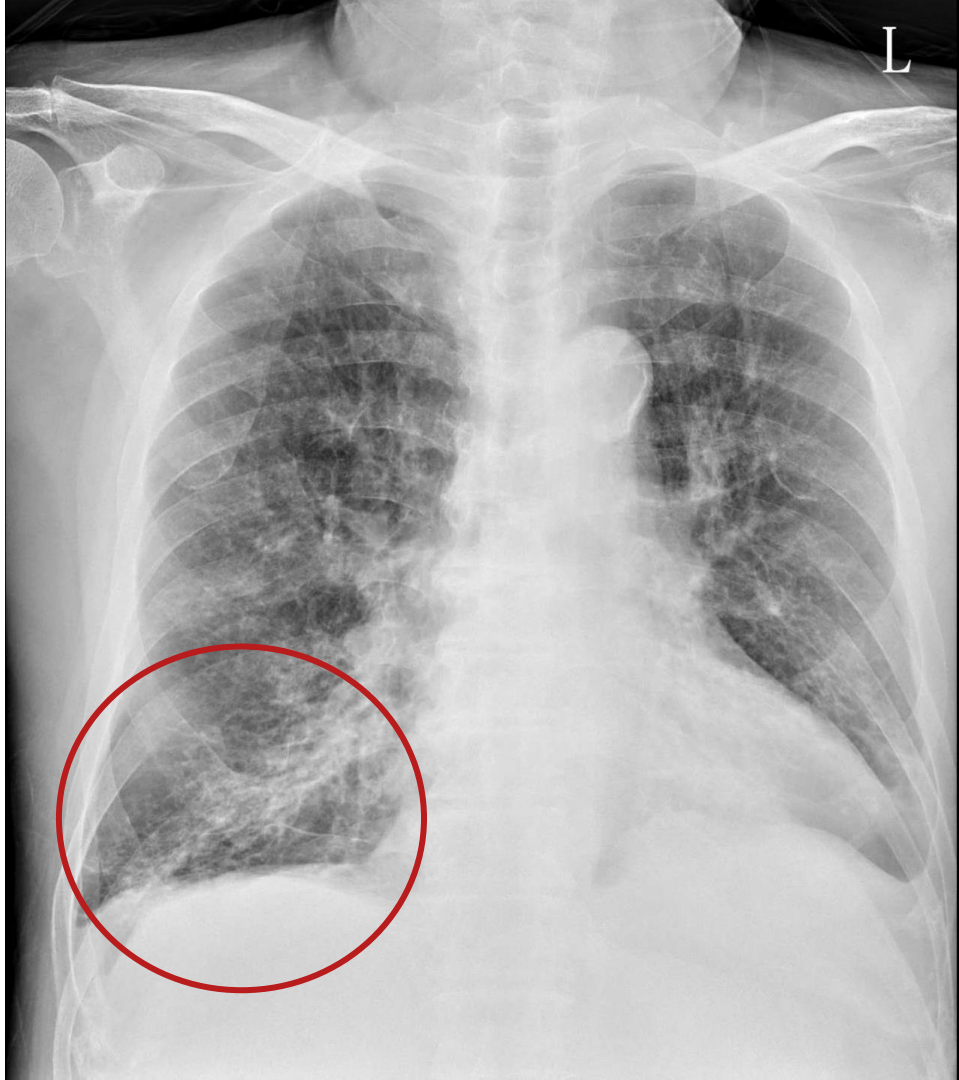
Severe bronchiectasis causes coarsening of the lung markings – very extensive in this case



Bronchiectasis

Tram track sign





Modified Reiff Score

Radiological Severity

Assesses bronchiectasis severity based on the number of lobes involved and the degree of bronchial dilatation.

** Note: The lingula is considered to be a separate lobe.*

MAX

MAXIMUM SCORE

18 Points

0

No Bronchiectasis

Normal bronchial caliber and wall thickness

1

Tubular

Mild dilatation with parallel bronchial walls (tram-track sign)

2

Varicose

Moderate dilatation with beaded or irregular bronchial outline

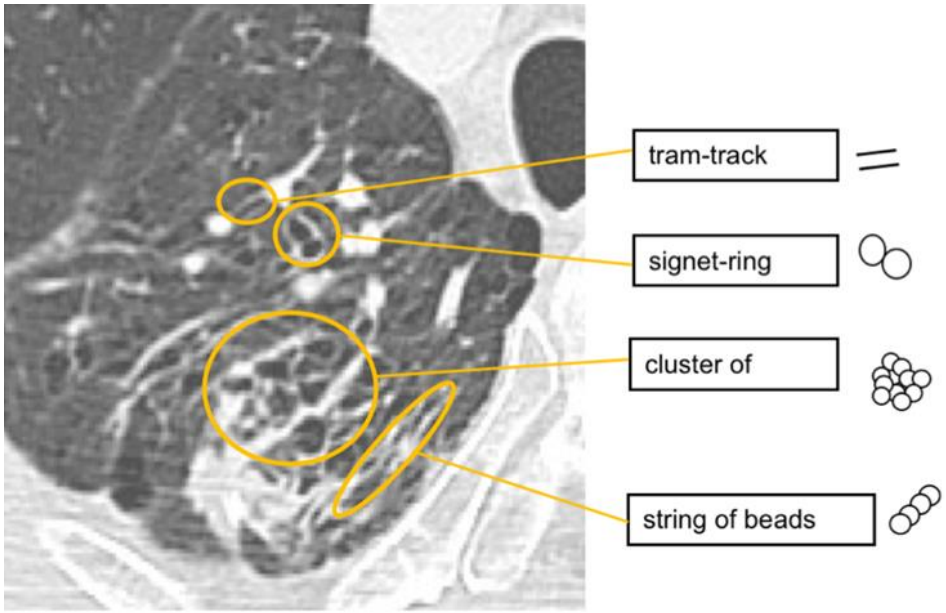
3

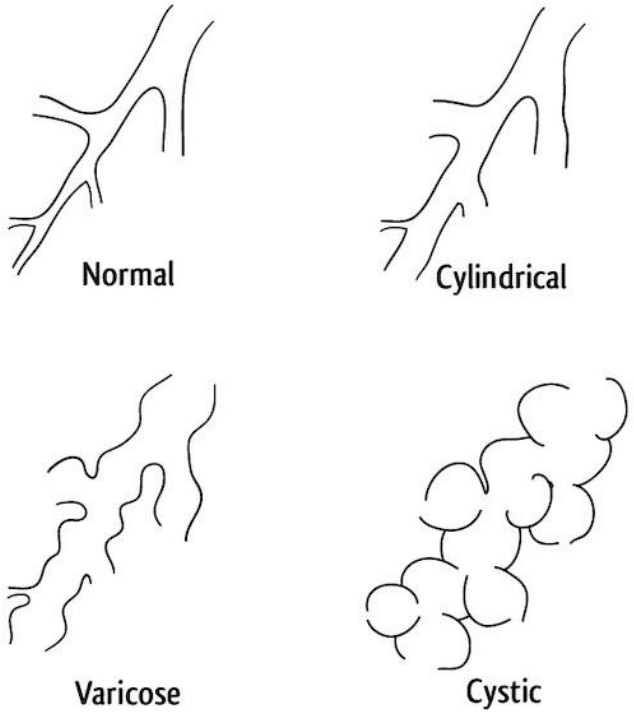
Cystic

Severe dilatation presenting as balloon-like air spaces

Source: AJR Am J Roentgenol. 1995 Aug;165(2):261-7.

Different types



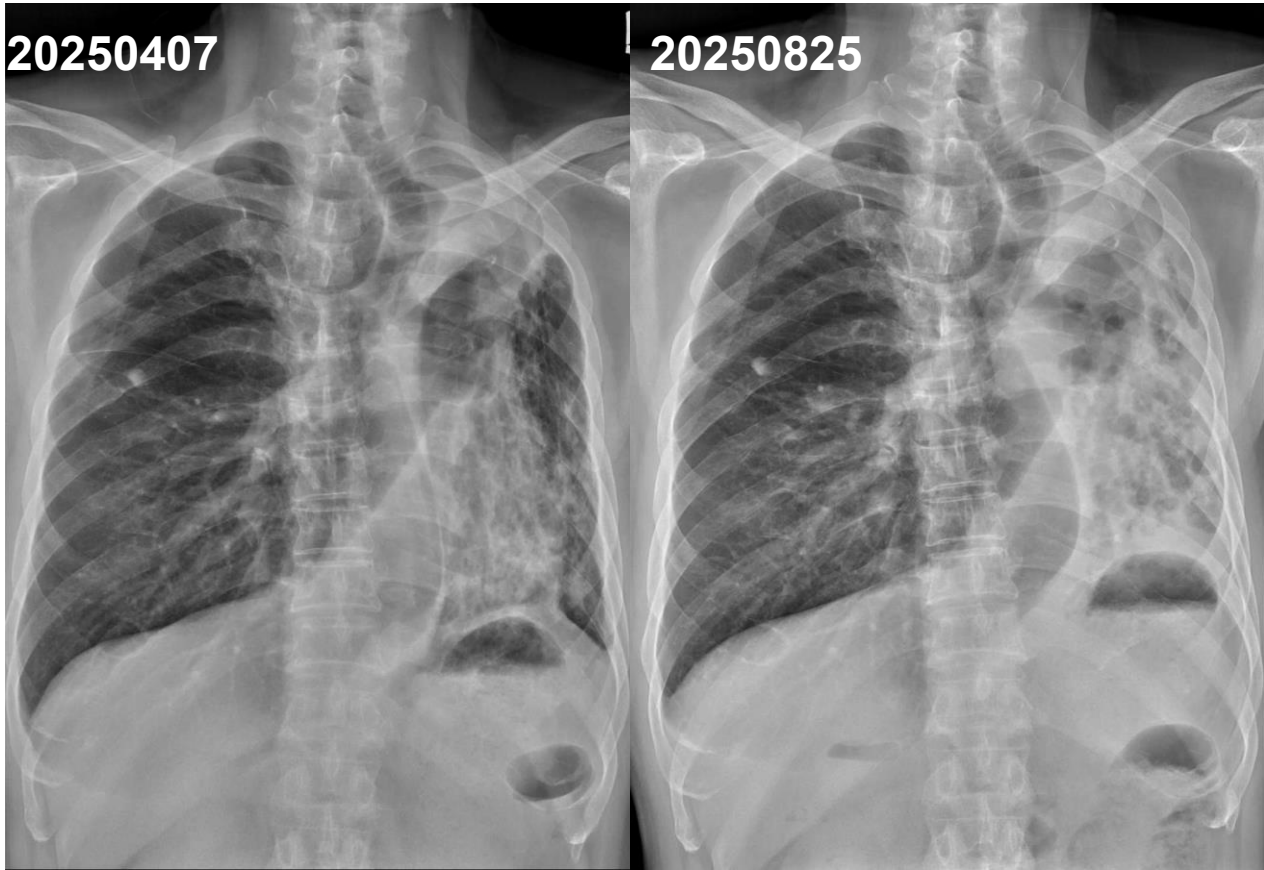


Radiopaedia. Bronchiectasis

Bronchiectasis progression

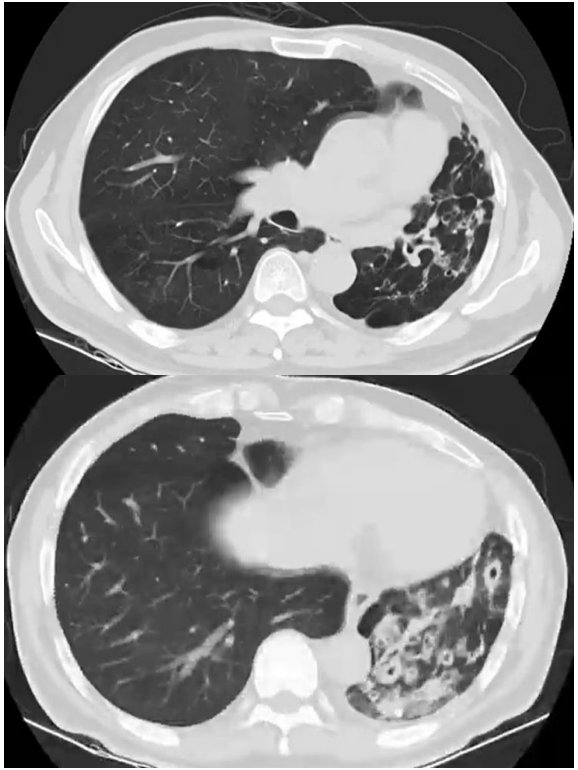
Old TB

Childhood asthma

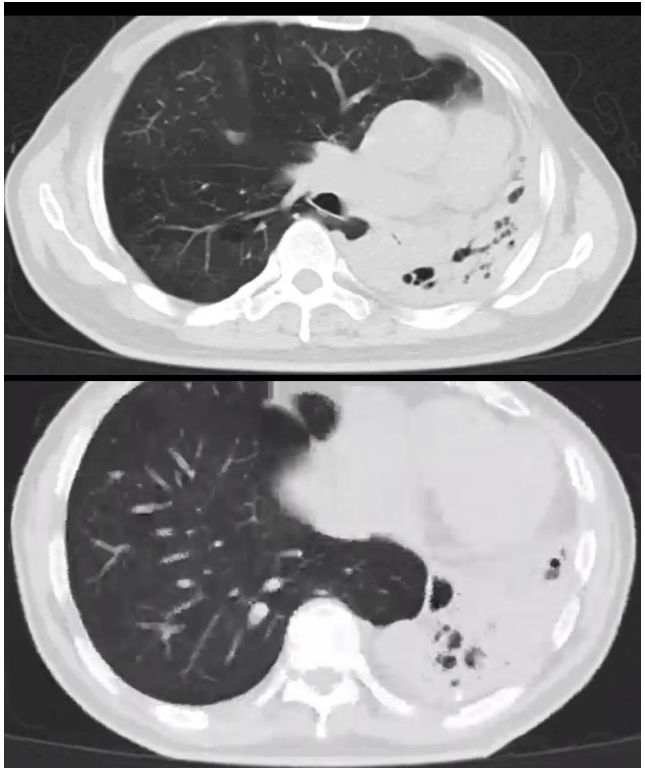


Bronchiectasis progression

Baseline



Progression



Allergic bronchopulmonary aspergillosis

必要條件（兩項都要）

- 有**氣喘(須懷疑)**或 cystic fibrosis (**Childhood asthma**)
- 證據顯示對 Aspergillus 過敏：**Aspergillus 特異性 IgE 陽性** 或 皮膚 prick test 陽性

其他支持條件（至少 2 項）

- **總 IgE > 500–1000 IU/mL（多數 >1000）**
- Aspergillus-specific IgG 或 precipitin 陽性
- **嗜酸性球 > 500 /μL（未用 steroid 時）**
- 影像學異常: 中央型支氣管擴張、**mucus plugging**

m207 (黑麴黴菌)(KU/L)	2026/01/26 14:59	Class 2 (1.04)

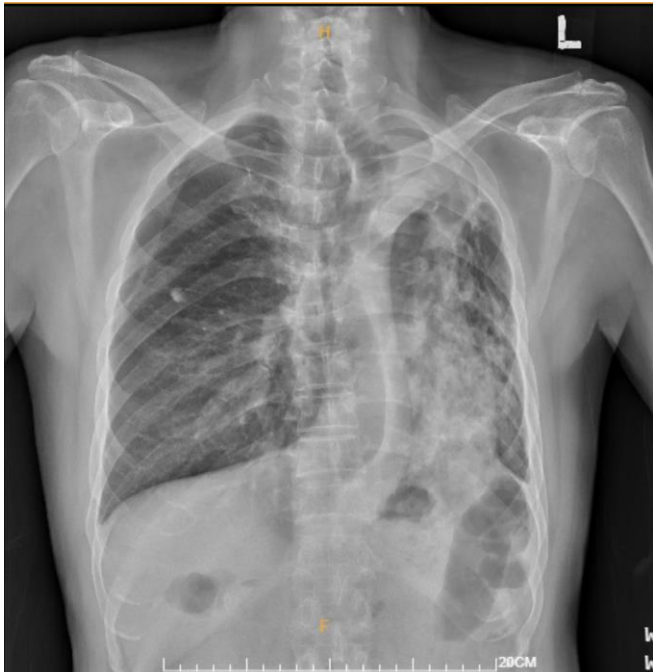
科室:WS No:260112036664 BLOOD 採檢:2026/01/12 15:51 登入:2026/01/13

檢驗項目	檢驗值	單位	參考值
IgE 免疫球蛋白E	1926	KU/L (IU/mL)	<114
Allergen(定性)	9.31	PAU/L	0~0.349

Allergic bronchopulmonary aspergillosis

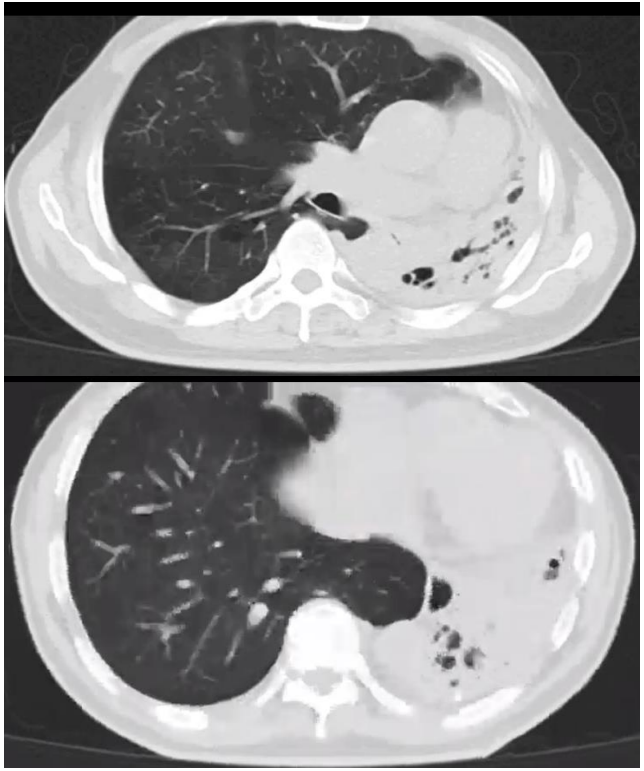
Current treatment: oral corticosteroid 0.5mg/kg*2weeks, then tapper

sputum幾乎沒有了

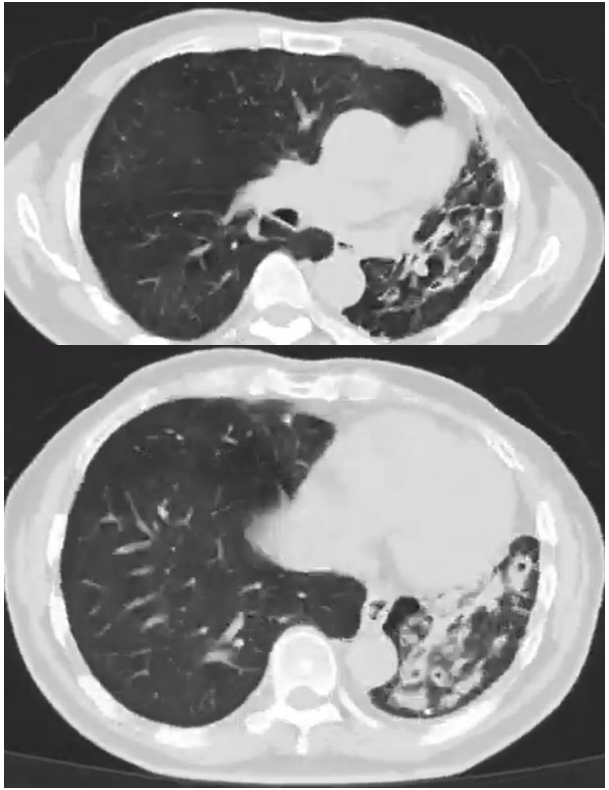


Allergic bronchopulmonary aspergillosis

Before treatment



After treatment



Diffuse panbronchiolitis

71M Chronic cough and dyspnea on exertion

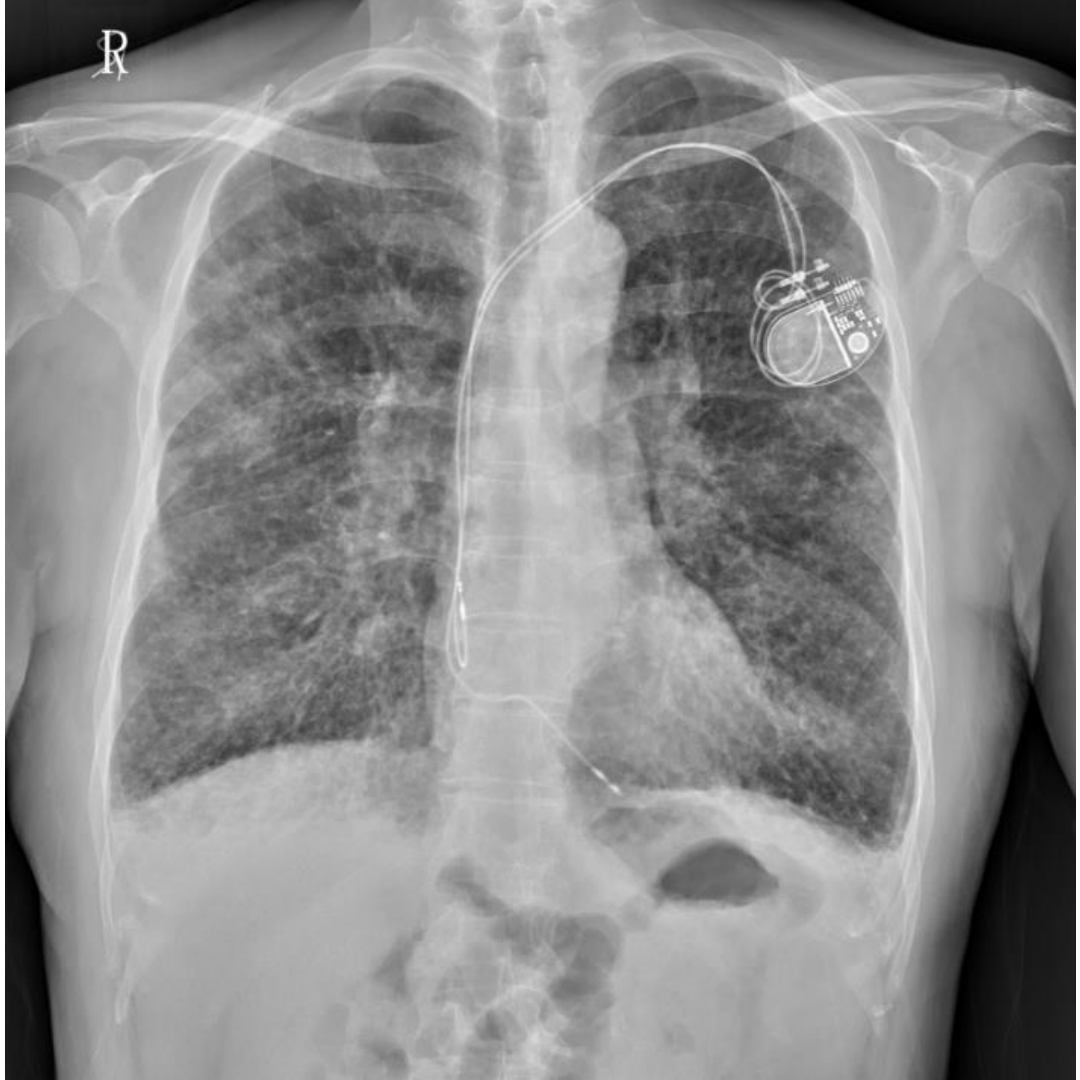
Phx: recurrent Pseudomonas infection

Diffuse panbronchiolitis

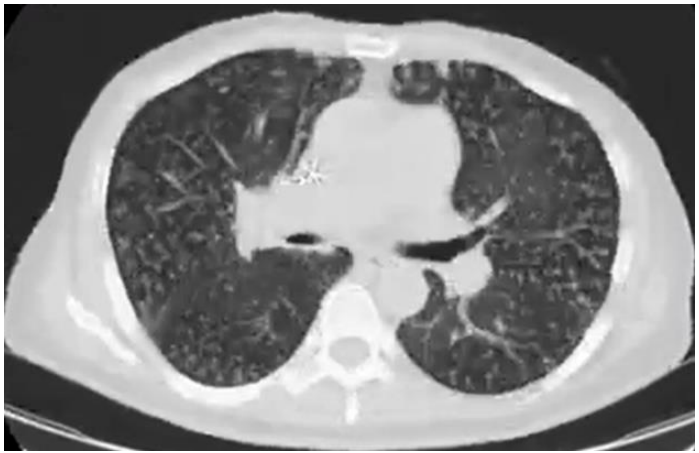
10 years later

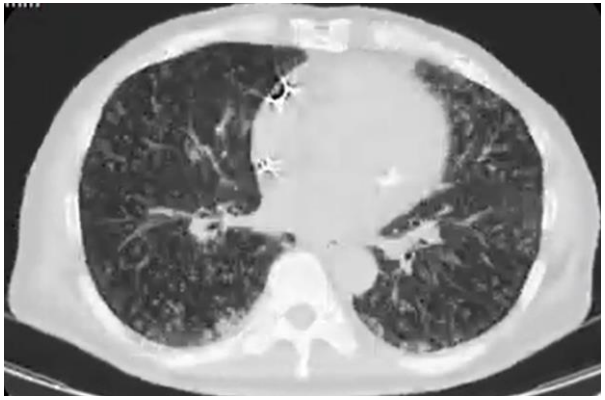
Frequent CV comorbidities

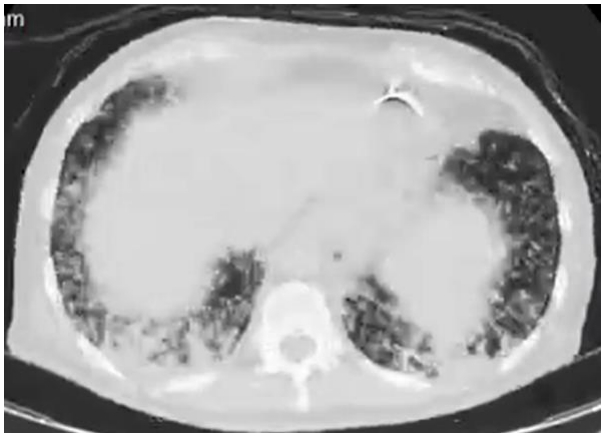
(complete AV block s/p pacemaker)



Diffuse panbronchiolitis







Take Home Message

- TB and cryptococcosis are important mimickers and should always be considered in the differential diagnosis.
- In NTM, cavitation characteristics (size, wall thickness, feeding bronchus sign, and adjacent consolidation) predict disease progression.
- Airway imaging provides insights beyond diagnosis, revealing disease severity and prognostic features (e.g., mucus plugging and airway remodeling).