Introduction of CT Approach and Semi-quantitation of ILD

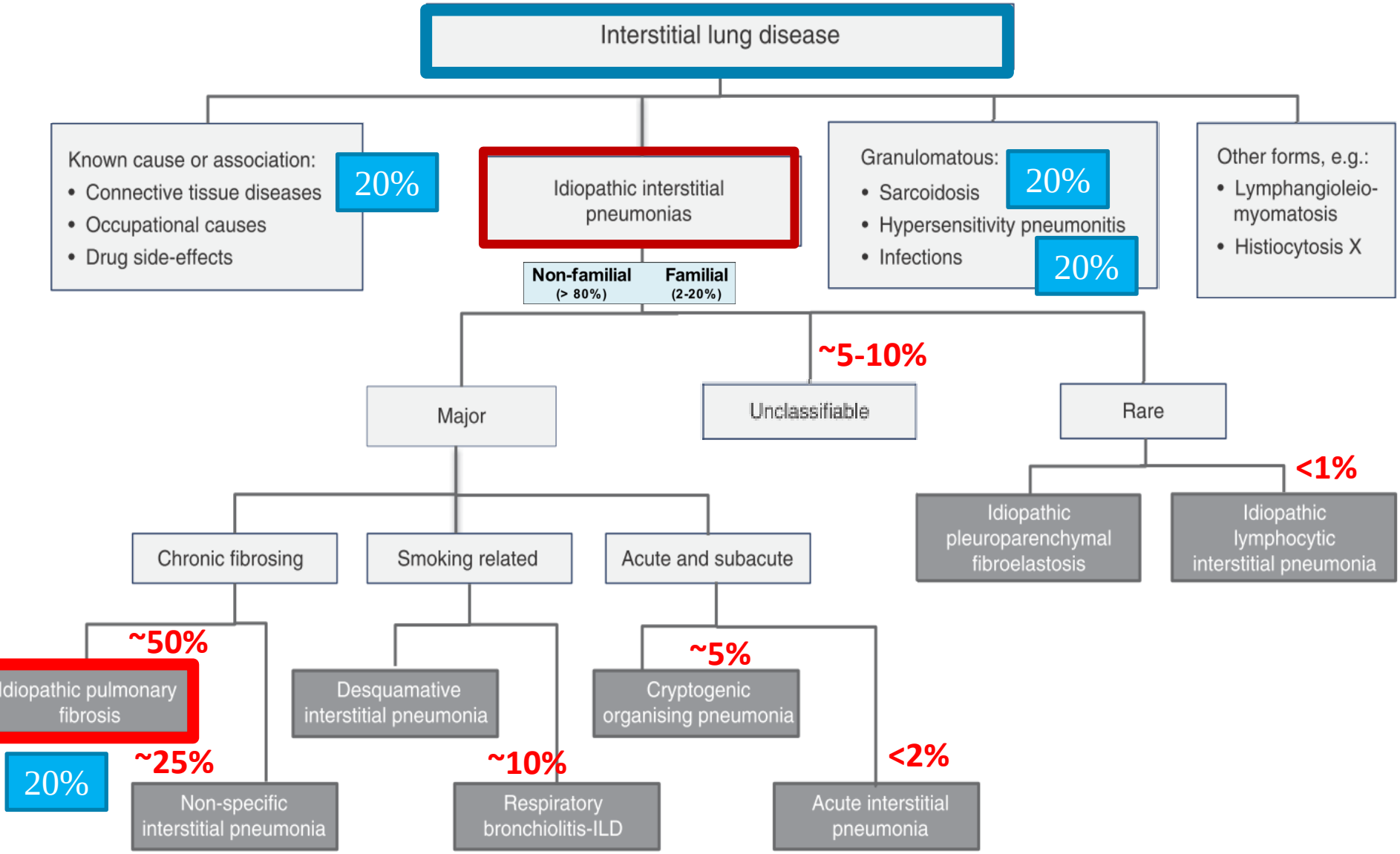
Ming-Ting Wu, M.D. 吳銘庭醫師

Professor of Radiology, NYCU

Department of Radiology, KSVGH

Kaohsiung, Taiwan

2013 ATS-ERS Classification of IIP



An official American Thoracic Society/European Respiratory Society statement: update of the international multidisciplinary classi fi cation of the idiopathic interstitial pneumonias. Am J Respir Crit Care Med 2013; 188 : 733 – 748.

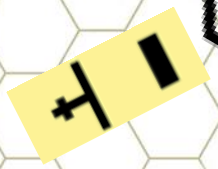
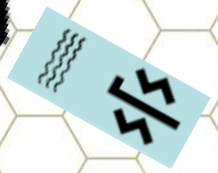
UC

Science?

Philosophy ?

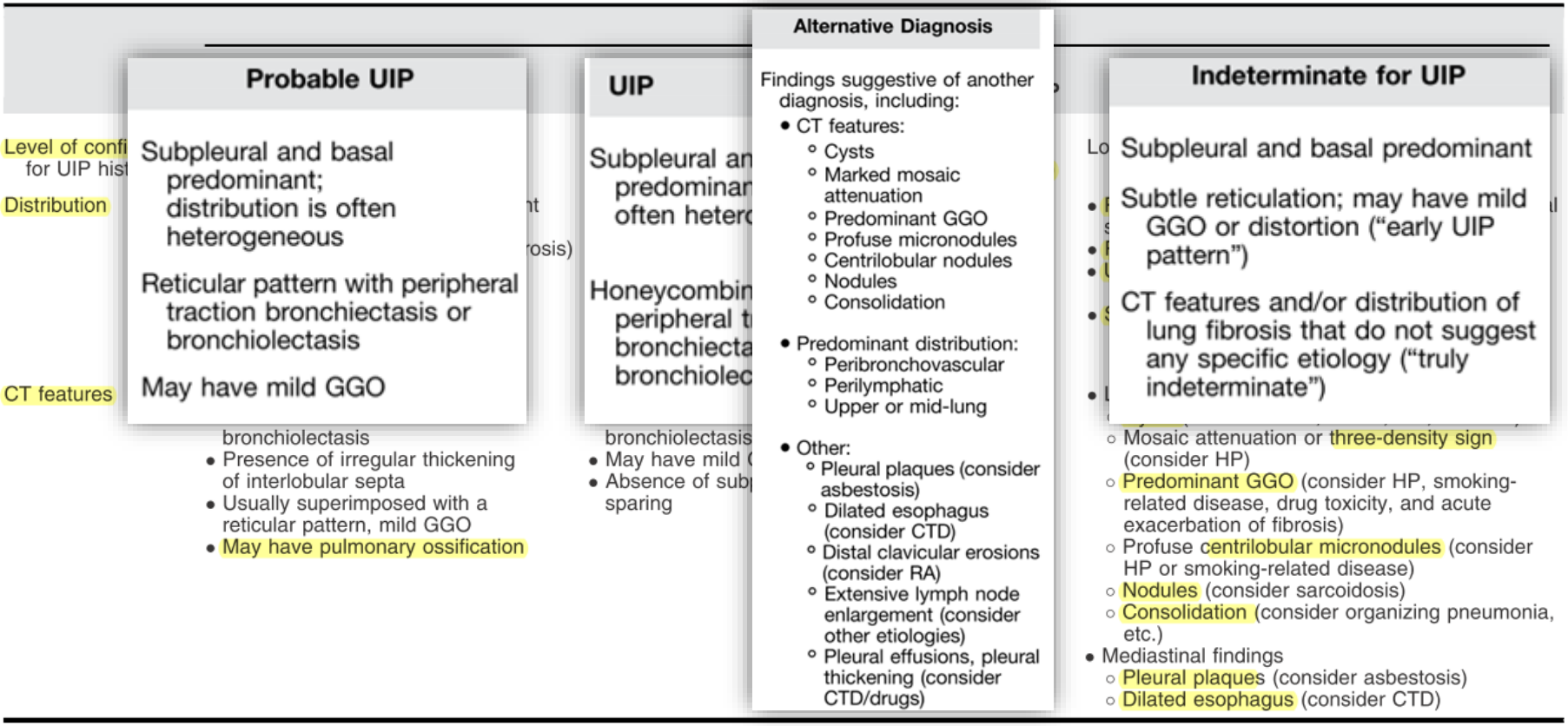
- **>200** recognized diffuse interstitial lung diseases
- **~10** pathological patterns
- **~5-6** HRCT manifestations




Idiopathic Pulmonary Fibrosis (an Update) and Progressive Pulmonary Fibrosis in Adults

An Official ATS/ERS/JRS/ALAT Clinical Practice Guideline



Raghu G et al. AJRCCM 2022; 205:e18-e47

IPF on the basis of HRCT and biopsy patterns

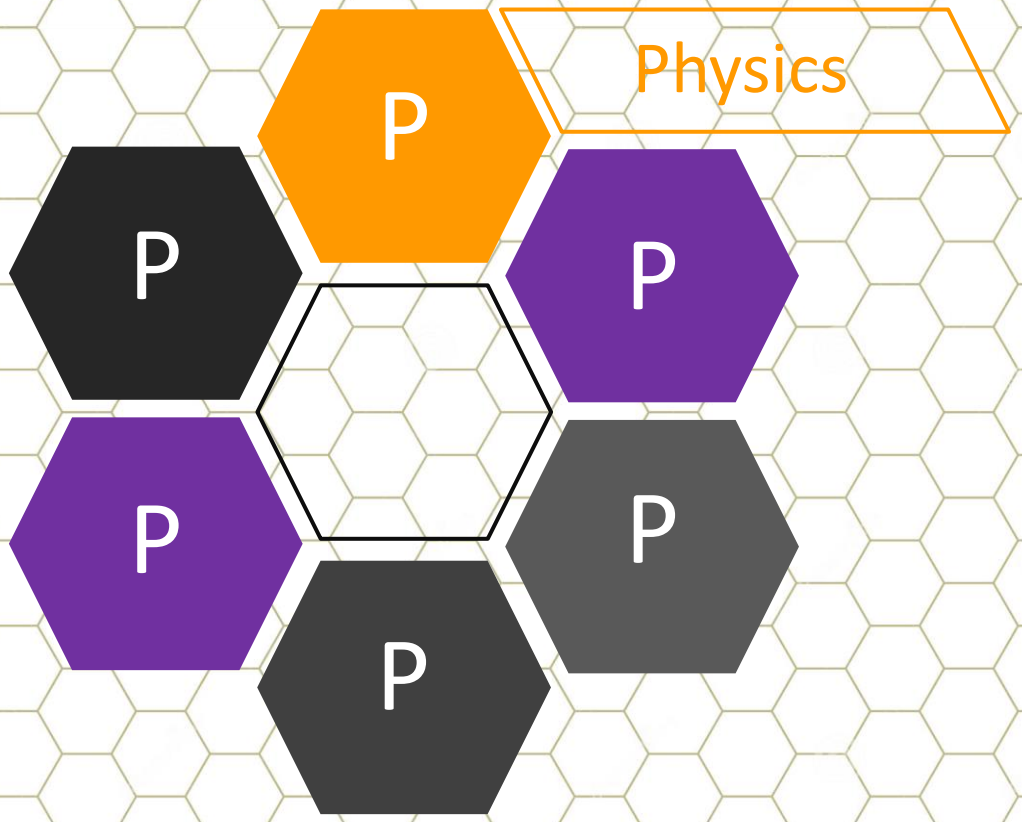
IPF suspected*		Histopathology pattern†			
		UIP	Probable UIP	Indeterminate for UIP or biopsy not performed	Alternative diagnosis
HRCT pattern	UIP	IPF	IPF	IPF	Non-IPF dx
	Probable UIP	IPF	IPF	IPF (Likely)‡	Non-IPF dx
	Indeterminate	IPF	IPF (Likely)‡	Indeterminate§	Non-IPF dx
	Alternative diagnosis	IPF (Likely)‡	Indeterminate§	Non-IPF dx	Non-IPF dx

IPF suspected*		Histopathology pattern			
		UIP	Probable UIP	Indeterminate for UIP	Alternative diagnosis
HRCT pattern	UIP	IPF	IPF	IPF	Non-IPF dx
	Probable UIP	IPF	IPF	IPF (Likely)**	Non-IPF dx
	Indeterminate	IPF	IPF (Likely)**	Indeterminate***	Non-IPF dx
	Alternative diagnosis	IPF (Likely)** /non-IPF dx	Non-IPF dx	Non-IPF dx	Non-IPF dx

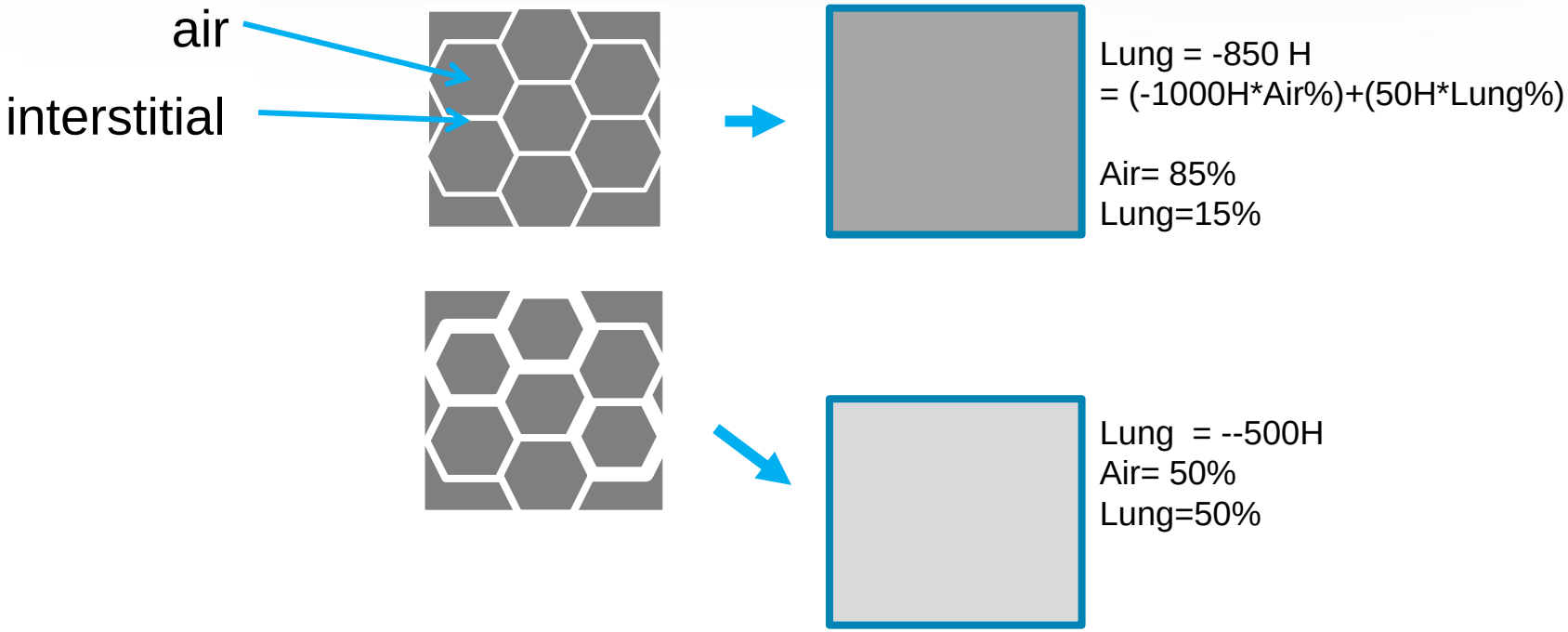
smaller biopsy siz … hen any of the following feat … on bronchiectasis and … nchiectasis in two or more lob … 70 yr, 3) increased neutrop… diagnosis of IPF. § Indetermin…

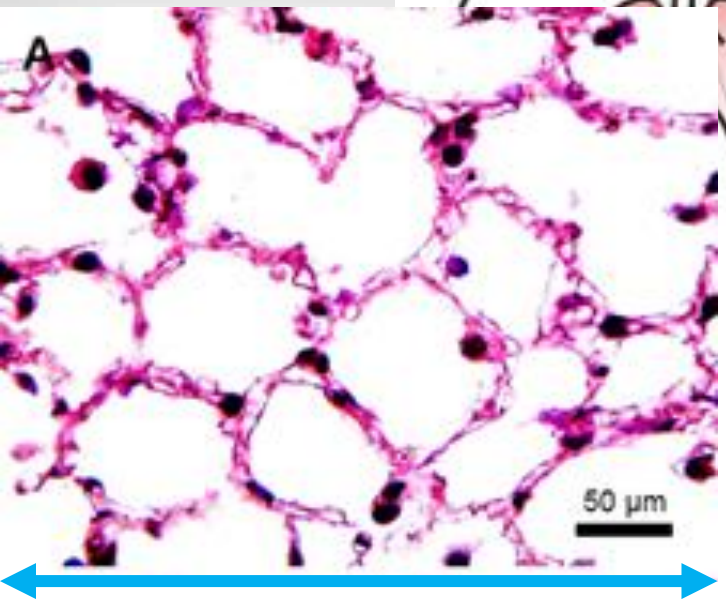
Raghu G et al. AJRCCM 2022; 205:e18-e47

6 Perspectives

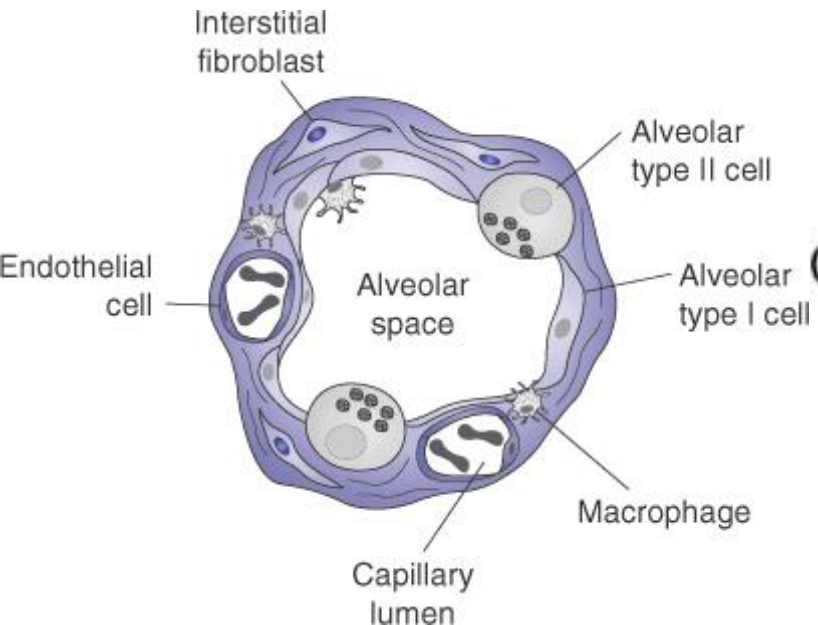


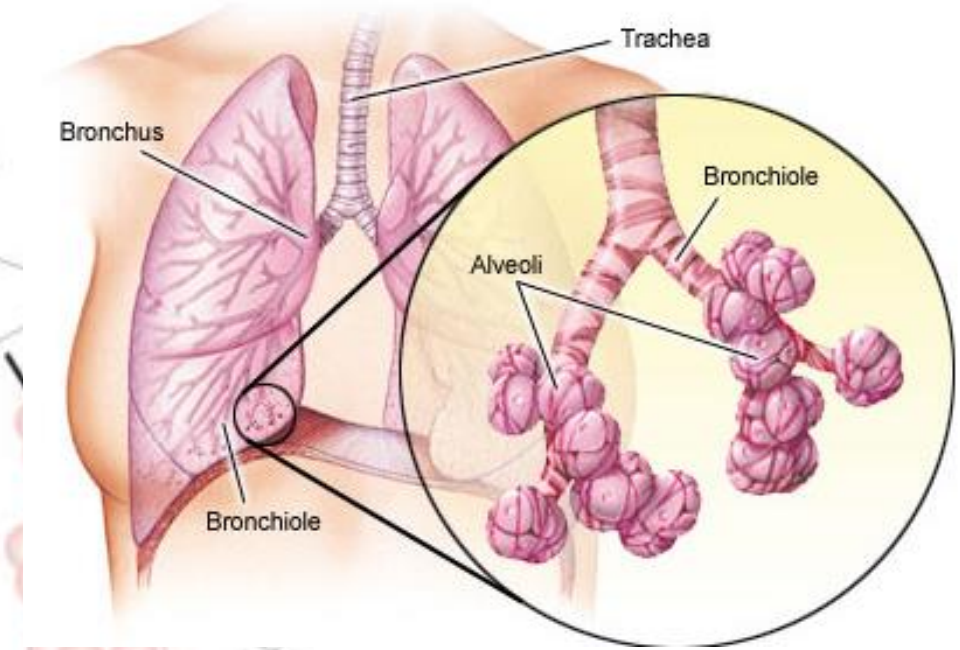
Partial volume effect: Intra-voxel average

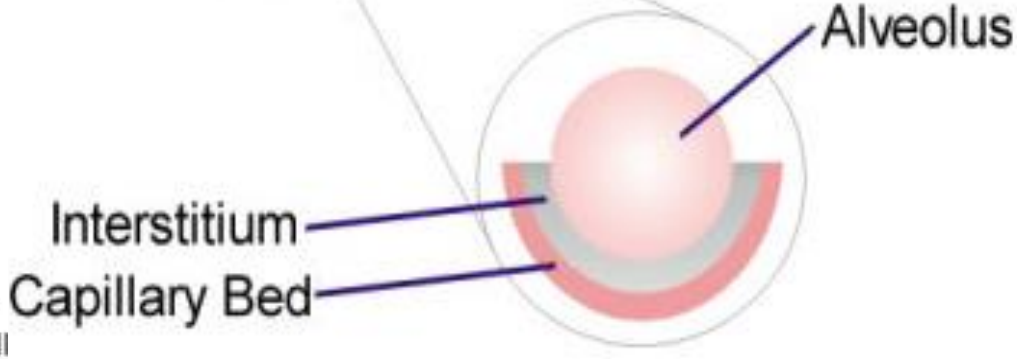




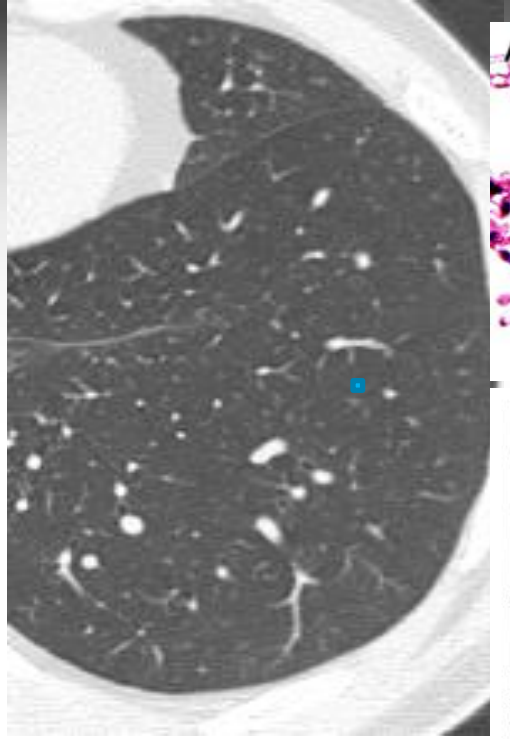
0.5 mm

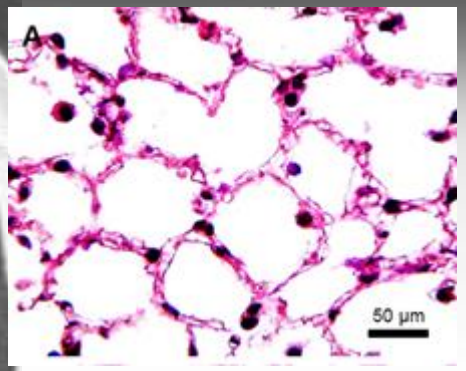


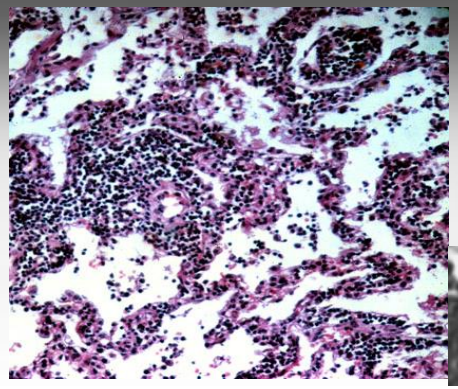


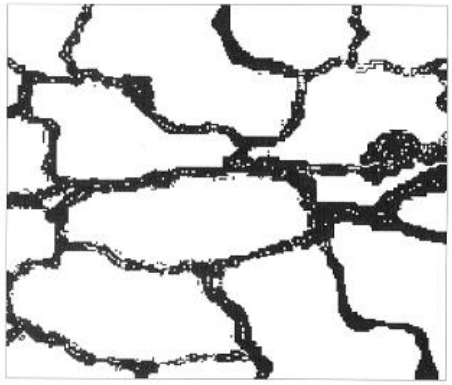


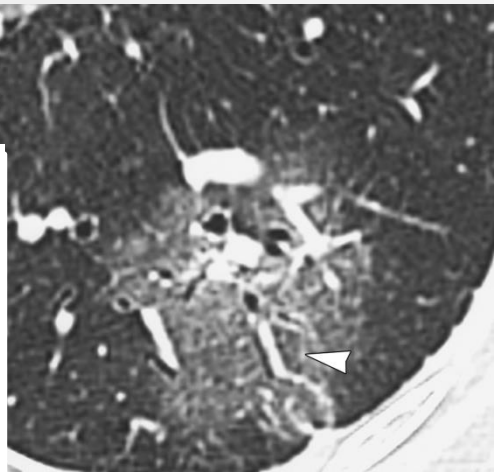
Interstitial compartment is the portion of the lung sandwiched between the epithelial and endothelial basement membrane



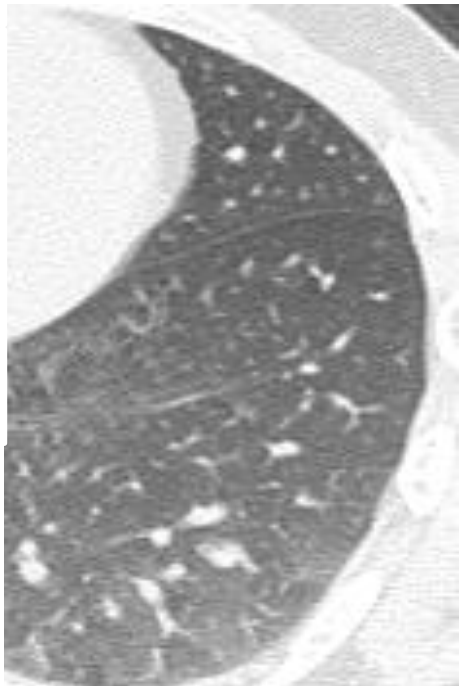






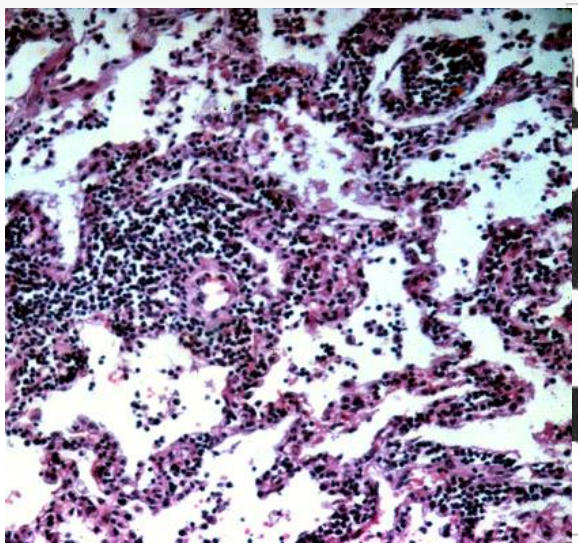
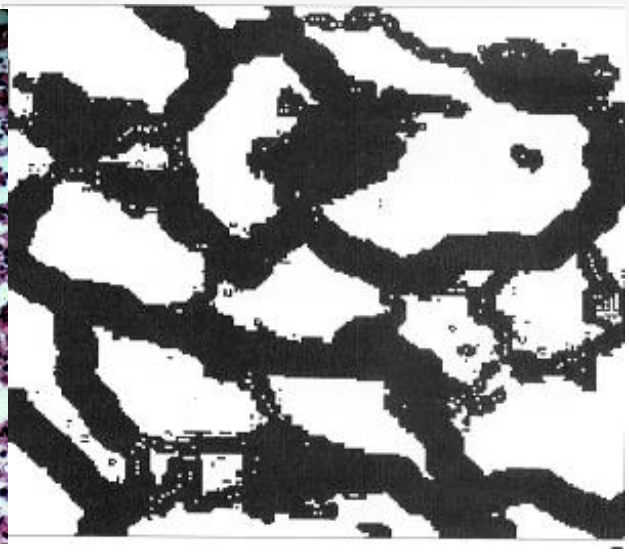
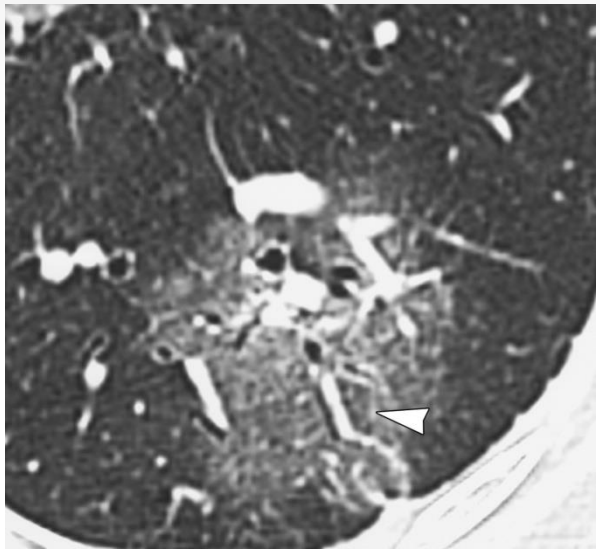
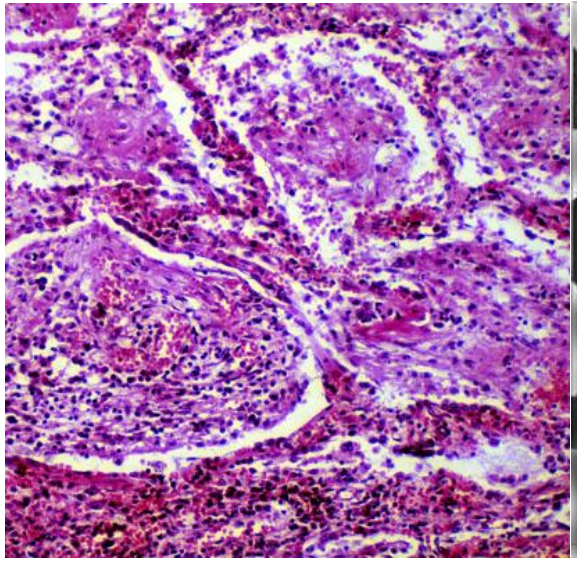
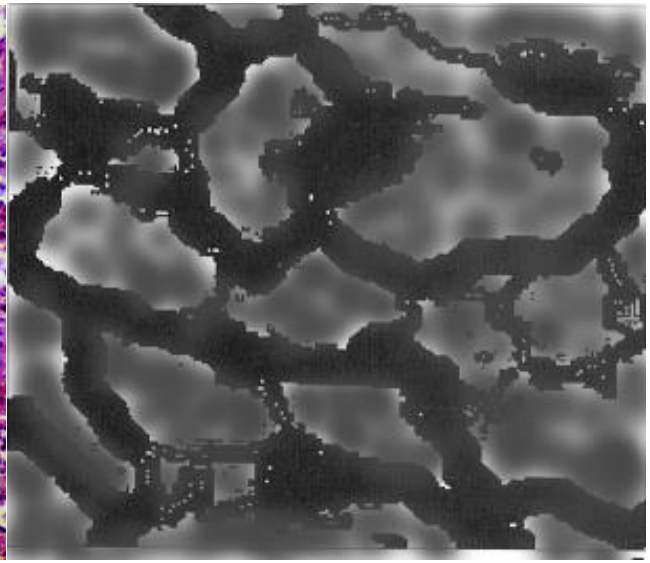
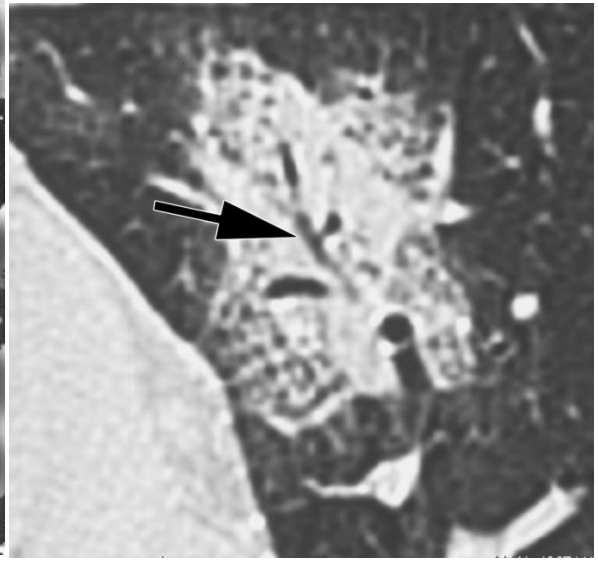


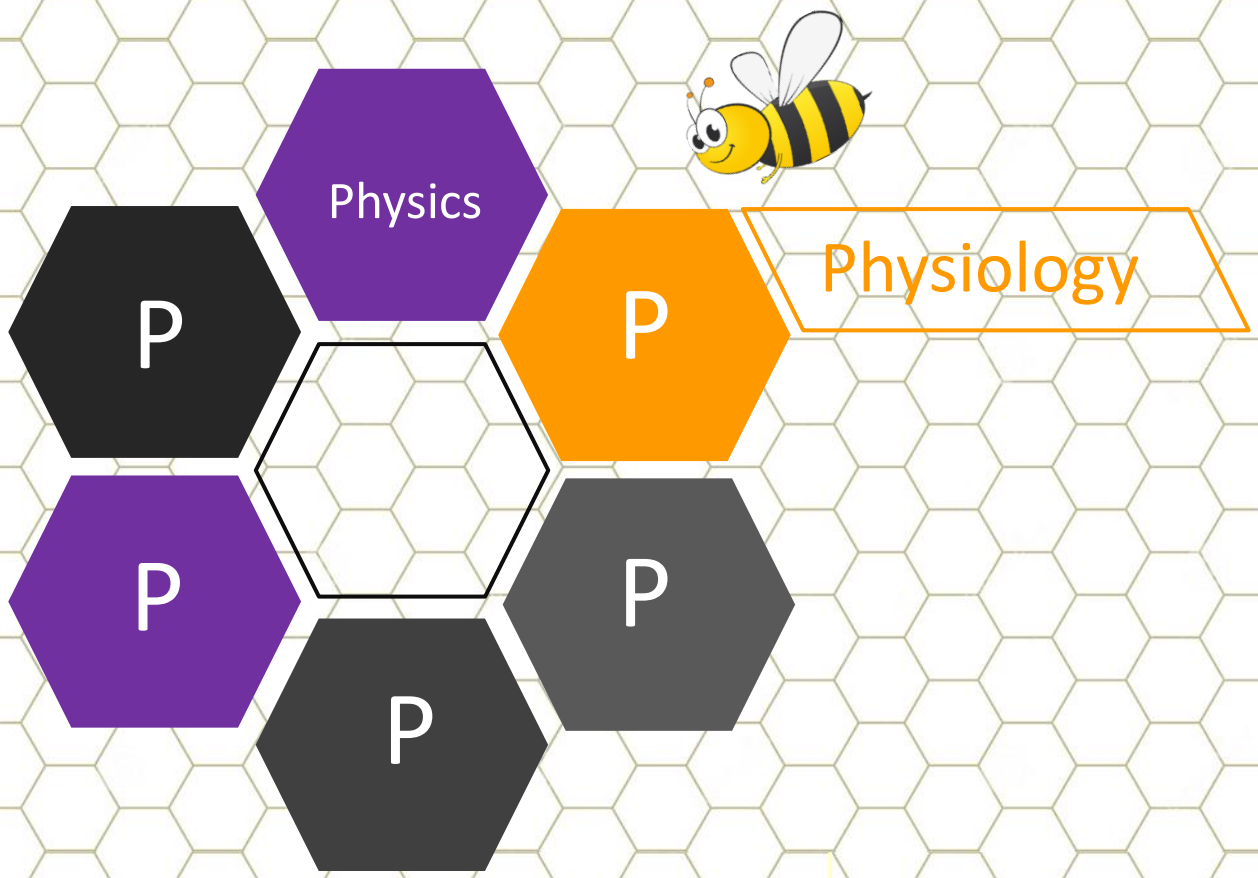
edema,
perfusion



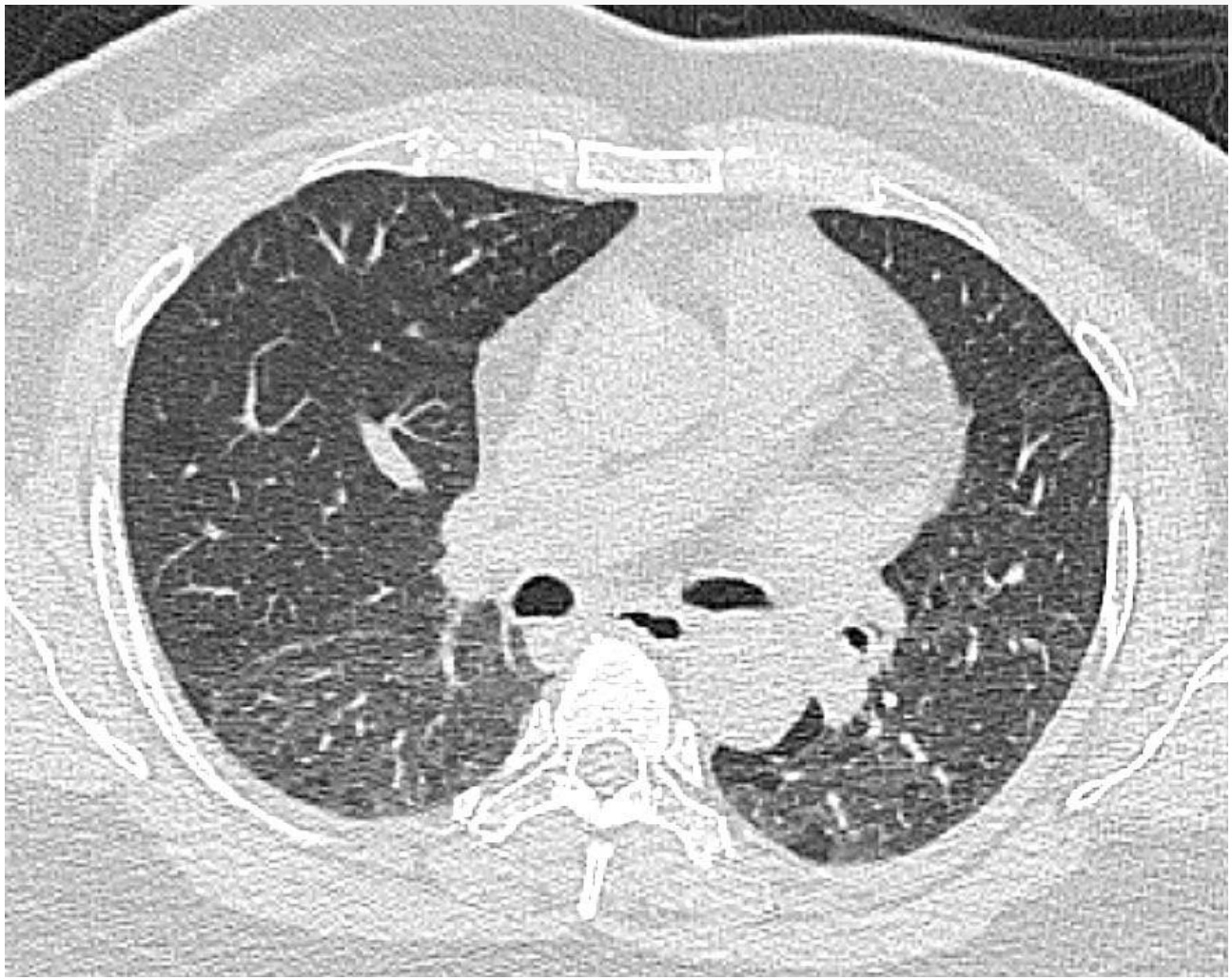
ground-glass opacity
can be an interstitial process!

Ground-glass opacity vs. consolidation
(underlined vessels + vs. -)

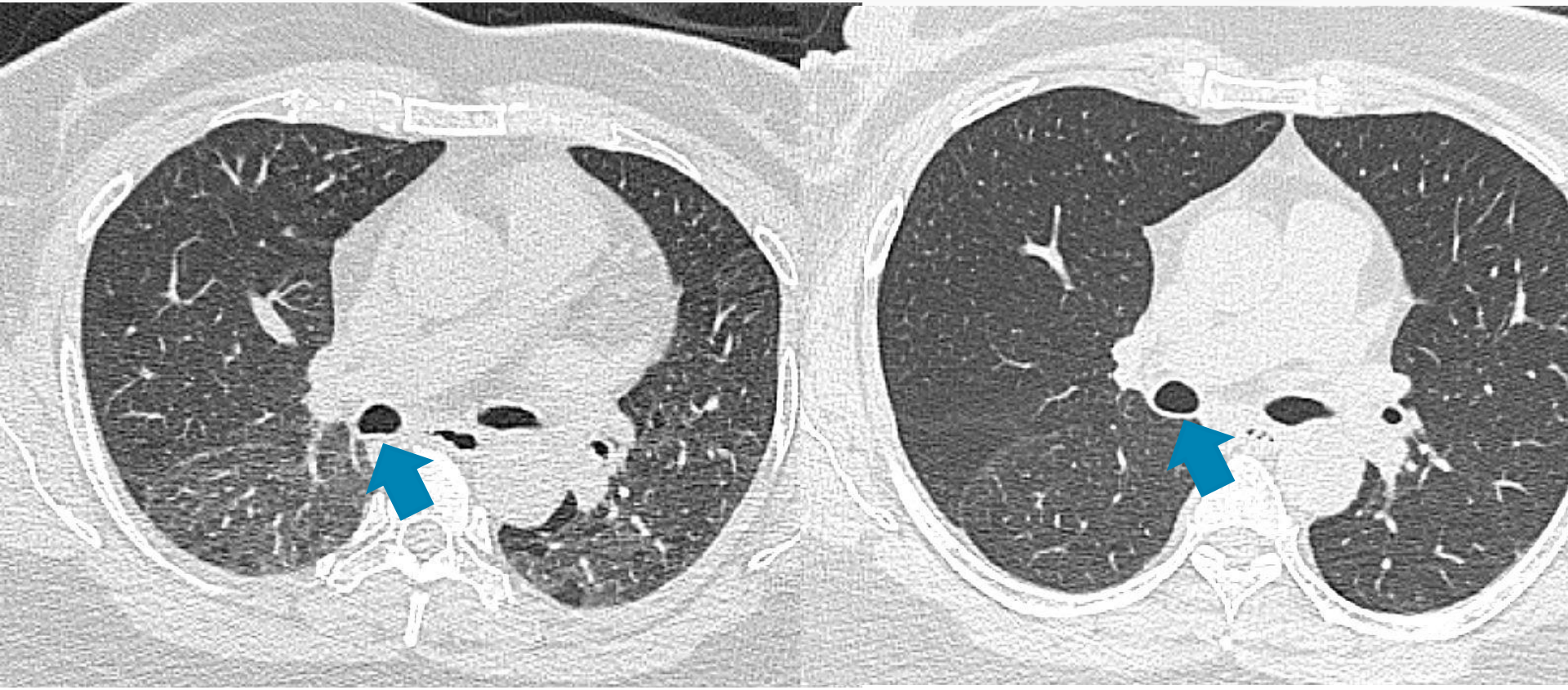








Physics
P
P
Physiology
P
P
P

Is there GGO?

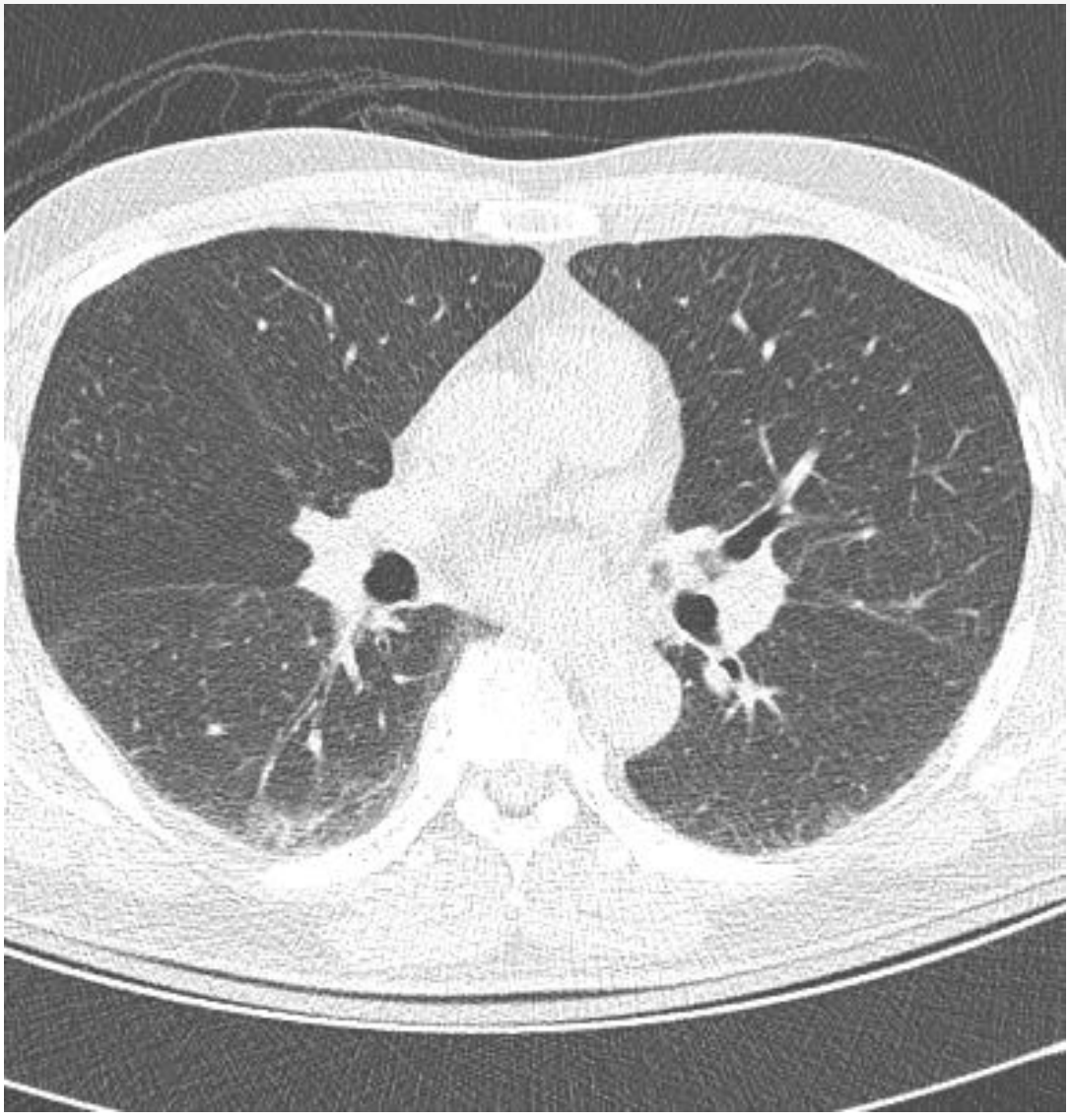


The Influence of Expiratory phase



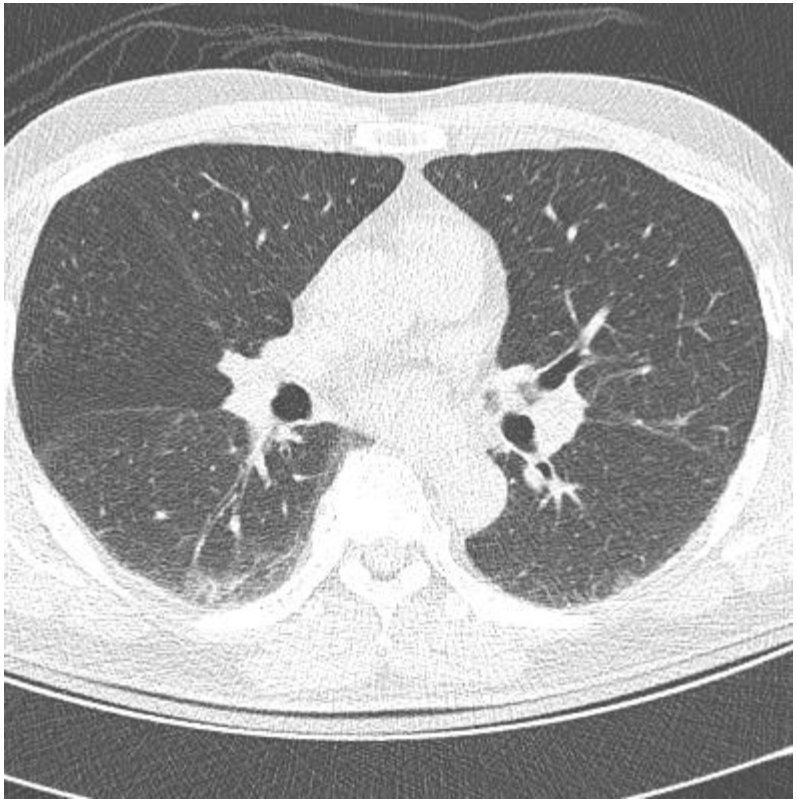
Is there ILA? (interstitial lung abnormality)

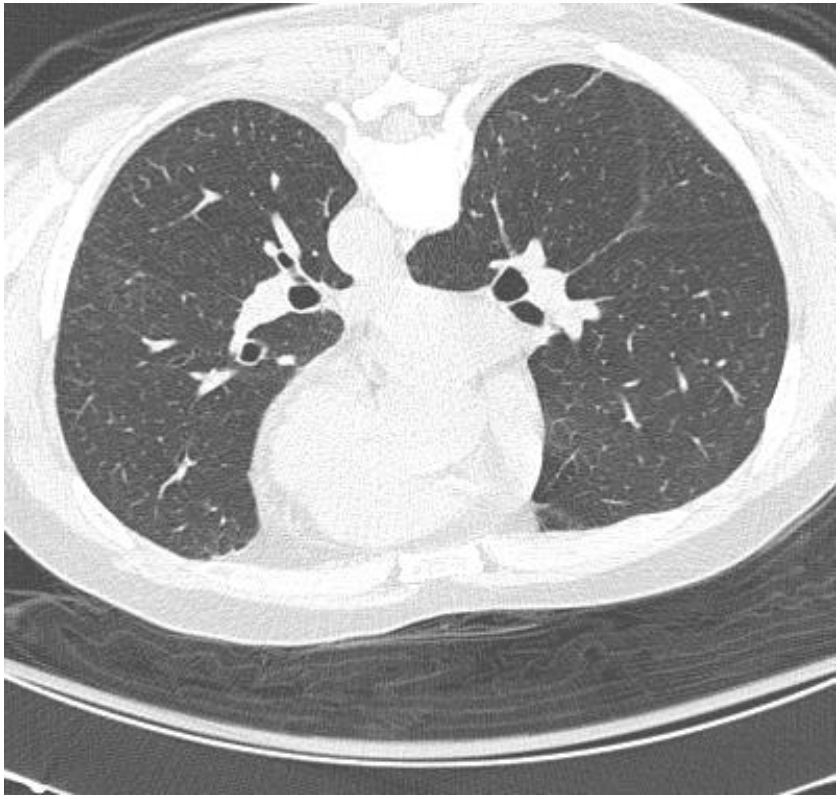
Is it NSIP? indeterminate UIP?



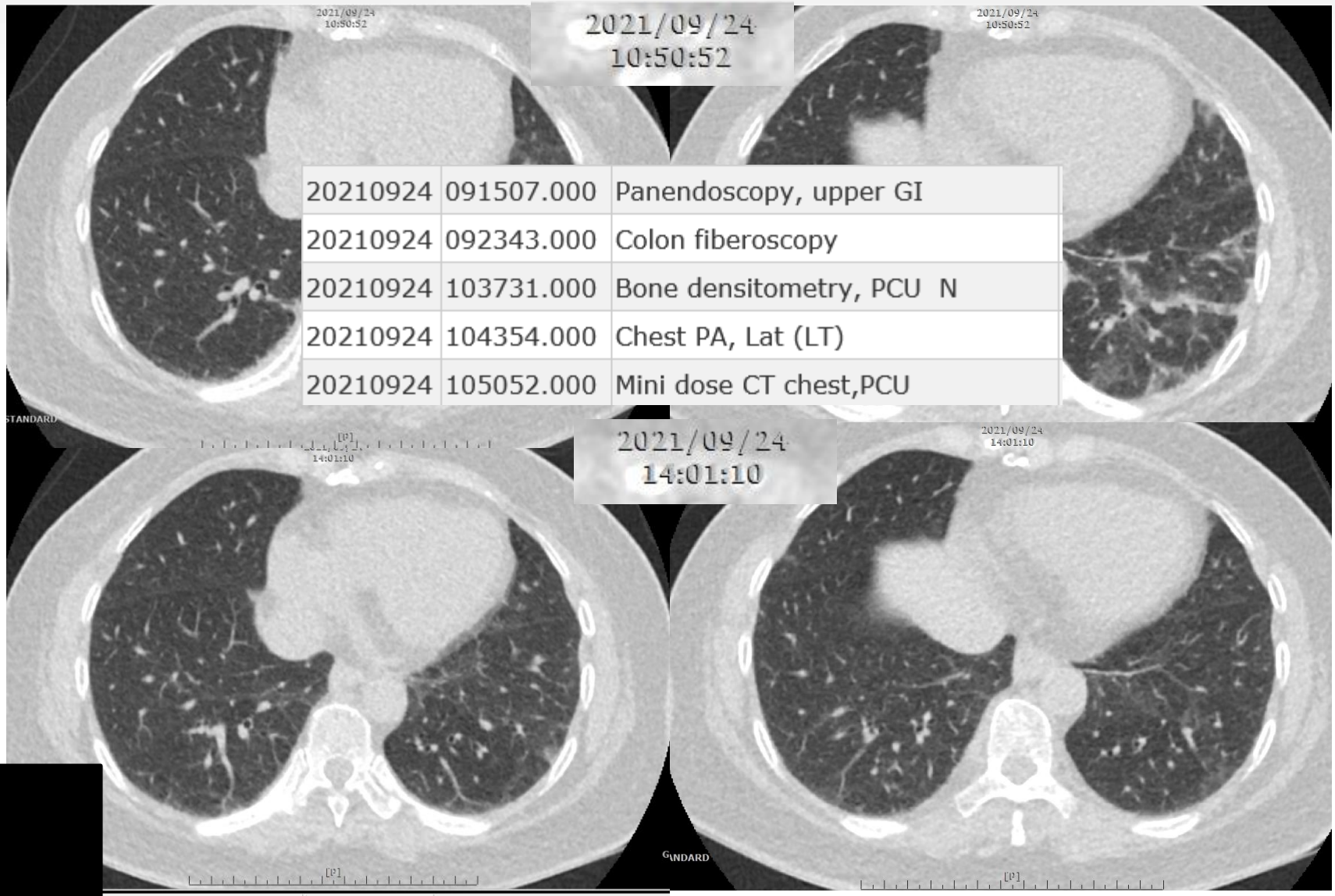
Effect of gravity

Why some centers prefer Prone HRCT routinely



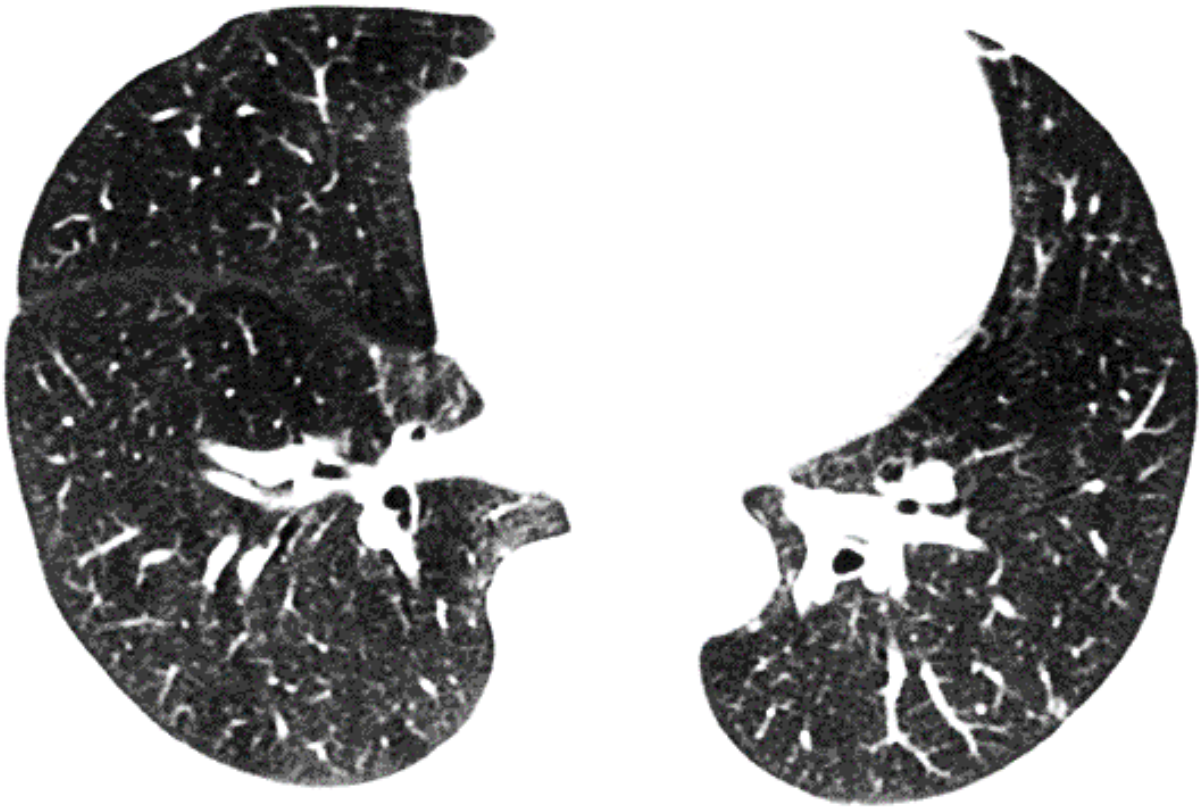


Post-scope Atelectasis



20210924	091507.000	Panendoscopy, upper GI
20210924	092343.000	Colon fiberoscopy
20210924	103731.000	Bone densitometry, PCU N
20210924	104354.000	Chest PA, Lat (LT)
20210924	105052.000	Mini dose CT chest,PCU

53 YOF SOB for months

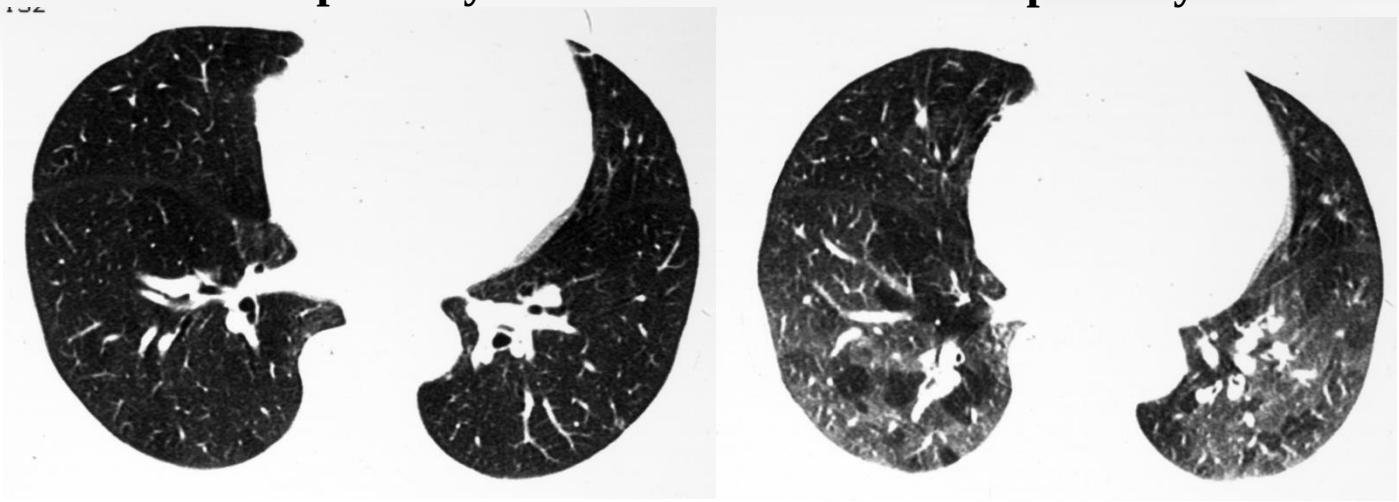


Mosaic perfusion due to small airway disease

Constrictive bronchiolitis = bronchiolitis obliterans

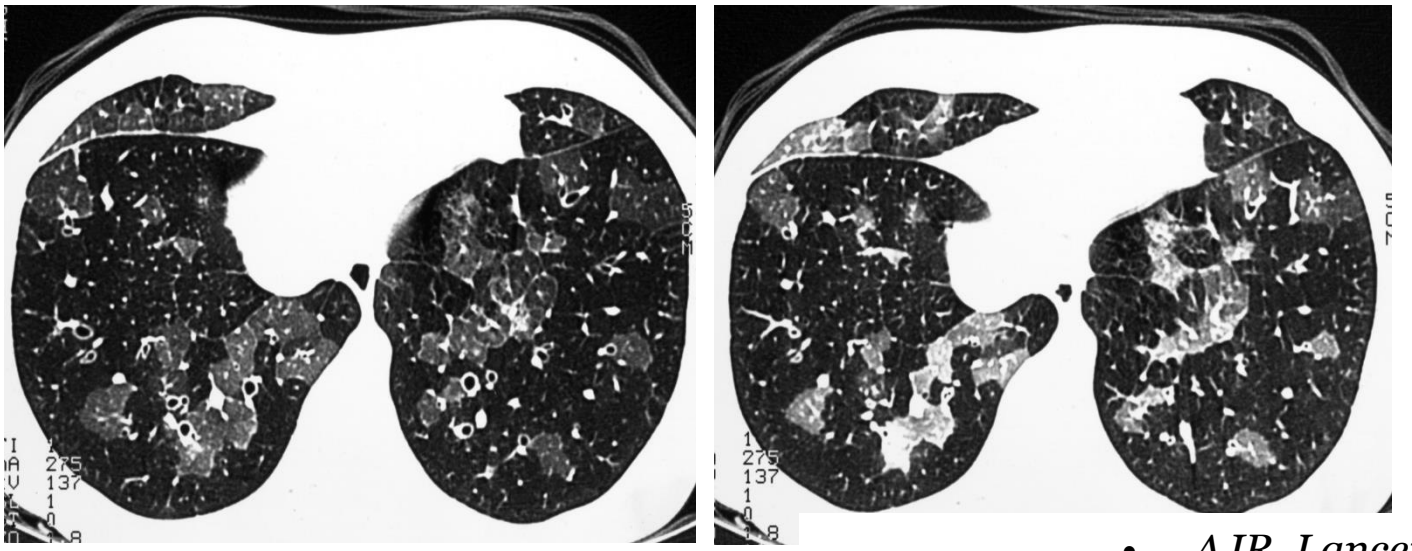
inspiratory **expiratory**

CASE A.
FEV1 =
50% pred



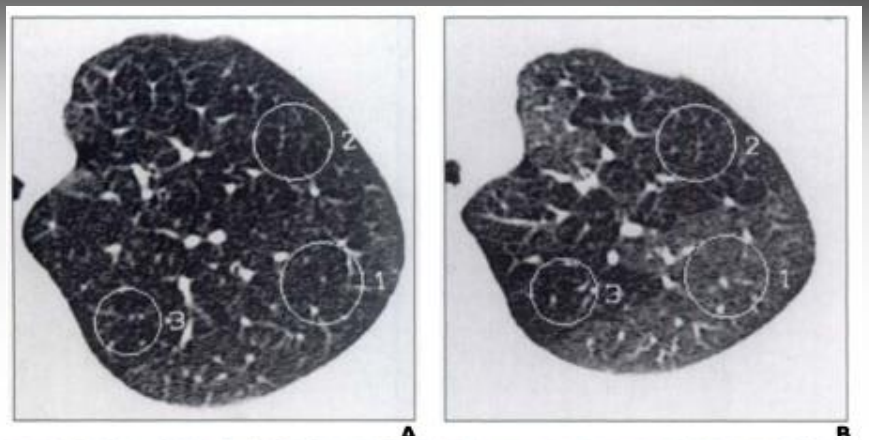
The contrast between light and dark is accentuated on the expiratory image.

CASE B.
FEV1 =
20% pred



- *AJR Lancet 1996*

Correlation of High-Resolution CT and Pulmonary Function in Bronchiolitis Obliterans: A Study Based on 24 Patients Associated with Consumption of *Sauropus Androgynus*



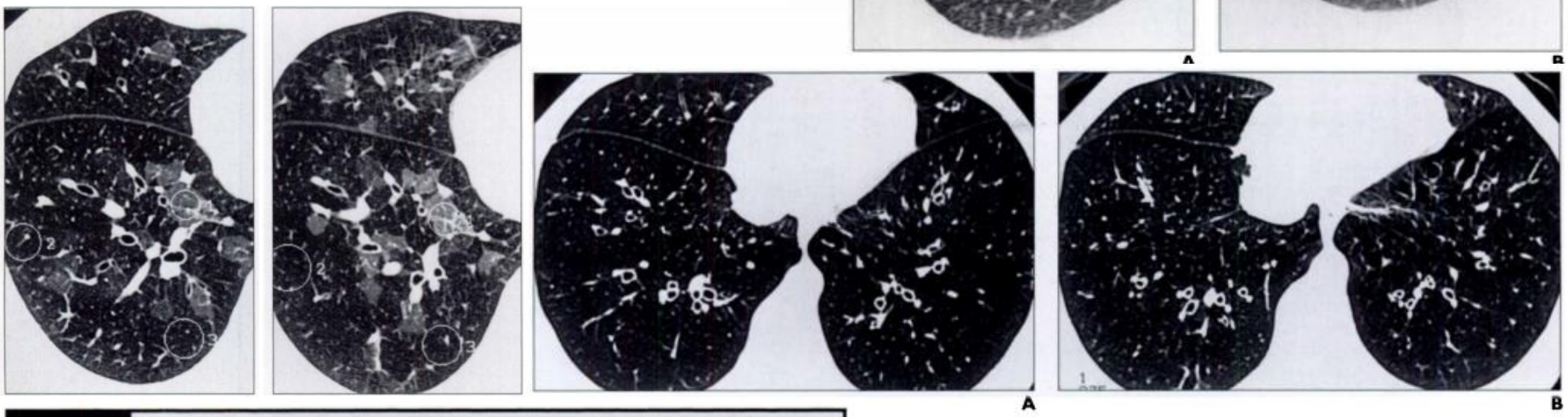
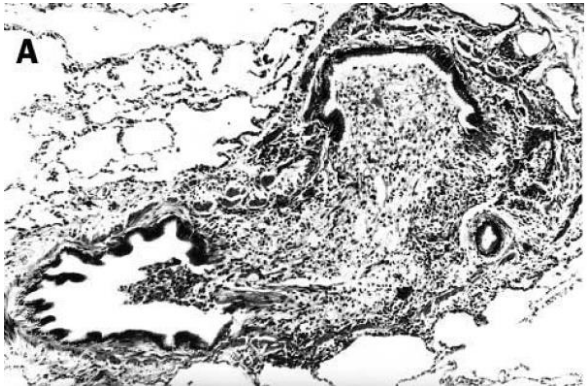


TABLE 2 Spearman Rank Correlation of Pulmonary Function Testing and Scores Given to High-Resolution CT Findings

Score	FEV_1	FVC	DL_{CO}
Bronchial dilatation	−0.41[a]	−0.31	−0.24
Extent of bronchiectasis	−0.42[a]	−0.29	−0.29
Extent of air-trapping	−0.73[b]	−0.48[a]	−0.43[a]
Dynamic attenuation	0.85[b]	0.71[b]	0.66[b]

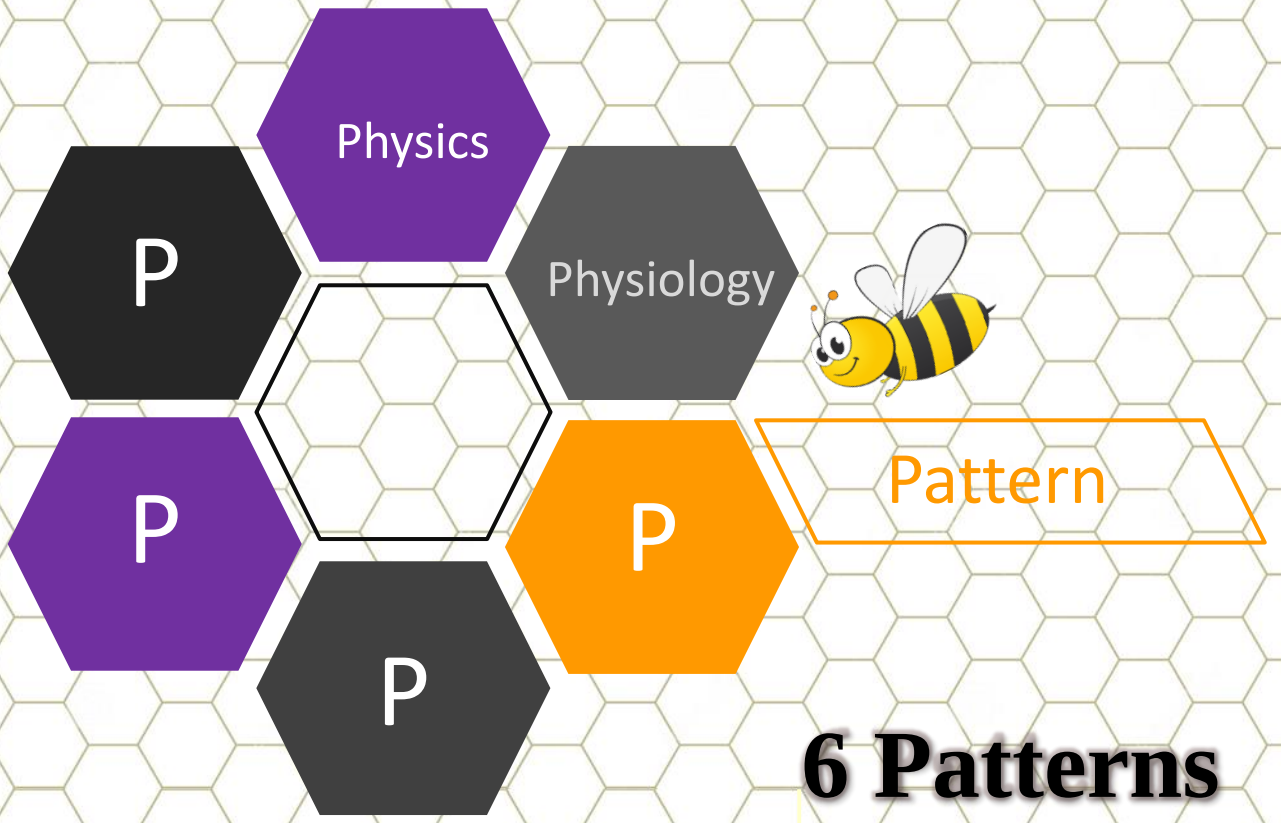
THE LANCET



Outbreak of bronchiolitis obliterans associated with consumption of *Sauropus androgynus* in Taiwan

278 Pt with SABO, 8 lung transplants

AJR Lancet 1996; 348:83-85

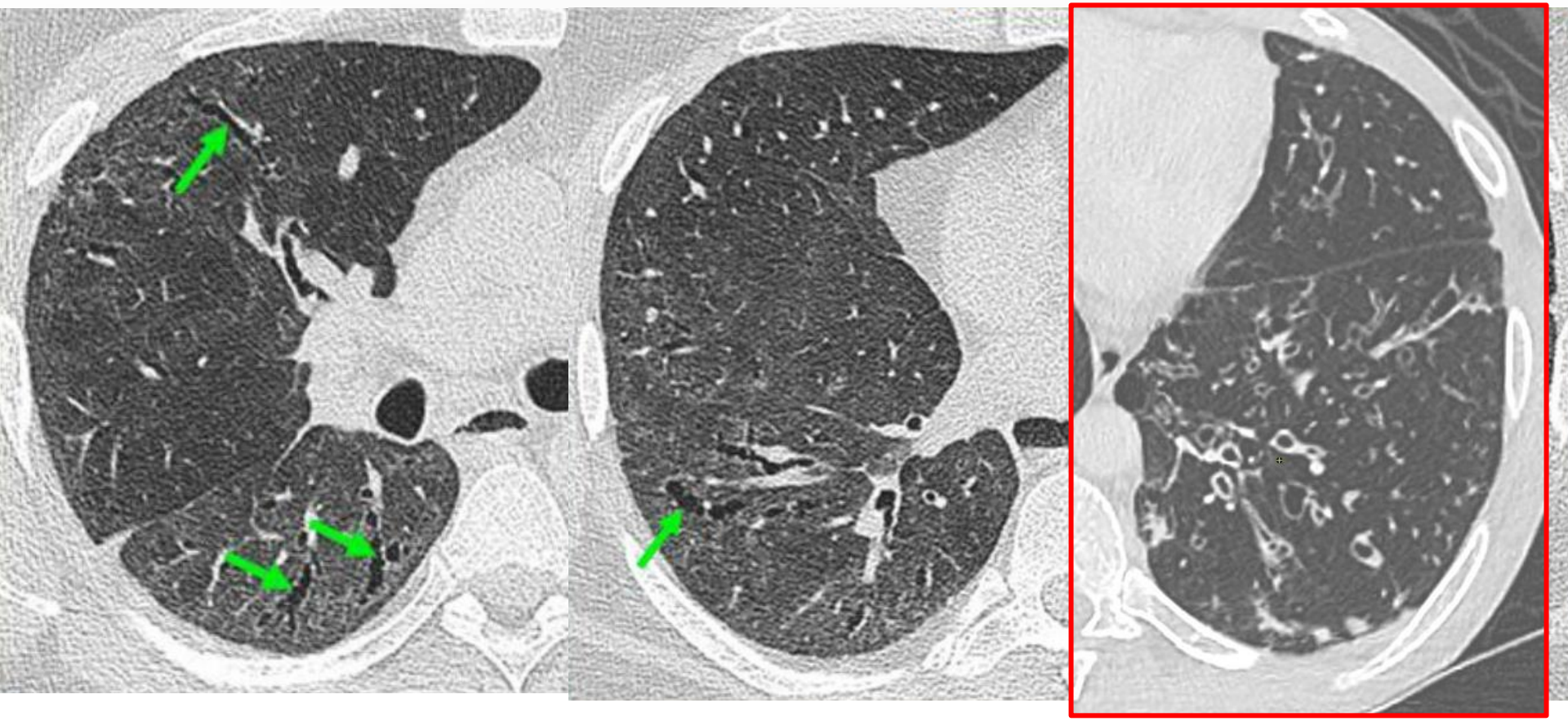


6 Patterns

6 Patterns

- Ground Glass
  - Mosaic
- Honeycomb
- Reticulation
- Traction bronchiectasis
- Distribution

Traction bronchiectasis



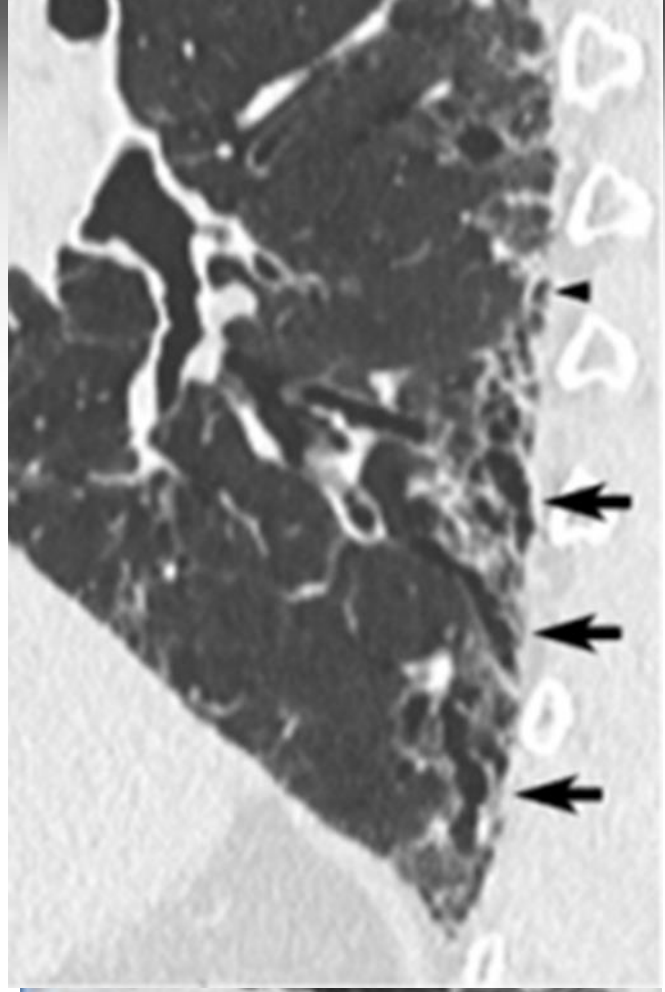
Traction is a surrogate **marker** of the **burden of fibroblastic foci** in the adjacent lung parenchyma which is a known indicator of poor prognosis

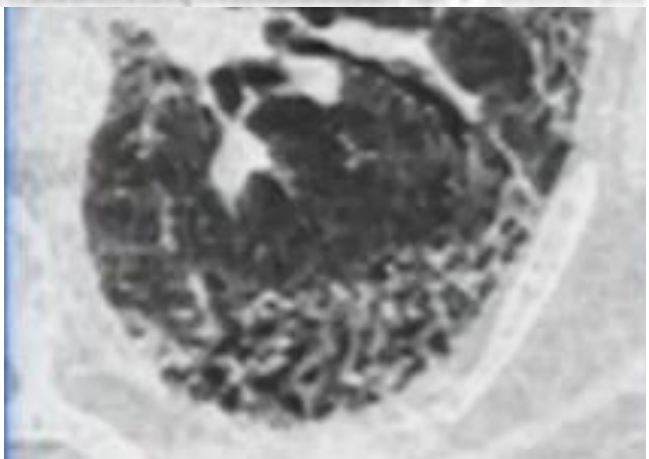
Traction bronchiectasis: Central vs. peripheral

- **False positive identification**
  -honeycombing
  -dilated bronchi within OP/DAD
  -conspicuous, but not dilated bronchi within GGO

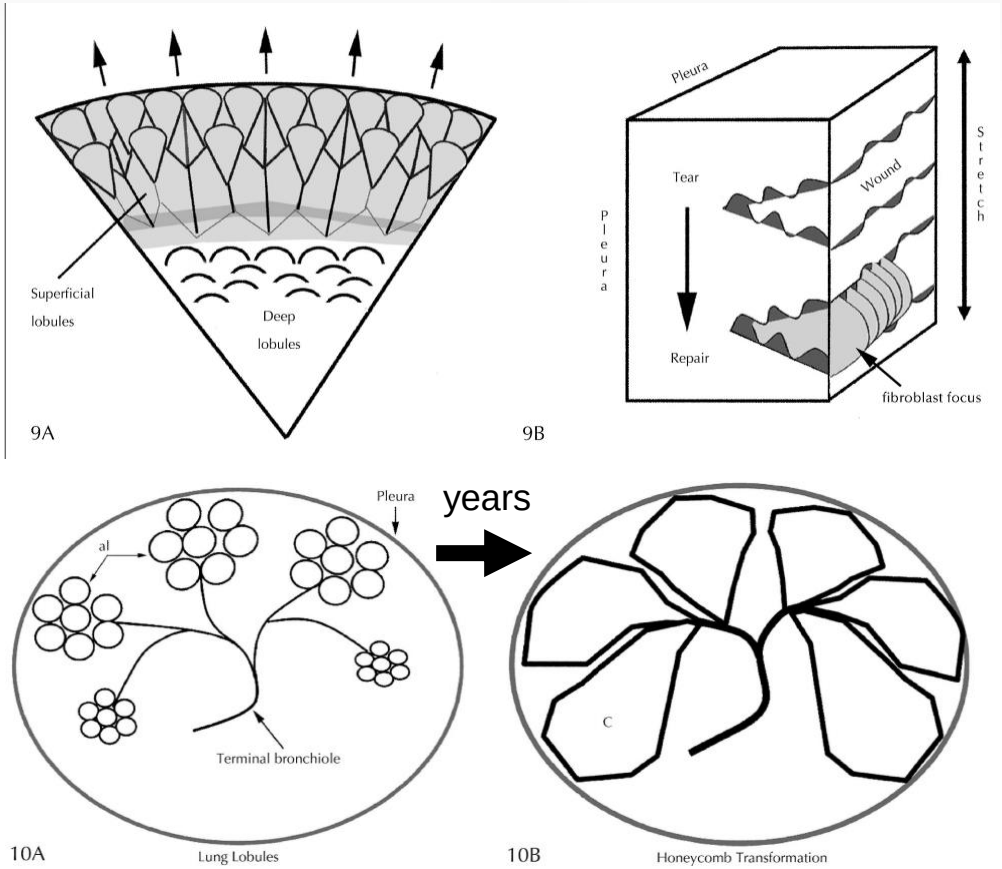
- **False negative**
  -Within honeycombing (advanced)

*Kappas =**0.58-0.69***





Traction –Repair Injury Hypothesis



Arch Pathol Lab Med—Vol 136, June 2012

A, the structural relationships between the superficial and deep lung lobules are important in the mechanics of lung ventilation
B, shear forces in the peripheral lung lead to tears in the epithelium, followed by prolonged fibroblastic repair.

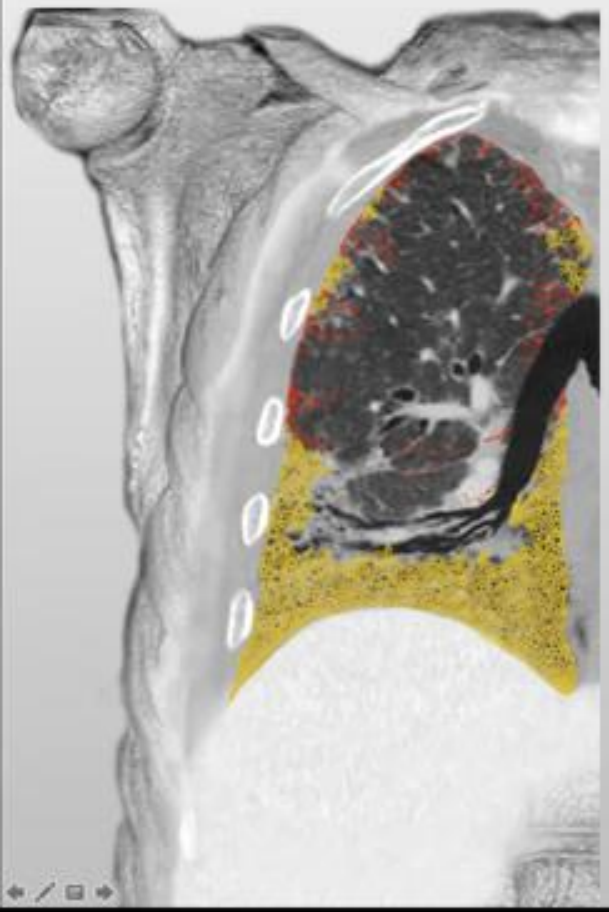
The alveoli (al) in the involved lobules (A) become obliterated in scar, and the terminal ends of the respiratory bronchioles and alveolar ducts expand to form (B) aggregations of mucous-filled cysts (C)

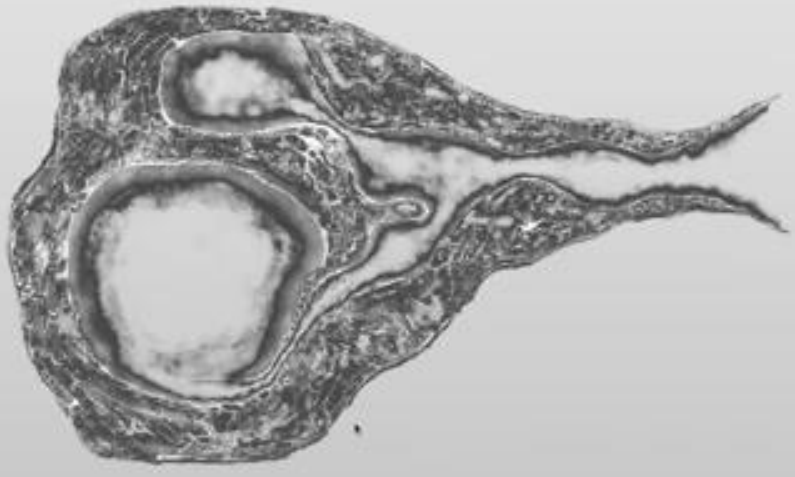
- Microscopic honeycombing cyst:
  Lining: airway respiratory mucosa;
  Walls: smooth muscle of the terminal airway
- Continued respiratory motion caused progressive dilatation of residual respiratory bronchioles… years…
- Grossly, CT honeycombing

.

Traction bronchiectasis to Honeycombing

Honeycombing: bronchiolar dilatation/flap valve formation





Jeffrey R. Galvin AIRP

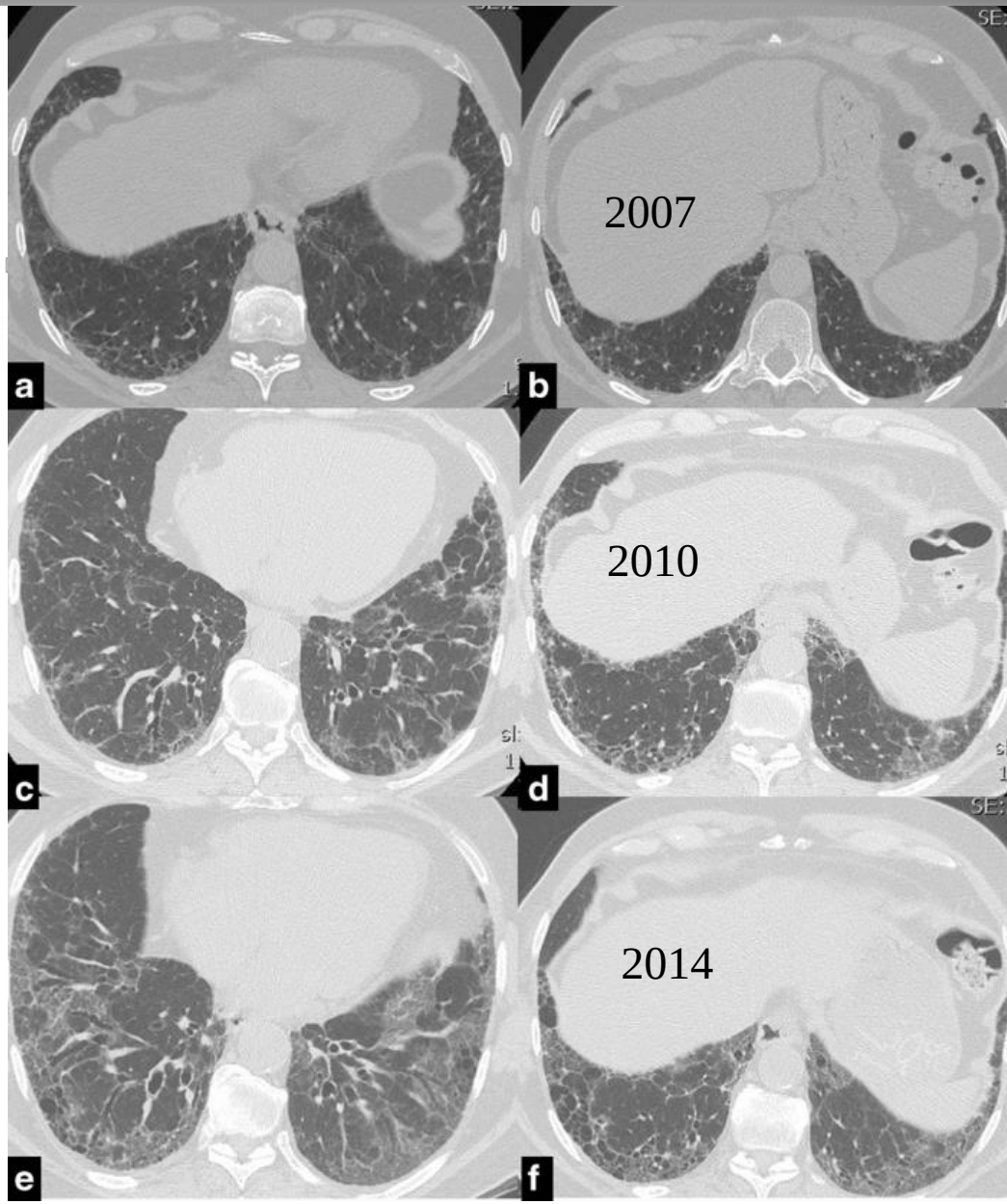
From “traction bronchiectasis” to honeycombing in idiopathic pulmonary fibrosis: A spectrum of bronchiolar remodeling also in radiology?

Sara Piciucchi[1*], Sara Tomassetti[2], Claudia Ravaglia[2], Christian Gurioli[2], Carlo Gurioli[2], Alessandra
Angelo Carloni[4], Marco Chilosi[5], Thomas V Colby[6] and Venerino Poletti[2,7]

- TXB in IPF is better interpreted as resulting from **bronchiolar proliferation rather than from pure mechanical traction** of a single airway by scarring tissue.

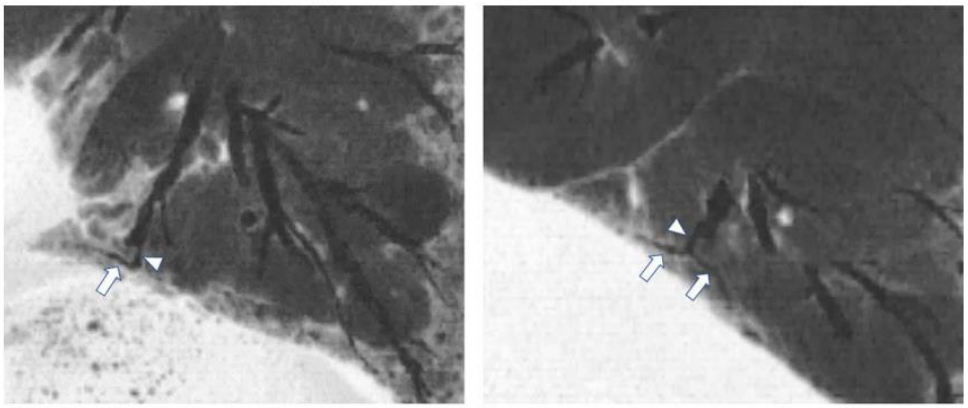
UIP

- TXB and honeycombing is a unique and **continuous** process of **bronchiolar dysplastic proliferation** and to interpret accordingly the HRCT features.



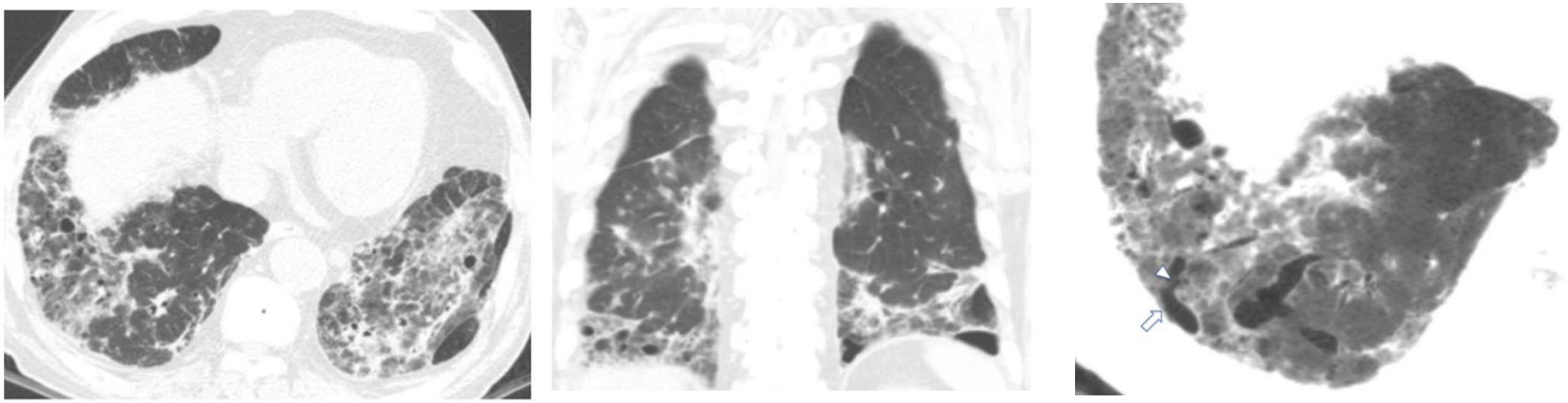
Piciucchi et al. BMC Pulmonary Medicine (2016) 16:87
DOI 10.1186/s12890-016-0245-x

Right-Angled Traction Bronchiectasis in Differentiating Idiopathic Pulmonary Fibrosis Without Honeycombing From Idiopathic Nonspecific Interstitial Pneumonia



A B

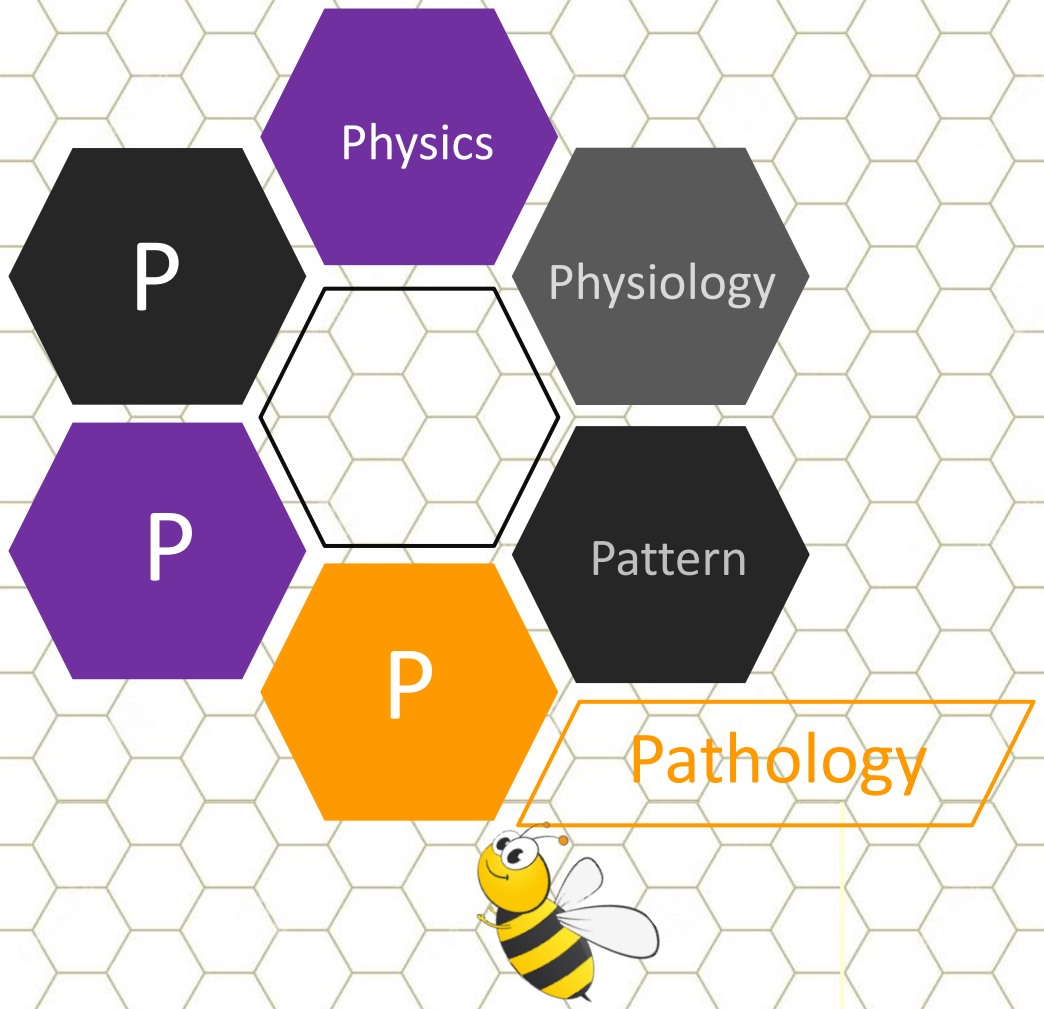
- mIP: 20 mm slab/5 mm increment
- 90 degree between the proximal and distal bronchus (usu. parallel to pleura) in the background of fibrosis
- The mean kappa value for 90°-TxB was 0.49 ± 0.19



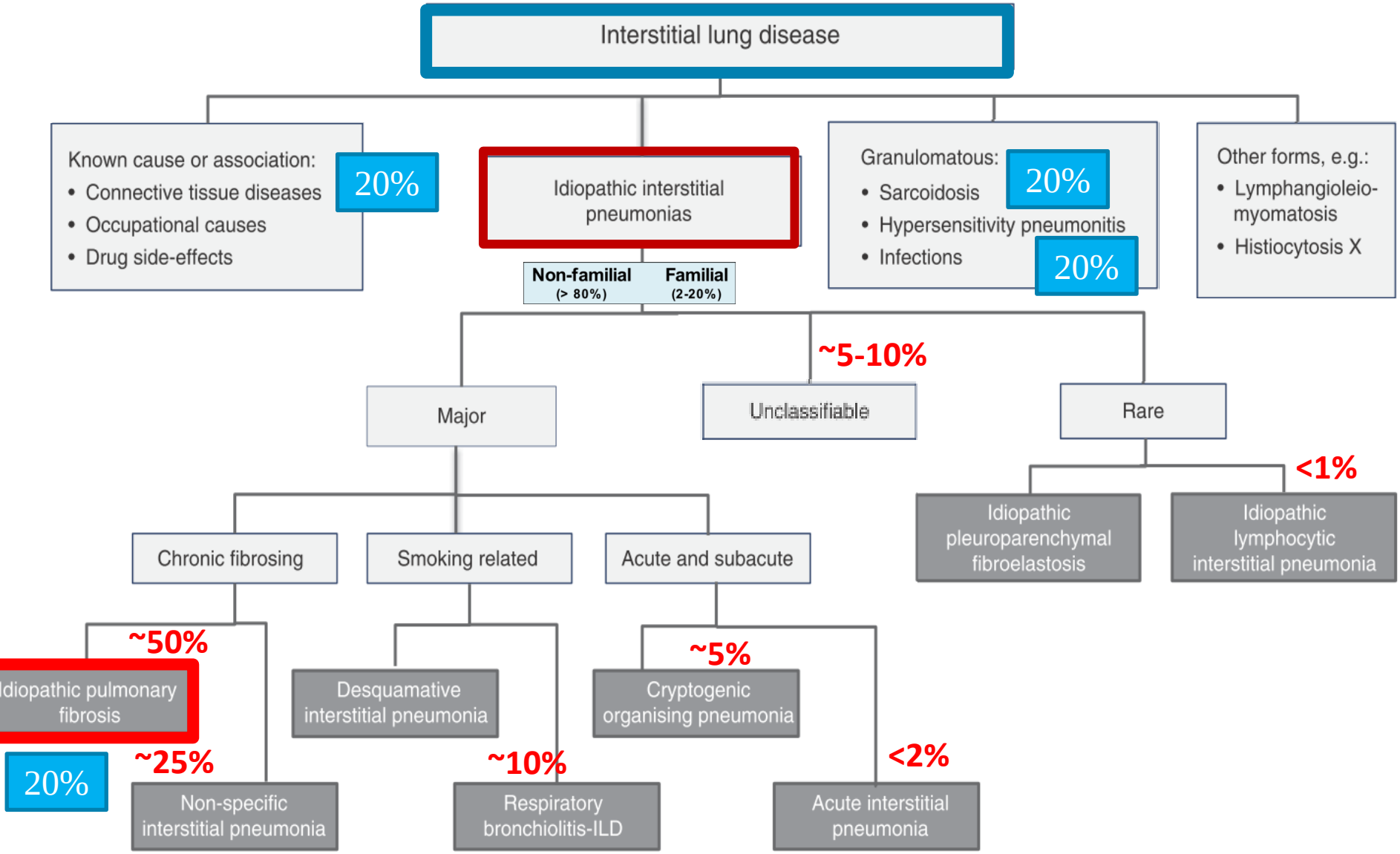
A

68 YOM. A.B heterogenous reticulation, GGO and bronchovascular involvement => alternative dx. C. mIP 90°-TxB. Patho. = UIP

Jin Mo Goo, SNU,H, Invest Radiol 2020;55: 387 – 395)

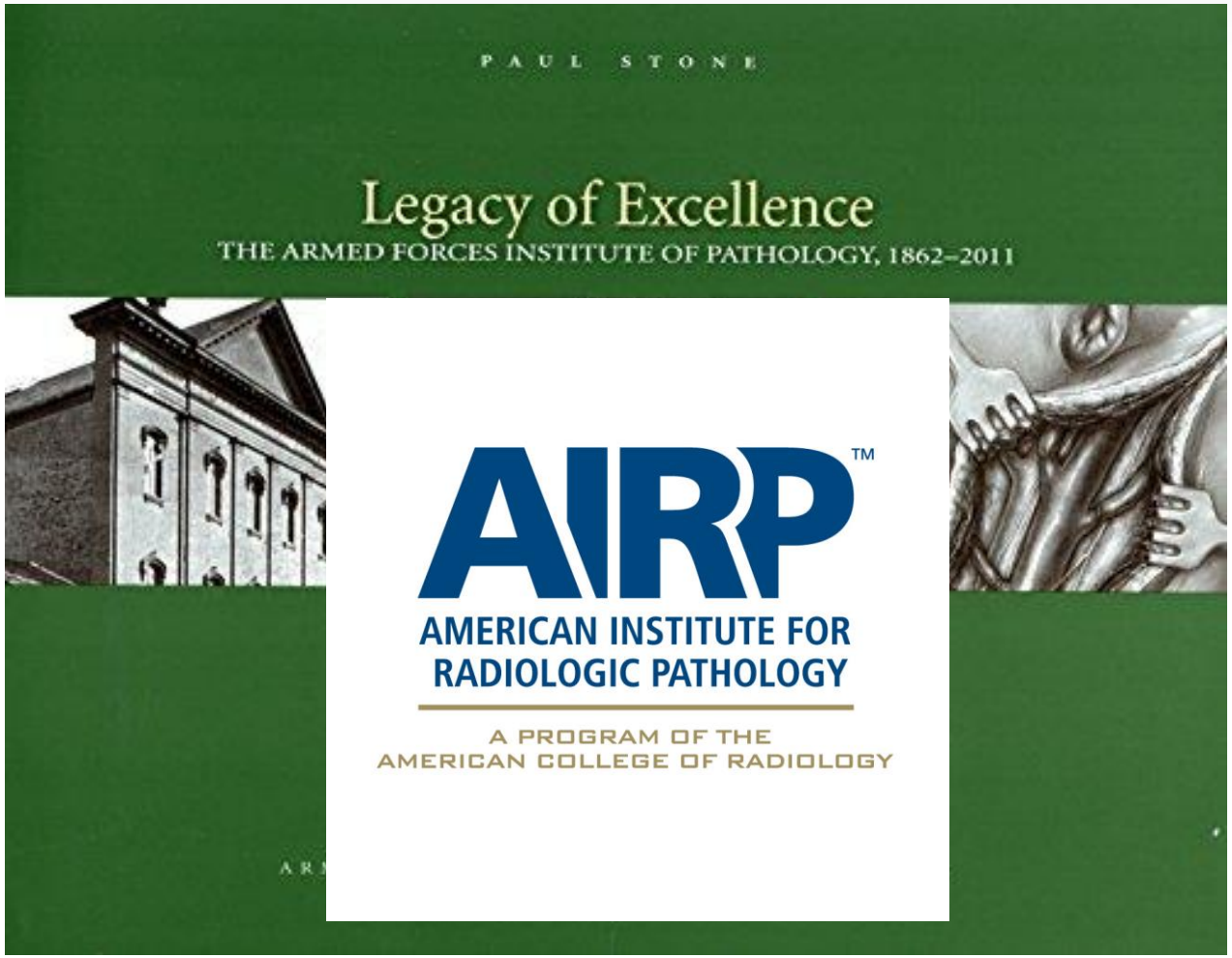

Physics
P
Physiology
P
Pattern
P
Pathology

2013 ATS-ERS Classification of IIP



An official American Thoracic Society/European Respiratory Society statement: update of the international multidisciplinary classi fi cation of the idiopathic interstitial pneumonias. Am J Respir Crit Care Med 2013; 188 : 733 – 748.

Fibrosing Alveolitis = UIP



Protocol

P

Physics

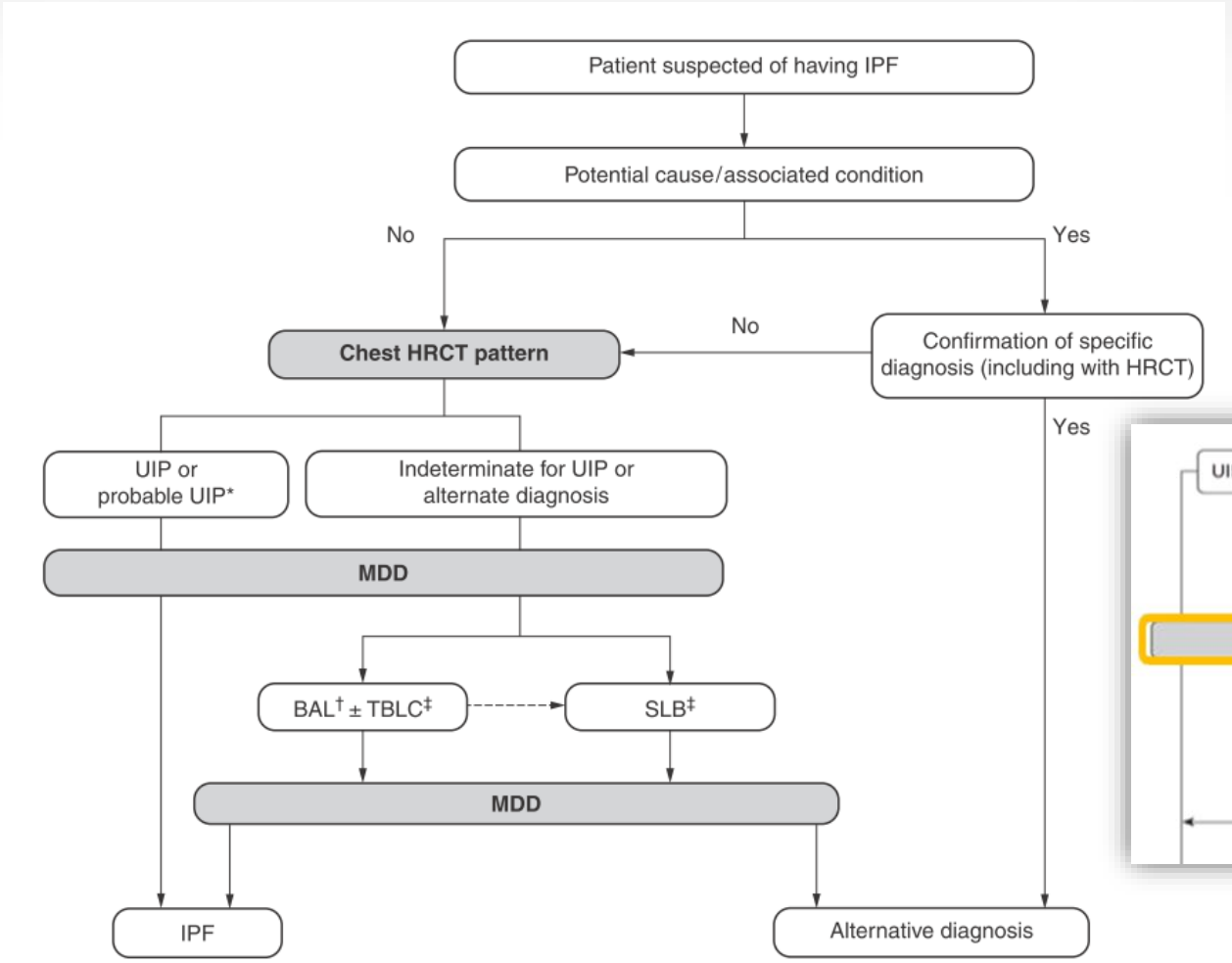
Physiology

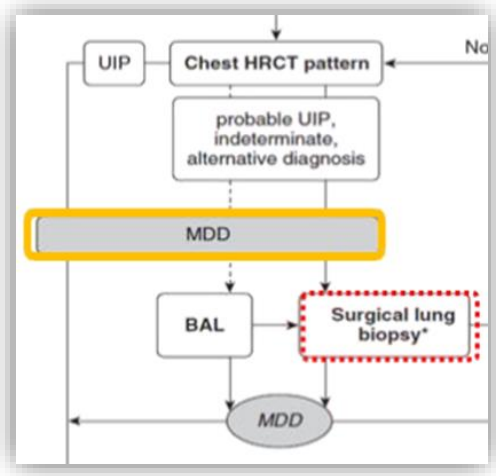
P

Pattern

Pathology

Diagnostic algorithm for idiopathic pulmonary fibrosis (IPF)





TBLC: transbronchial lung cryobiopsy SLB: surgical lung bx

Raghu G et al. AJRCCM 2022; 205:e18-e47

Multicentre evaluation of multidisciplinary team meeting agreement on diagnosis in diffuse parenchymal lung disease: a case-cohort study

SLF Walsh et al Lancet Respir Med 2016; 4: 557

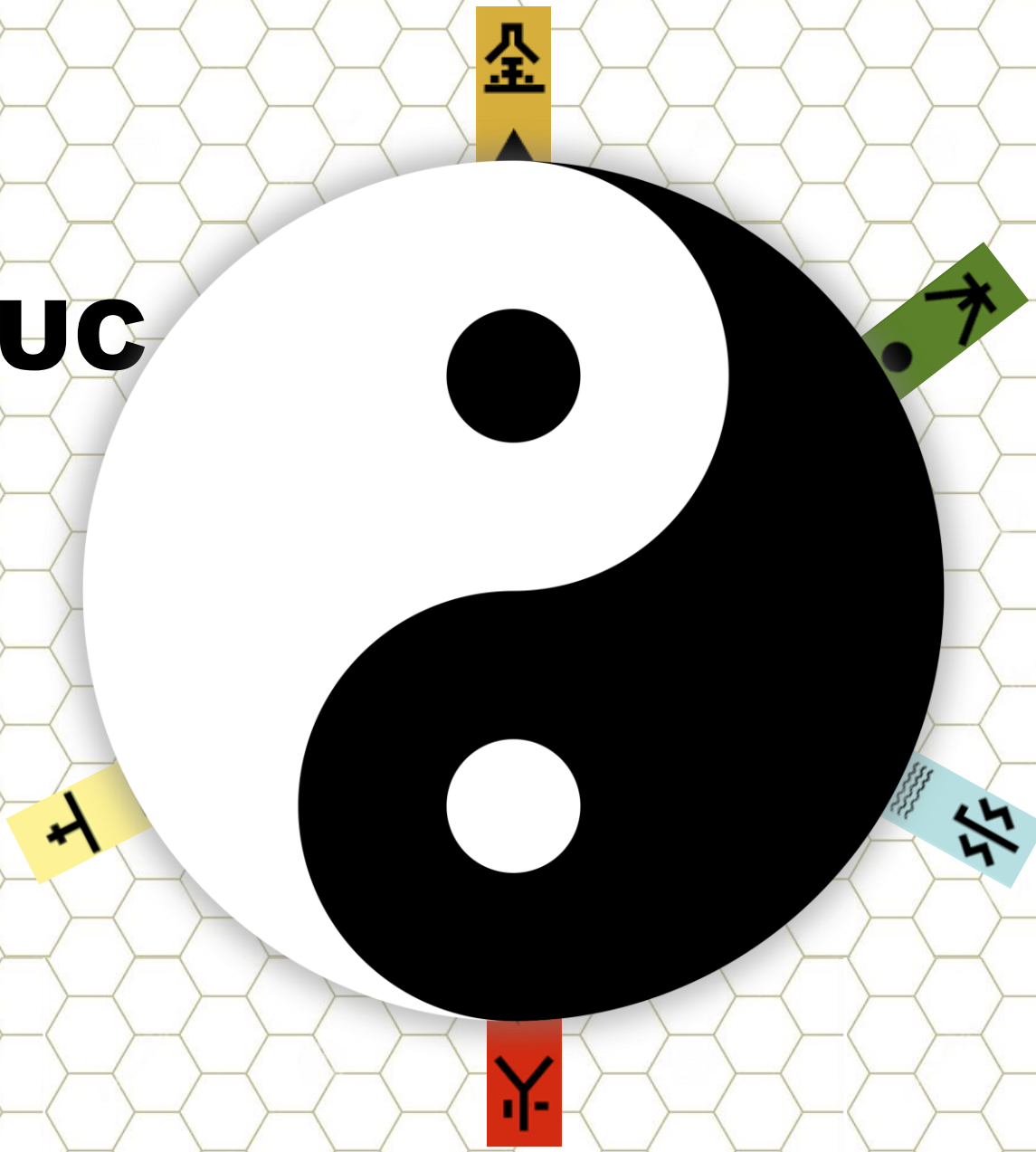
- 70 cases of ILD from Royal Brompton
- 7 MDT across Euro

% of 1st choice	Clinicians (κw)	Radiologists (κw)	Pathologists (κw)	MDTM (κw)
Idiopathic pulmonary fibrosis 18%	0·72 (0·67–0·76)	0·60 (0·46–0·66)	0·58 (0·45–0·66)	0·71 (0·64–0·77)
Connective tissue disease-related interstitial lung disease 30%	0·76 (0·70–0·78)	0·17 (0·08–0·31)	0·21 (0·06–0·36)	0·73 (0·68–0·78)
Non-specific interstitial pneumonia 9%	0·31 (0·27–0·41)	0·32 (0·26–0·41)	0·30 (0·00–0·53)	0·42 (0·37–0·49)
Hypersensitivity pneumonitis 9%	0·42 (0·30–0·47)	0·35 (0·29–0·43)	0·26 (0·10–0·45)	0·29 (0·24–0·40)

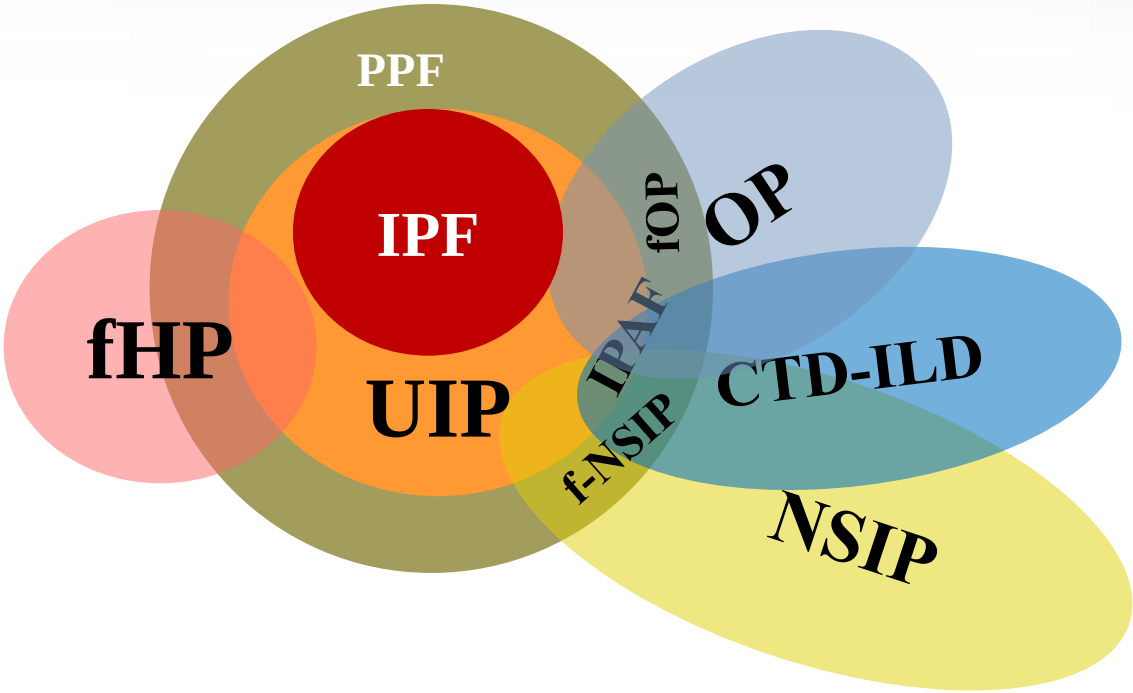
Data are median (IQR). MDTM=multidisciplinary team meeting.

Table 4: **Weighted kappa values (κw) for estimation of diagnostic likelihood for individual diagnoses of diffuse parenchymal lung disease**

UC



The HRCT Diagram

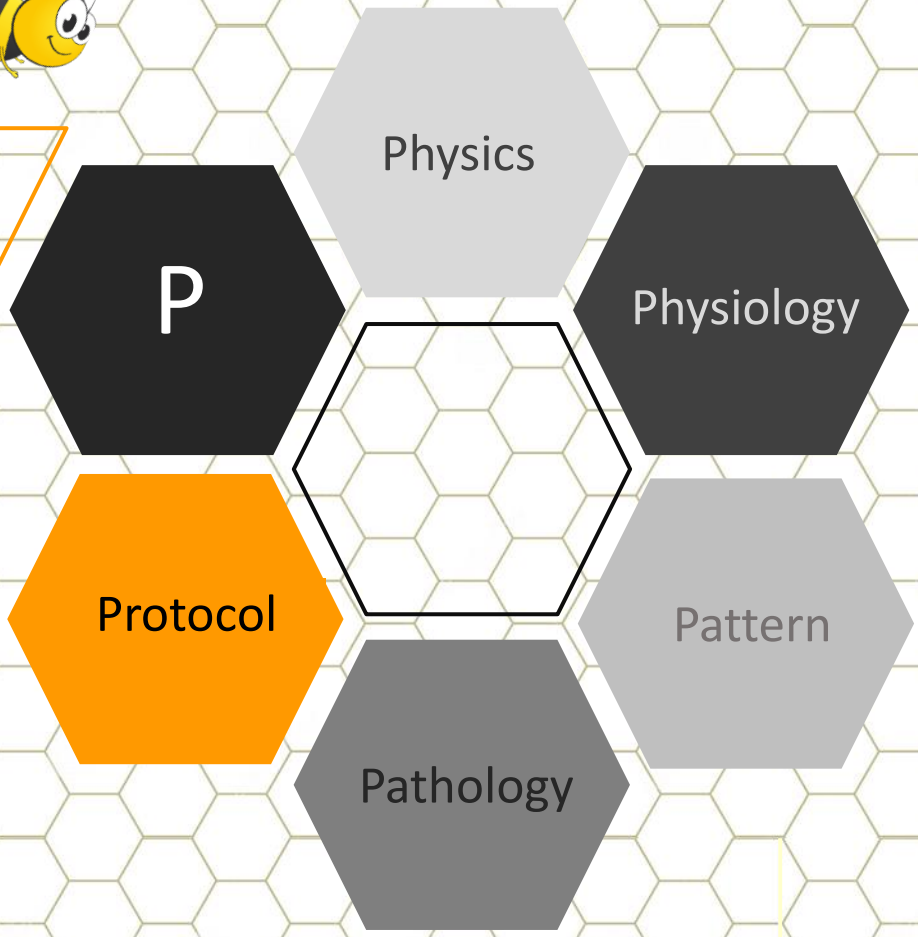


PF-ILD: Progressive fibrosis ILD
PFP-ILD: Progressive fibrosis phenotype ILD

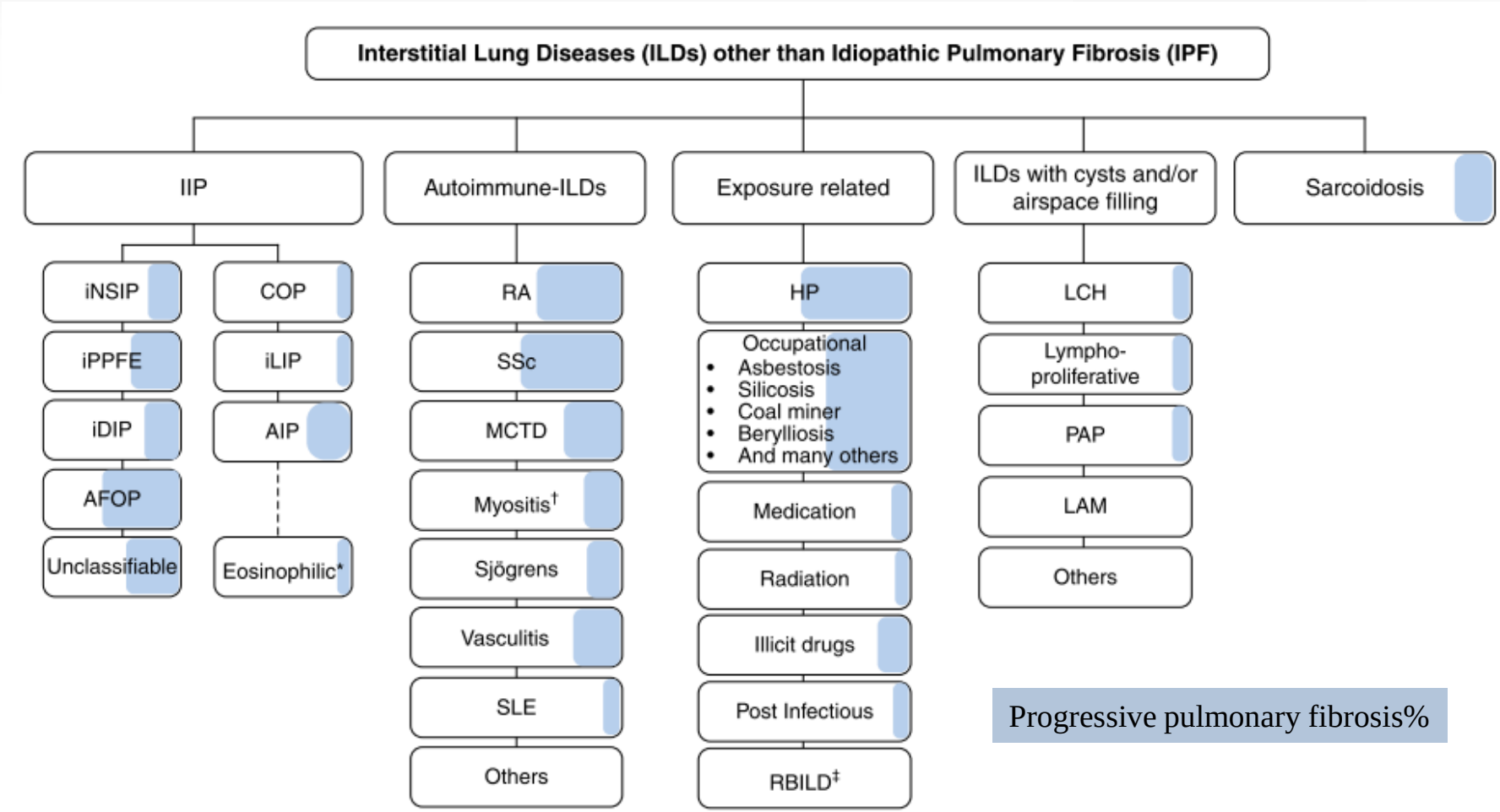
Design by Wu Ming-Ting

**One-third of non-IPF ILD patients are at risk of developing a progressive fibrosing phenotype

Progression



ILD (PPF%) other than IPF



Raghu G et al. AJRCCM 2022; 205:e18-e47

Progressive Pulmonary Fibrosis (PPF, PF-ILD)

Definition of PPF

In a patient with ILD of known or unknown etiology other than IPF who has radiological evidence of pulmonary fibrosis, PPF is defined as at least two of the following three criteria occurring within the past year with no alternative explanation*:

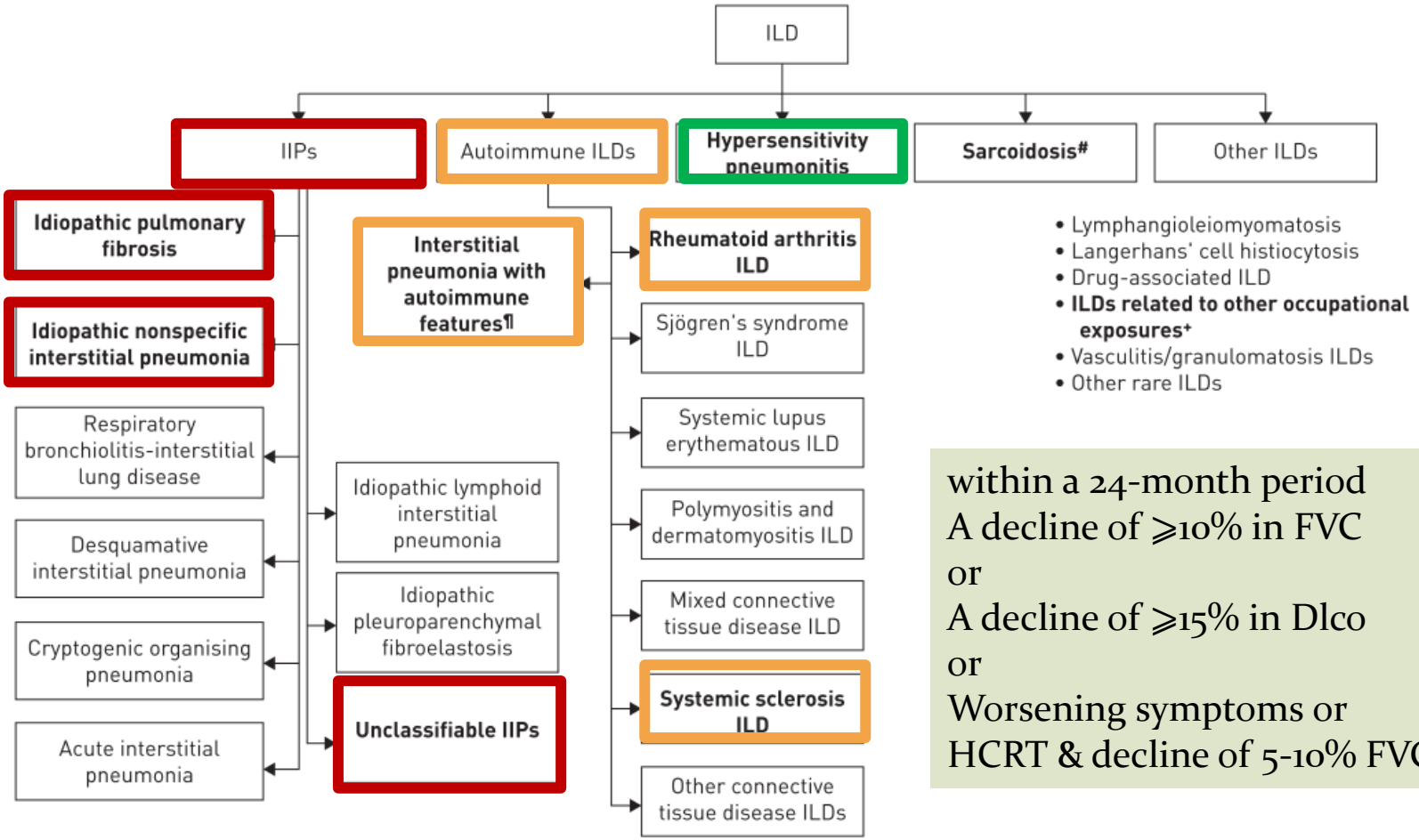
1 Worsening respiratory symptoms

2 Physiological evidence of disease progression (either of the following):
- a. Absolute decline in FVC ⩾5% predicted within 1 yr of follow-up
- b. Absolute decline in D_{LCO} (corrected for Hb) ⩾10% predicted within 1 yr of follow-up

3 Radiological evidence of disease progression (one or more of the following):
- a. Increased extent or severity of traction bronchiectasis and bronchiolectasis
- b. New ground-glass opacity with traction bronchiectasis
- c. New fine reticulation
- d. Increased extent or increased coarseness of reticular abnormality
- e. New or increased honeycombing
- f. Increased lobar volume loss

Raghu G et al. AJRCCM 2022; 205:e18-e47

Example of types of ILD that may likely be associated with a progressive fibrosing phenotype

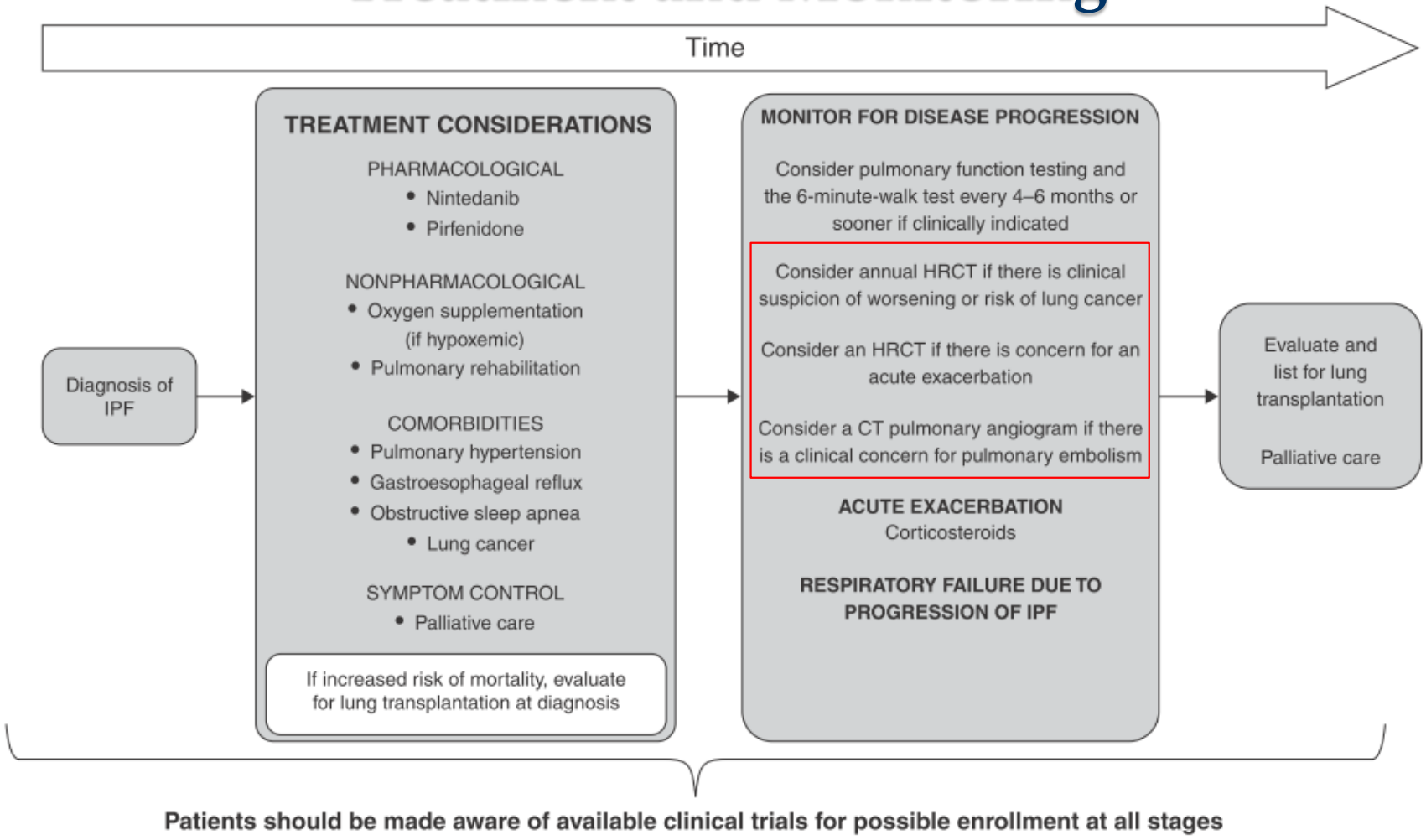


within a 24-month period
A decline of ⩾10% in FVC
or
A decline of ⩾15% in Dlco
or
Worsening symptoms or
HCRT & decline of 5-10% FVC

FIGURE 1 Types of interstitial lung disease (ILD) most likely to have a progressive-fibrosing phenotype (indicated in bold). IIPs: idiopathic interstitial pneumonias. #: stage IV sarcoidosis only; ¶: not an established clinical diagnosis; +: *e.g.* asbestosis, silicosis.

1. ATS/ERS. Am J Respir Crit Care Med 2002;165:277-304; 2. Travis WD et al. Am J Respir Crit Care Med 2013;188:733-48; 3. Fischer A et al. Eur Respir J 2015;46.976-87

Treatment and Monitoring

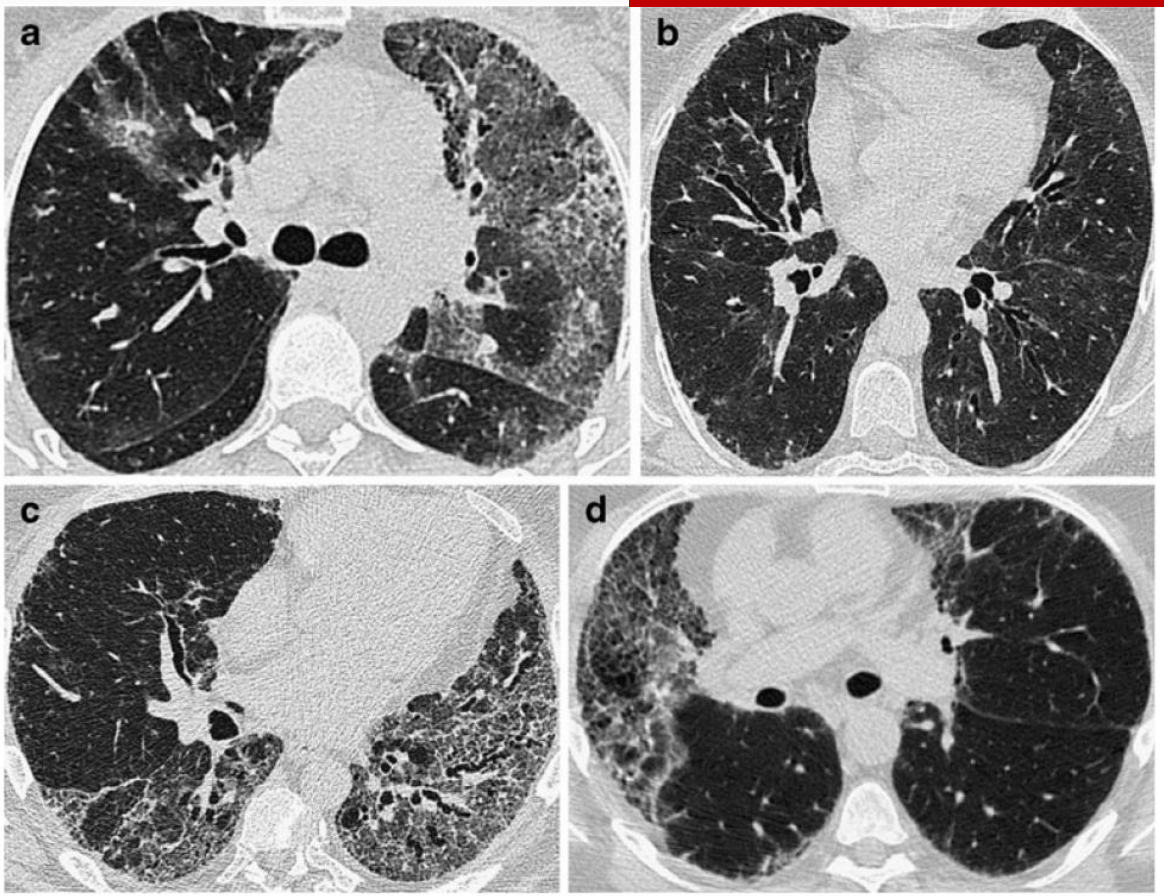


Raghu G et al. AJRCCM 2022; 205:e18-e47

Fibrotic idiopathic interstitial pneumonias: HRCT findings that predict mortality

Traction Bronchiectasis

Grade I, mild (peripheral)



grade II, moderate (central)

grade III, severe (both)

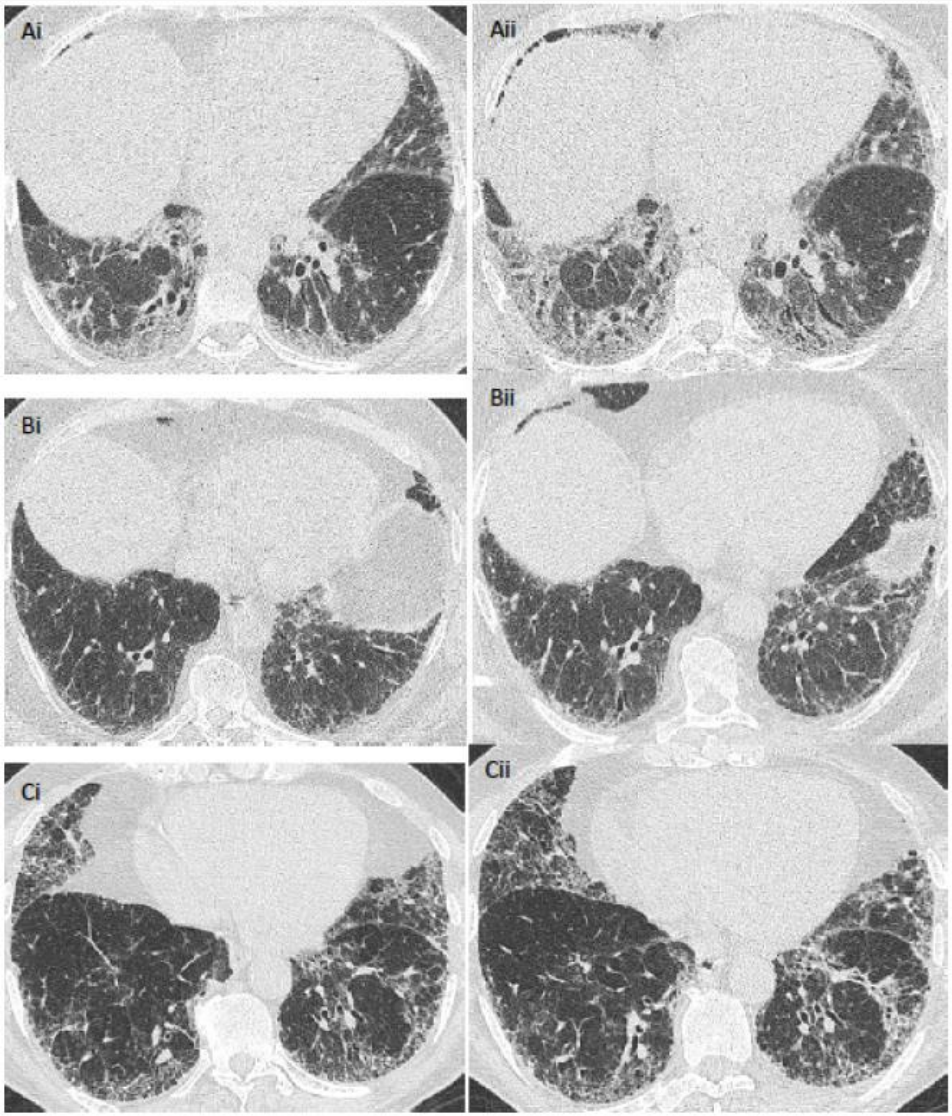
Grade I, mild (peripheral)

- **Poor Prognosis: Traction Bronchiectasis,** corrected for extent socre, regardless of the background on reticulation or honeycomb

Edey AJ, et al Eur Radiol. 2011;21:1586-93.

Serial CT analysis in idiopathic pulmonary fibrosis: comparison of visual features that determine patient outcome

ΔTraction Bronchiectasis



A: 50 YOM, antifibrotic (-) 6 M apart

FVC decline: >10% /yr,

TxBx change: markedly worsened (score=5)

Score 1=markedly improved, 2=slightly improved, 3=no change, 4=slightly worsened and 5=markedly worsened.

B: 62 YOM, antifibrotic (+)_13 M apart.

FVC decline 5.0% - 9.9%,

TxBx change: mildly worsened (score=4).

C: 77 YOM, antifibrotic (-) 15 M apart,

TxBx change: Score=3, stable)

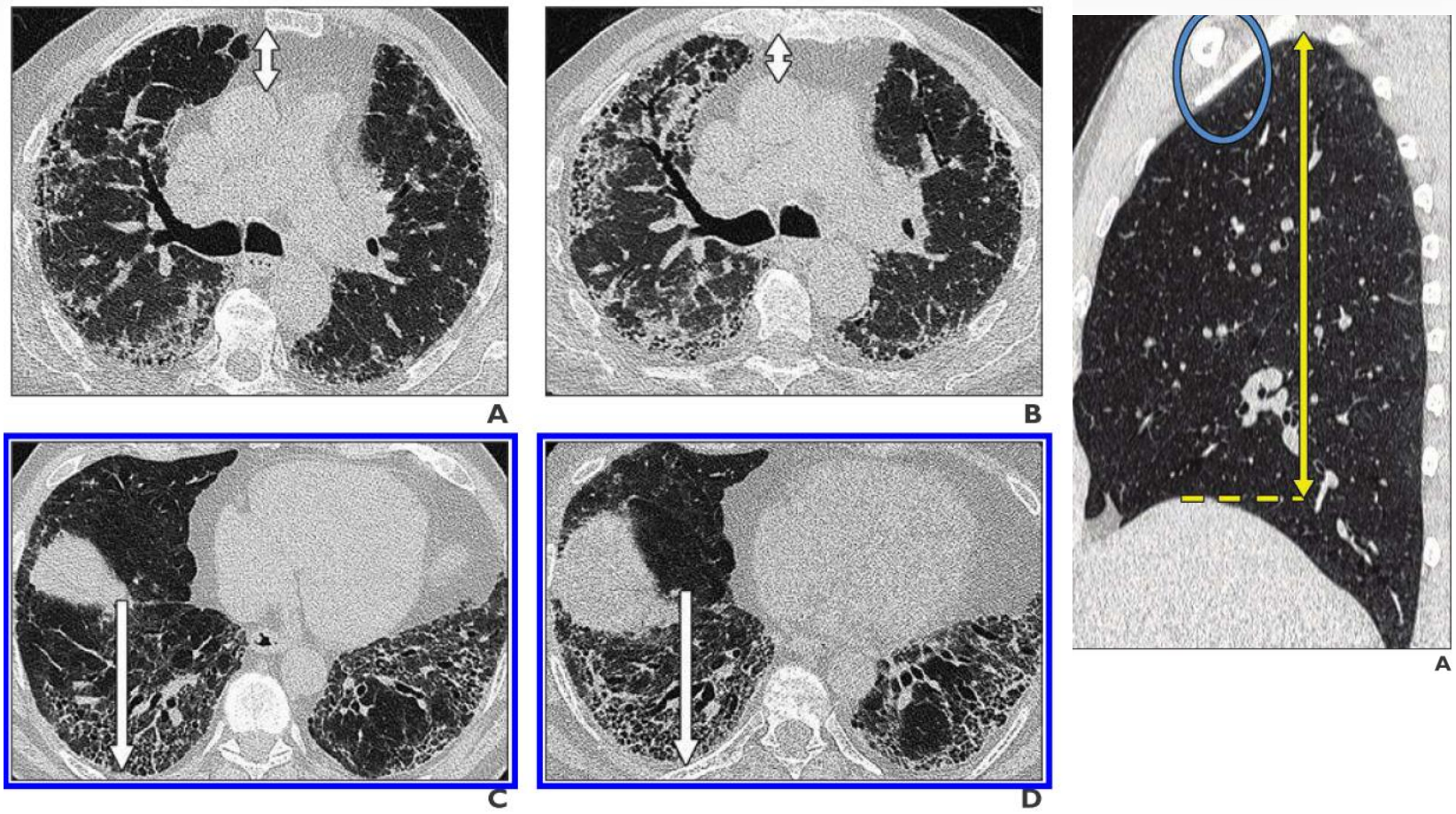
FVC decline (−5.0% to 4.9%)

stable. Parenchymal changes visible on the CT may reflect disease maturation rather than disease progression.

Jacob J, et al. Thorax 2020;75:648–654.

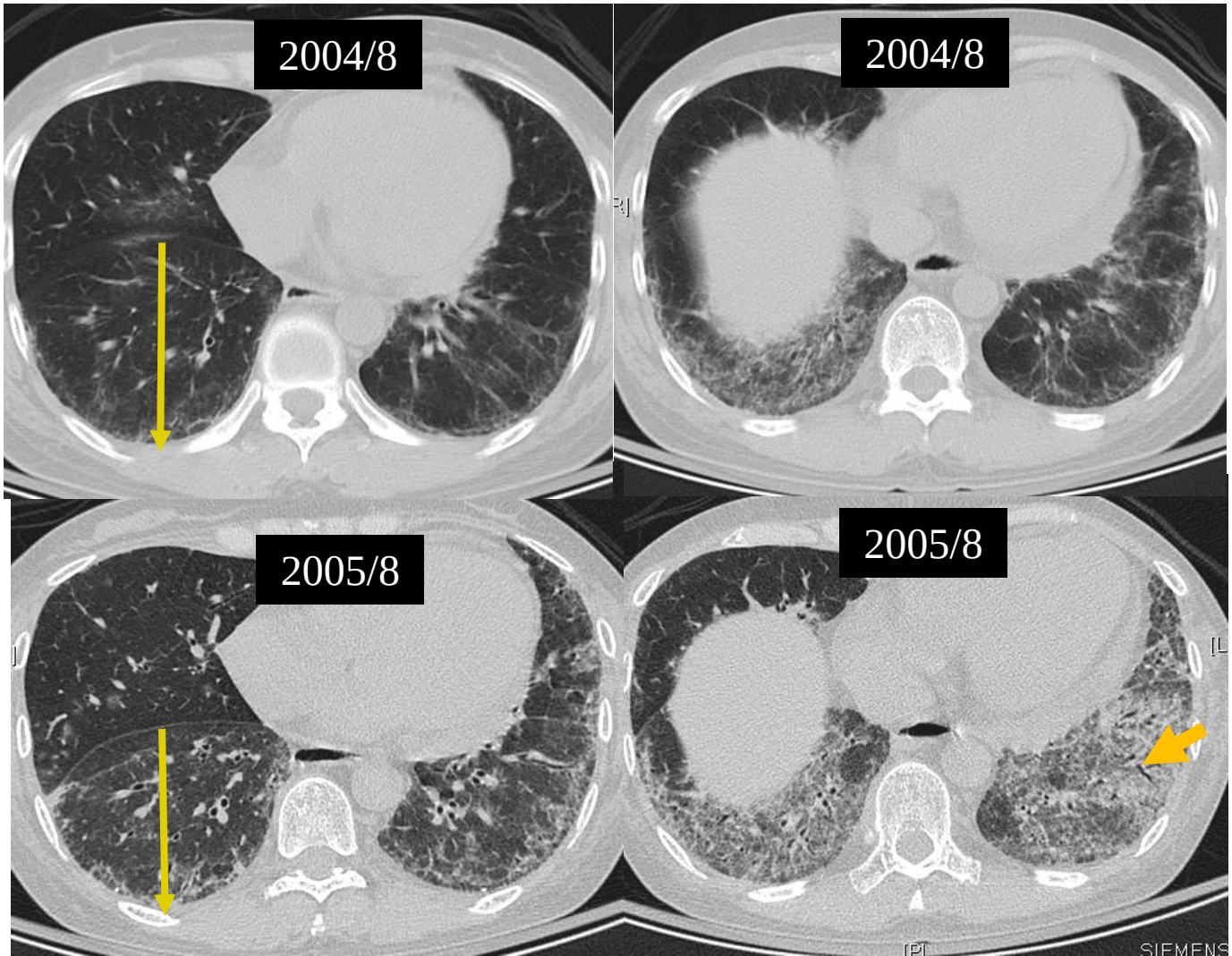
Visual and Automated CT Measurements of Lung Volume Loss in Idiopathic Pulmonary Fibrosis

Lung Volume

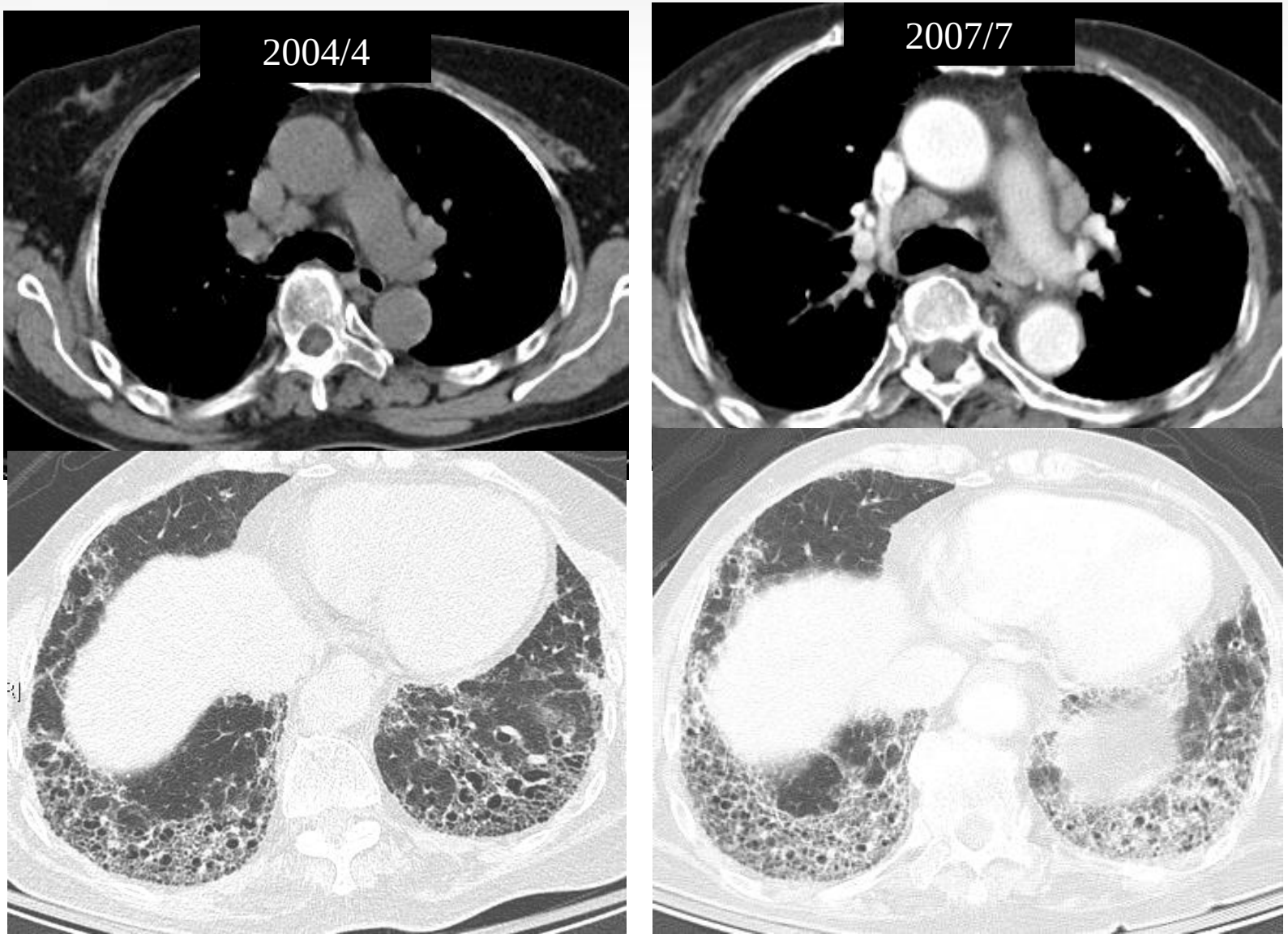


Robbie H, Jacob J, Walsh S et al. AJR 2019; 213:318–324

PF-SSc-ILD



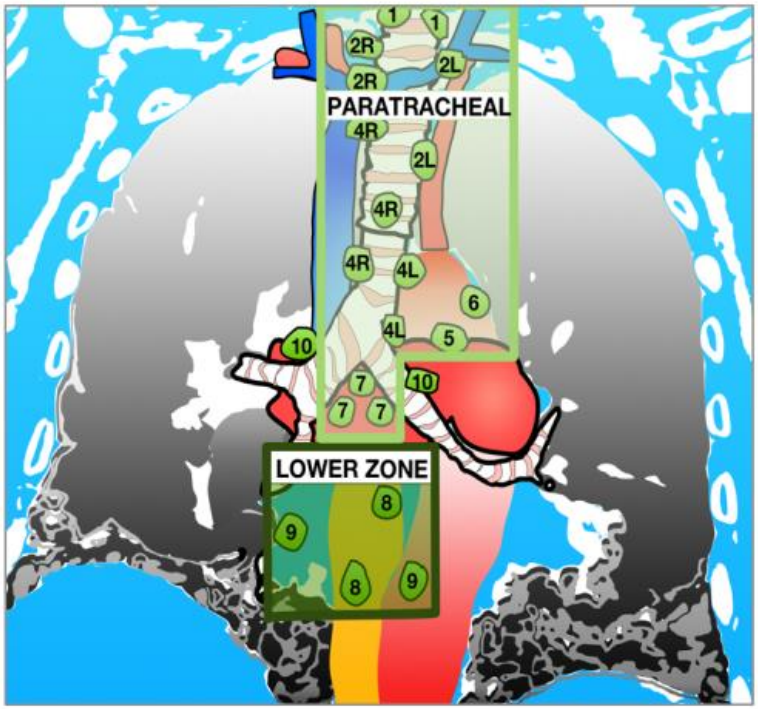
PF-ILD+progressive LNE

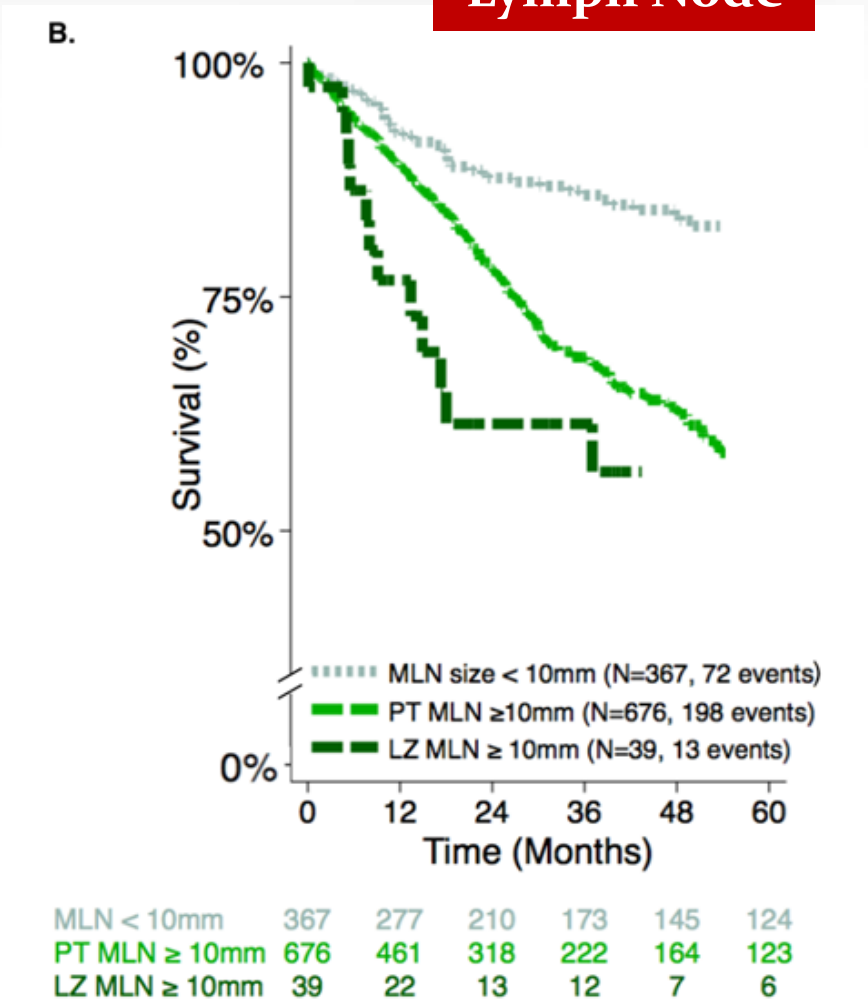


Prognosticating Outcomes in Interstitial Lung Disease by Mediastinal Lymph Node Assessment: An Observational Cohort Study with Independent Validation

Lymph Node

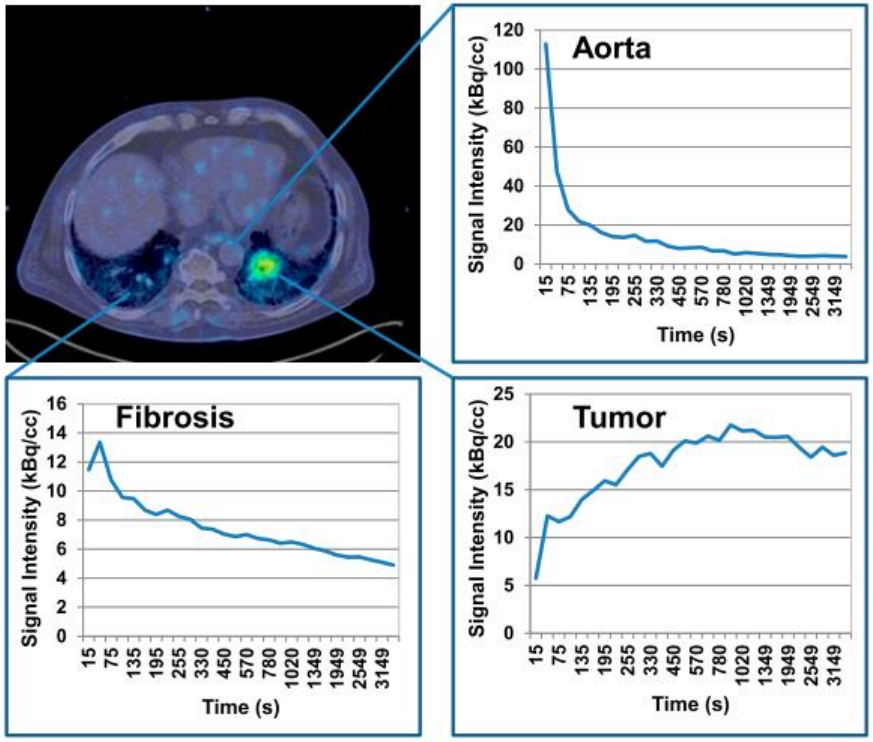
- 1094 Pt (53%M); f/u 10 years
- MLN > 10 mm (66% Pt) predict
  - TRS (Transplant-free survival)
  - all-cause mortality
  - hospitalization risk





Adegunsoye A (U Chicago) AJRCCM 2019;199:747

Fibroblast Activation Protein–Specific PET/CT Imaging in Fibrotic Interstitial Lung Diseases and Lung Cancer: A Translational Exploratory Study



- ^{68}Ga-labeled dynamic fibroblast activation protein (FAP) inhibitor **^{68}Ga-FAPI PET/CT**
- 15 patients with fILD with suspected lung cancer
- Histology validation: 4 human biopsy and Nedd4-2$^{-/-}$ mice with fibrotic lungs: patchy expression esp in the transition zone.
- Pattern specific to fibroblast activity

R € ohrich et al. J Nucl Med 2022; 63:127 – 133 DOI: 10.2967/jnumed.121.261925

Quantitation of ILD

Visual scoring

Semi-quantitative score

Full (auto) quantitative maps

Semi-QCT

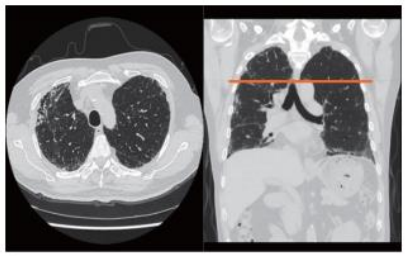

台灣間質性肺病影像半定量化
評估標準與結構式報告
使用說明
SSc-ILD extent >10%? 健保給付
中華民國放射線醫學會
Taiwan Radiological Society
地址：103 台北市大同區重慶北路三段63號2樓
電話：02-25865331
Email：office@rsroc.org.tw

台灣間質性肺病影像半定量化評估步驟與說明

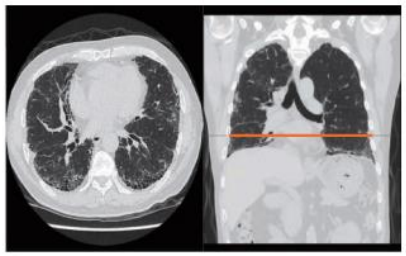
步驟 1. 將肺部分成六個截面：

如圖一所示，依照六項解剖學標的之橫切面做 HRCT 影像之評估，即主動脈弓上緣切面 (level 1)、隆凸下 1 公分 (level 2)、肺靜脈匯合處 (level 3)、level 3 至中點 (level 4)、右橫膈上方 1 公分 (level 5)、右橫膈下方 2 公分 (level 6)。

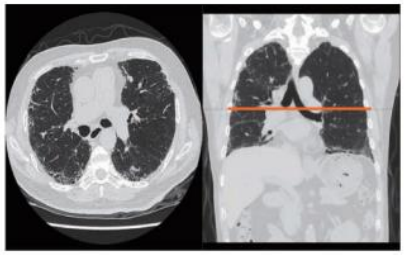
圖一



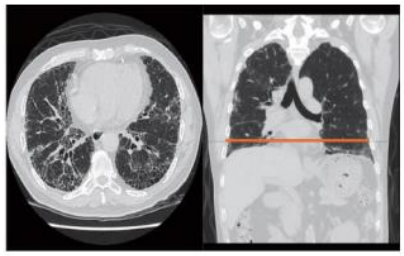
① 主動脈弓上緣切面 (aortic arch)



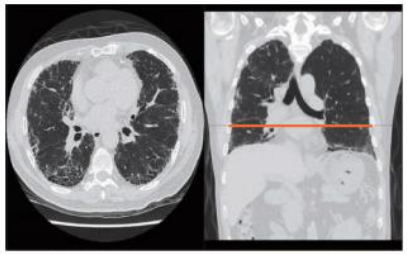
④ 3 與 5 的中間 (halfway between 3rd and 5th section)



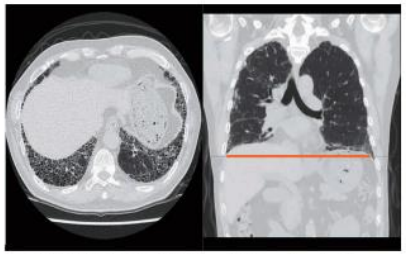
② 隆凸下 1 公分 (1 cm below the carina)



⑤ 右橫膈肌上方 1 公分 (1 cm above the right hemidiaphragm)



③ 肺靜脈匯合處 (pulmonary venous confluence)



⑥ 右橫膈肌下方 2 公分 (2 cm below the right hemidiaphragm)

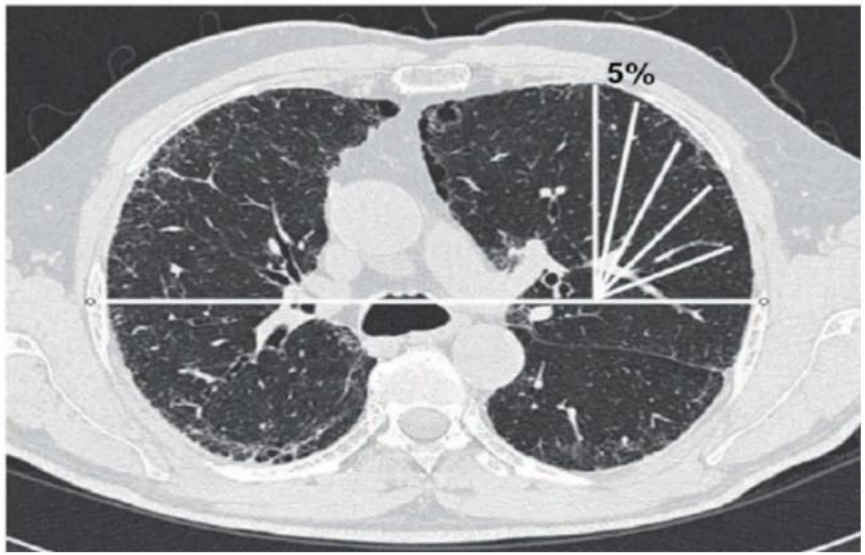
步驟 2. 纖維化侵犯肺野計算(異常部位估算)：

觀察上述六截面之橫切面影像裡是否含有代表肺纖維化的 CT 表徵，如蜂窩狀組織 (honeycombing)、網狀組織 (reticulation)、拉扯性支氣管擴張 (traction bronchiectasis) 及其伴隨之毛玻璃狀陰影 (ground-glass opacity wit traction bronchiectasis)。找出上述四項 CT 表徵並確定分佈位置與範圍之後，準備進行視覺半定量化評估。

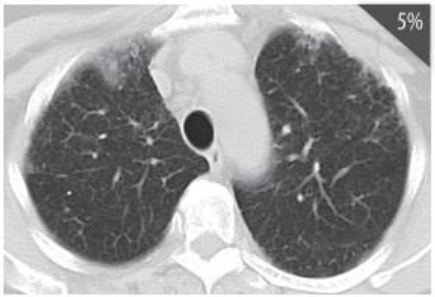
步驟 3. 視覺半定量化評估方法：

將上述六個截面符合肺纖維化之 CT 表徵範圍，以視覺評估方式(肉眼)來估算侵犯範圍百分比。估算數值以 5% 作爲最小級距。進行視覺評估時，將每一位置之 CT 影像中央劃出一條水平線並留下 50% 的可測量區域；再劃出第二條線垂直線與水平線交錯，留下每個肺 25% 的可評估區域。每 25% 又細分爲 5 個部分，每個部分對應 5% 的面積。依上述方式分別估算六個截面的異常部位，取其六個截面估算結果的平均值，即是該名患者纖維化影響肺野範圍(異常部位範圍)百分比。

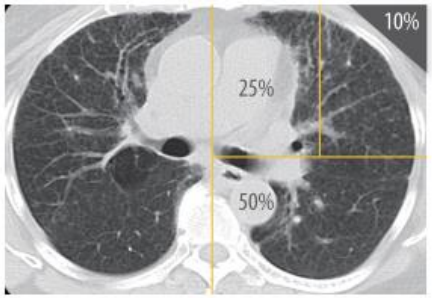
圖二



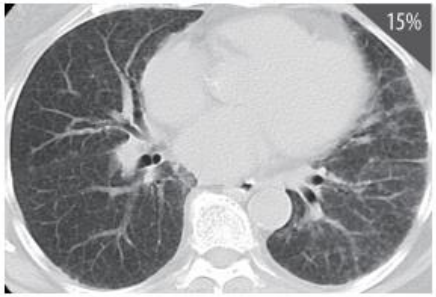
Q: Is the ILD extent > 10%



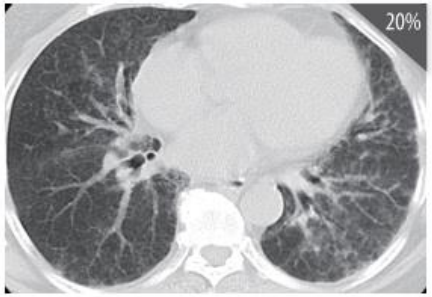
1 aortic arch



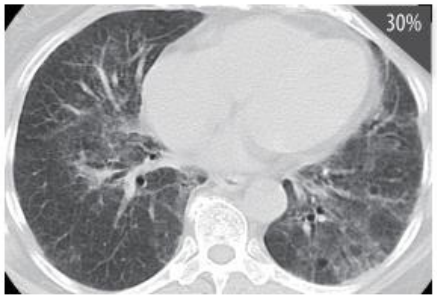
2 1 cm below the carina



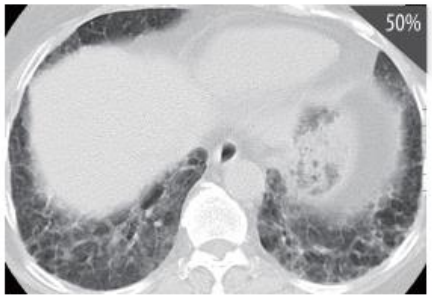
3 right pulmonary venous confluence



4 halfway between the third and fifth section

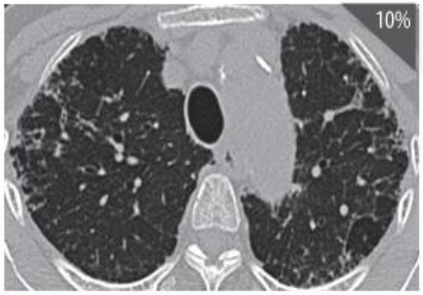


5 1 cm above the right hemidiaphragm

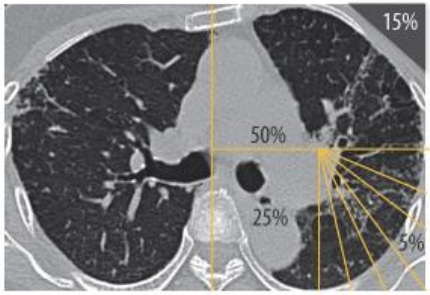


6 2 cm below the right hemidiaphragm

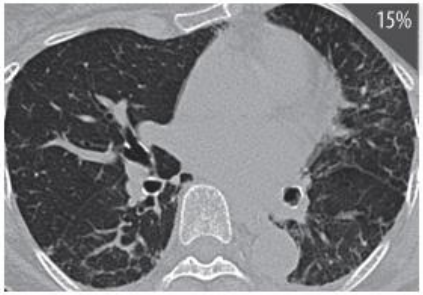
如果經視覺估算六個位置的 fibrosis extent，分別爲 5%、10%、15%、15%、20%、30%、50%，則整體之纖維化比例爲上述總額之平均：**(5+10+15+20+30+50)/6=21.6%**



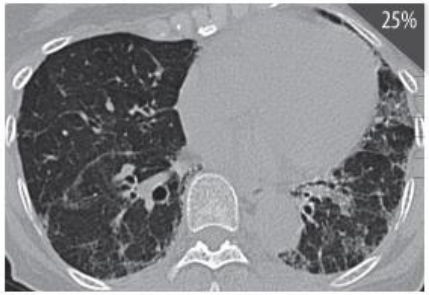
1 aortic arch



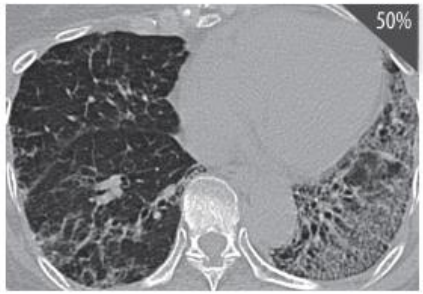
2 1 cm below the carina



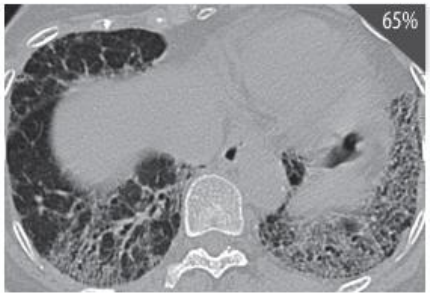
3 right pulmonary venous confluence



4 halfway between the third and fifth section



5 1 cm above the right hemidiaphragm



6 2 cm below the right hemidiaphragm

如果經視覺估算六個位置的 fibrosis extent，則整體纖維化比例爲：
(10+15+15+25+50+65)/6=30%

Structure Report

下方表格爲根據 2018 ATS/ERS/JRS/ALAT 共同發表的 IPF 臨床診斷指引中的【影像診斷標準與定義】內容[3]所設計的結構性報告，提供放射線影像報告含健保審查要項。由於健保審查以 ≥ 10% 之纖維化爲藥物給付條件，若 <10% 可能僅爲 interstitial lung abnormality (ILA)，因此必須在報告中提及。

《標準 HRCT 判讀 ILD 應該爲 non-contrast enhanced, standard dose, thin section <=1.5mm, sharp or lung kernel, supine position in full inspiration。若在其他狀況，則勾選下方 scanning parameters(詳細請參考原始文獻[3] 之 Table 3 : HRCT screening parameters，及Table 4：HRCT Scanning Pattern)》

CT scanning parameters

Dose	Standard ( )	Low dose ( )	Note
Slice thickness	( ) mm		For visual assessment in clinical practice, it is suggested to use sharp or lung kernel in thin slice thickness (<= 1-1.25 mm) with or without gap, while for computer aided quantification, please use standard kernel in contiguous thin slices (<= 1-1.25 mm) to avoid noise from edge enhancement.
Kernel	( ) sharp	( ) standard	
Respiration	( ) inspiration	( ) expiration	
Position	( ) supine	( ) prone	

HRCT Findings

HRCT features			Absence	Presence	Note
Predominant distribution	( )	Subpleural			
	( )	Basal			
	( )	Peribronchovascular			
	( )	Perilymphatic			
	( )	Upper or mid-lung			
Findings	( )	Ground glass opacity (GGO)			
	( )	Reticulation			
	( )	Traction bronchiolectasis			
	( )	Honeycombing			
	( )	Cysts			
	( )	Dilated esophagus			
	( )	Emphysema			
	( )	Others			
Fibrosis extent	( )	Honeycombing + Reticulation+ Traction bronchiectasis+ Ground glass opacity with traction bronchiectasis ('GGO+TB'; taken to signify fine fibrosis)		( ) ≥10% ( ) <10%	

HRCT patterns		Description
( )	UIP	*Subpleural and basal predominant; distribution is often heterogeneous *Honeycombing with or without peripheral traction bronchiectasis or bronchiolectasis
( )	Probable UIP	*Subpleural and basal predominant; distribution is often heterogeneous *Reticular pattern with peripheral traction bronchiectasis or bronchiolectasis *May have mild GGO
( )	Indeterminate for UIP	*Subpleural and basal predominant *Subtle reticulation; may have mild GGO or distortion ("early UIP pattern") *CT features and/or distribution of lung fibrosis that do not suggest any specific etiology ("truly indeterminate for UIP")
( )	Alternative diagnosis	Findings suggestive of another diagnosis, including: *CT features: ✓ Cysts ✓ Marked mosaic attenuation ✓ Predominant GGO ☐ Profuse micronodules ☐ Centrilobular nodules ☐ Nodules ☐ Consolidation *Predominant distribution: ✓ Peribronchovascular ✓ Perilymphatic ✓ Upper or mid-lung *Other: ✓ Pleural plaques (consider asbestosis) ✓ Dilated esophagus (consider CTD) ✓ Distal clavicular erosions (consider RA) ✓ Extensive lymphnodenlargement (consider other etiologies) ✓ Pleural effusions, pleural thickening (consider CTD/drugs)

Final impression based on HRCT findings

HRCT patterns			
( )	UIP		
( )	Probable UIP		
( )	Indeterminate for UIP		
( )	Alternative diagnosis		
( )	NSIP		
( )	Suspicious for CTD-ILD		
( )	Suspicious for chronic hypersensitivity pneumonia		
( )	Suspicious for organizing pneumonia (OP)		
( )	Other		

References:

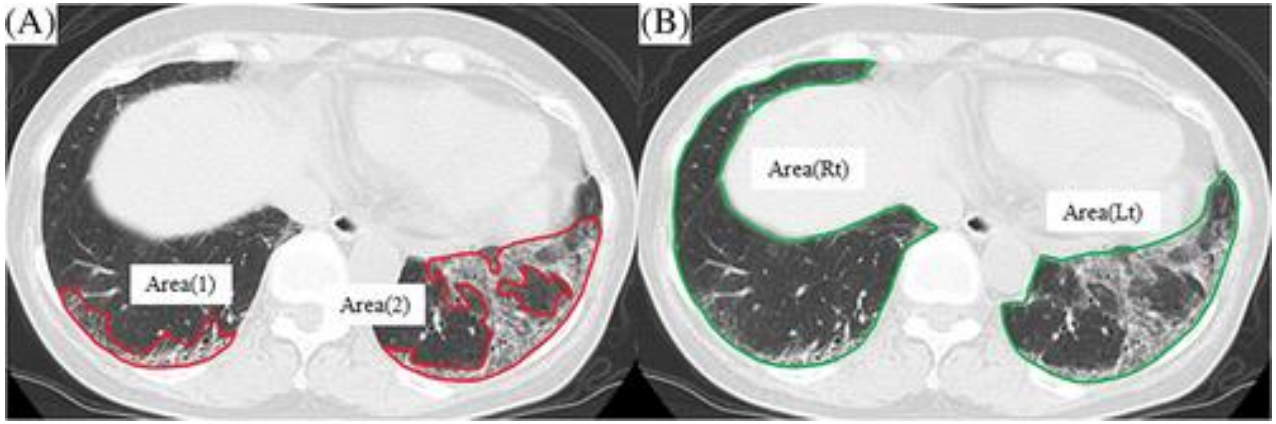
1. Fraser E, St Noble V, Hoyles RK, et al. Readily accessible CT scoring method to quantify fibrosis in IPF. BMJ Open Resp Res 2020;7:e000584. doi:10.1136/bmjresp-2020-000584 https://bmjopenrespres.bmj.com/content/7/1/e000584
2. Sánchez RP, Fernández-Fabrellas E, Samper GJ, Montañana MLD, Vilar LN (2018) Visual HRCT Score to Determine Severity and Prognosis of Idiopathic Pulmonary Fibrosis. Int J Respir Pulm Med 5:084. doi.org/10.23937/2378-3516/1410084 https://clinmedjournals.org/articles/ijrpm/international-journal-of-respiratory-and-pulmonary-medicine-ijrpm-5-084.php?jid=ijrpm
3. Ganesh Raghu, Martine Remy-Jardin, et al. Diagnosis of Idiopathic Pulmonary Fibrosis. An Official ATS/ERS/JRS/ALAT Clinical Practice Guideline. Am J Respir Crit Care Med Vol 198, Iss 5, pp e44–e68, Sep 1, 2018. DOI: 10.1164/rccm.201807-1255ST https://www.atsjournals.org/doi/full/10.1164/rccm.201807-1255ST

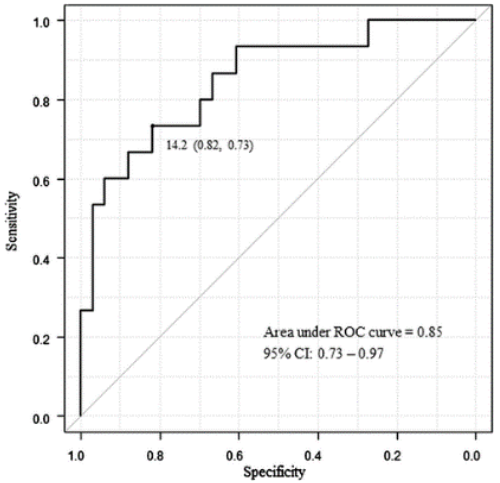
Q: Is the ILD extent > 10%

Simplified Quantification

- 48 patients, SSc-ILD
- Six anatomical levels :
  1. arch of the aorta
  2. carina
  3. pulmonary venous confluence
  4. a point halfway between level 3 and level 5
  5. 1 cm above the dome of the right hemidiaphragm
  6. 2 cm below the dome of the right hemidiaphragm

* Cut-off value for fibrosis score to overall survival (OS) was 14.2%, with moderate accuracy.



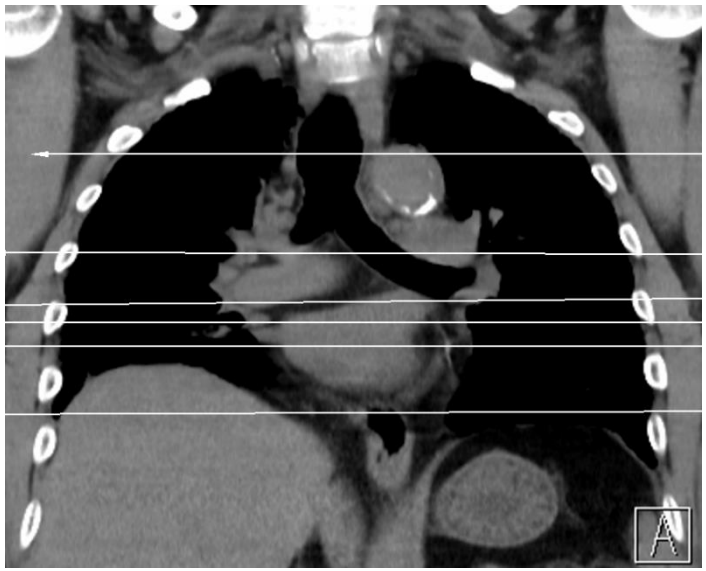


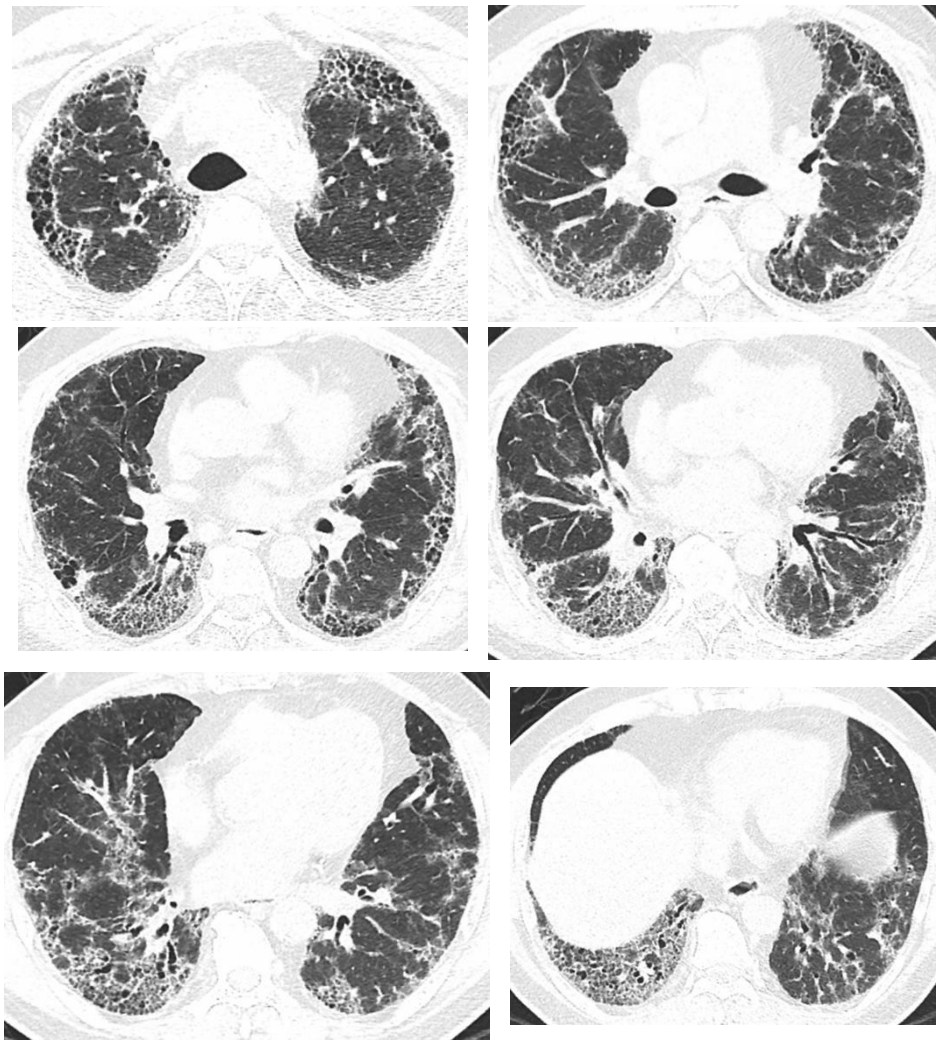
2 cm below the dome of the right hemidiaphragm

Respirology (2018) 23, 385–391

One lung of one slice = one score, total score = 12.

59 Y/O male, CTD-ILD pattern
Immune factor negative

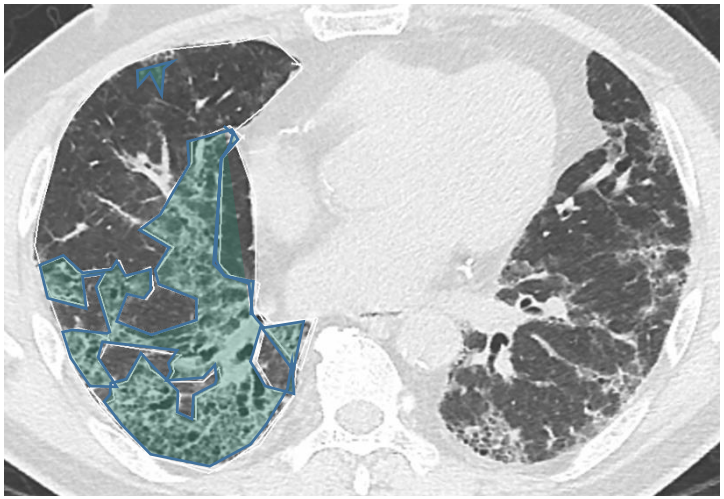




12 scores x 10% = 1.2 If total score > 1.2 pass the criteria

0.8+0.28+0.43 = 1.51 > 1.2 #

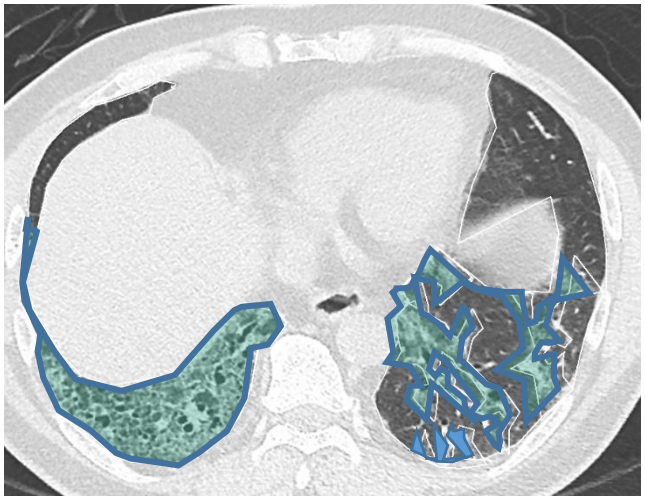
0.43



S5

0.8

0.28



S6

Quantitation of ILD

Visual scoring

Semi-quantitative score

Simplified quantitative score

Full (auto) quantitative maps

Texture Pattern * Extent

LN Enlargement

Vessel-related score

Lung Volume

Use of Quantitative CT to Predict Postoperative Lung Function in Patients with Lung Cancer[1]

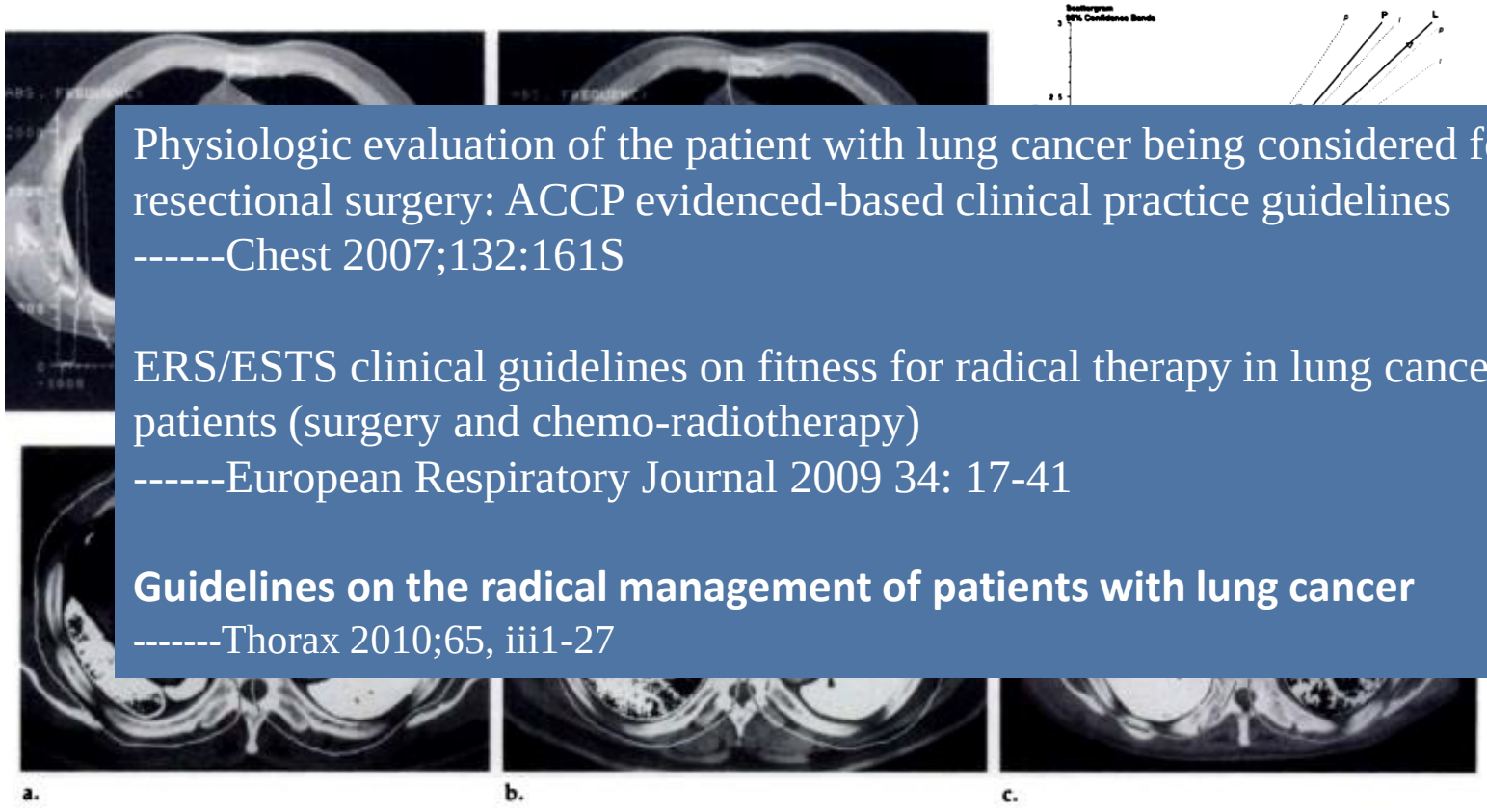
Ming-Ting Wu, MD • Jinn-Ming Chang, MD • Ambrose A. Chiang, MD • Jau-Yeong Lu, MD
Hon-Ki Hsu, MD • Wen-Hu Hsu, MD • Chien-Fang Yang, MD

Radiology 1994; 191:257–262

Prediction of Postoperative Lung Function in Patients with Lung Cancer: Comparison of Quantitative CT with Perfusion Scintigraphy

Ming-Ting Wu[1,2]
Huay-Ben Pan[1,2]
Ambrose A. Chiang[3–5]
Hon-Ki Hsu[2,6]
Huang-Chou Chang[2,6]
Nan-Jing Peng[2,7]
Ping-Hong Lai[1,2]
Huei-Lung Liang[1,2]
Chien-Fang Yang[1,2]

AJR:178, March 2002



Physiologic evaluation of the patient with lung cancer being considered for resectional surgery: ACCP evidenced-based clinical practice guidelines
------Chest 2007;132:161S

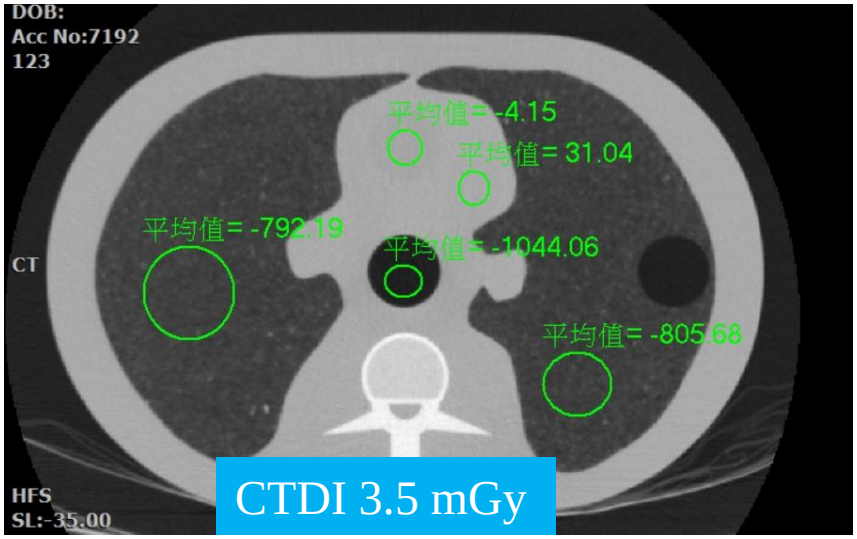
ERS/ESTS clinical guidelines on fitness for radical therapy in lung cancer patients (surgery and chemo-radiotherapy)
------European Respiratory Journal 2009 34: 17-41

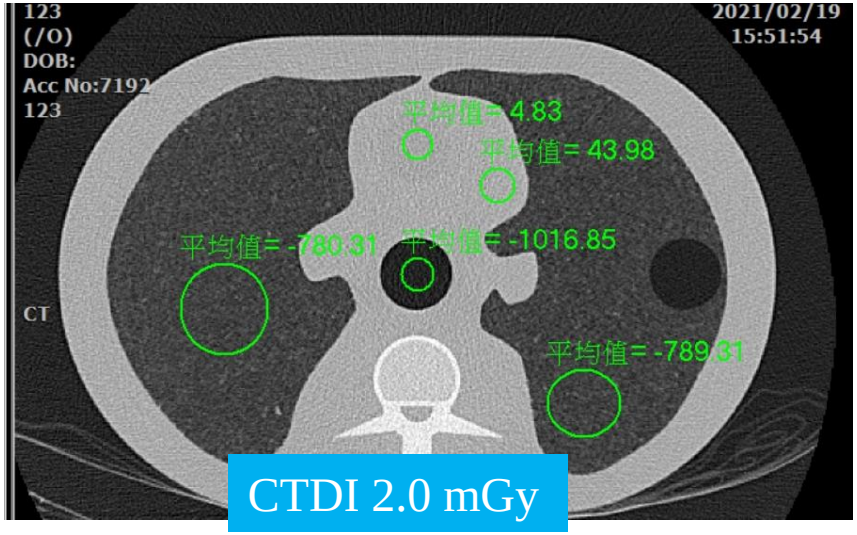
Guidelines on the radical management of patients with lung cancer
-------Thorax 2010;65, iii1-27

Radiology 1994; AJR 2002

Pulmo Phantom

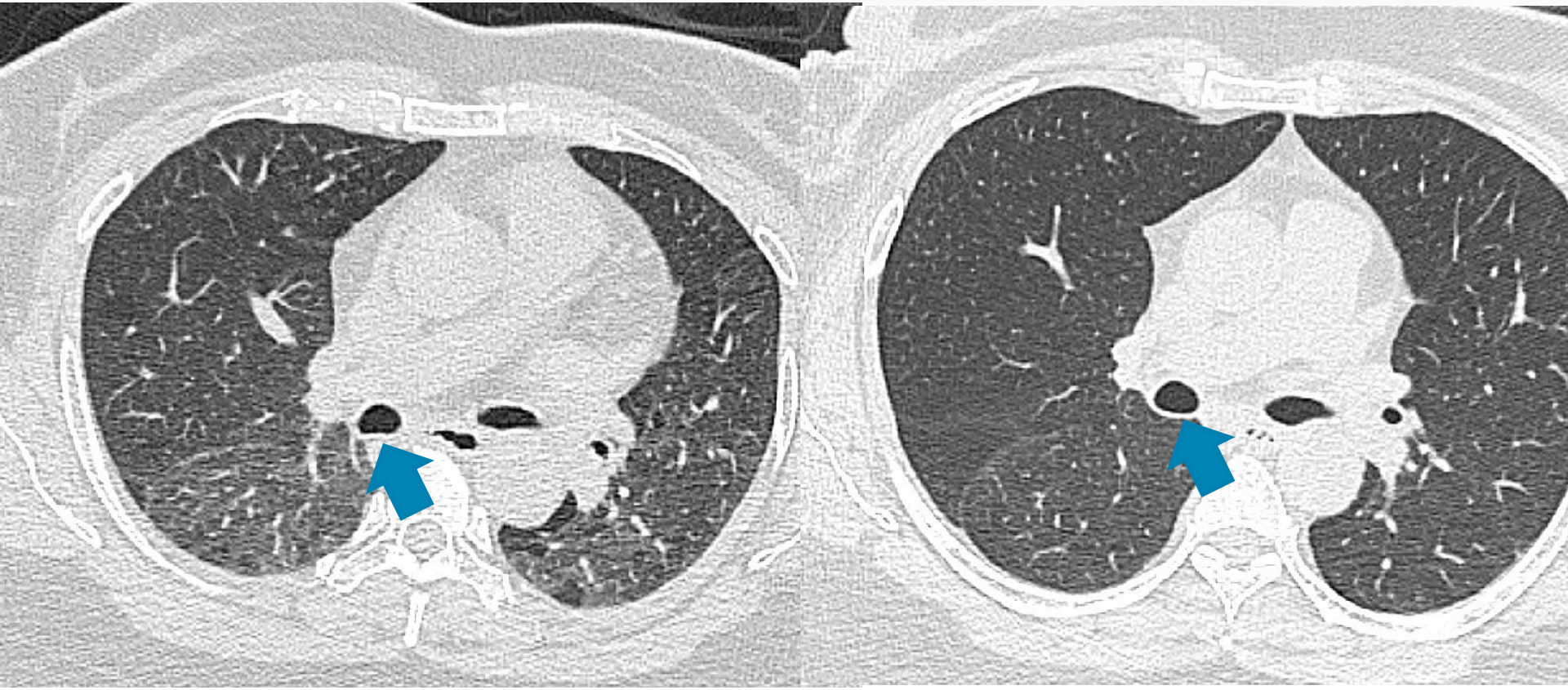
- The H value varies in different exposure and recon setting



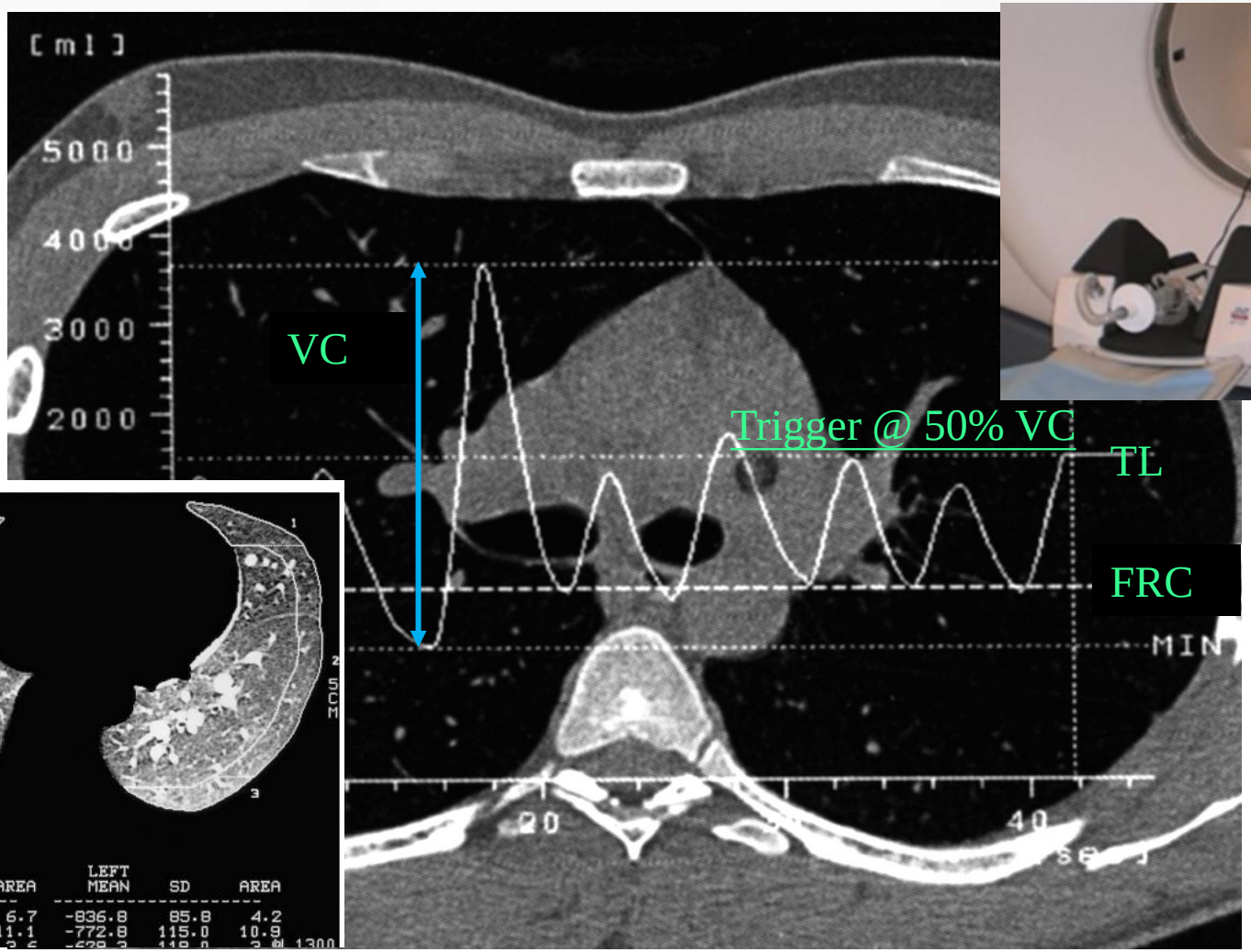


- *Siemens Somatom HQ, KSVGH, 1995*

The Influence of Expiratory phase



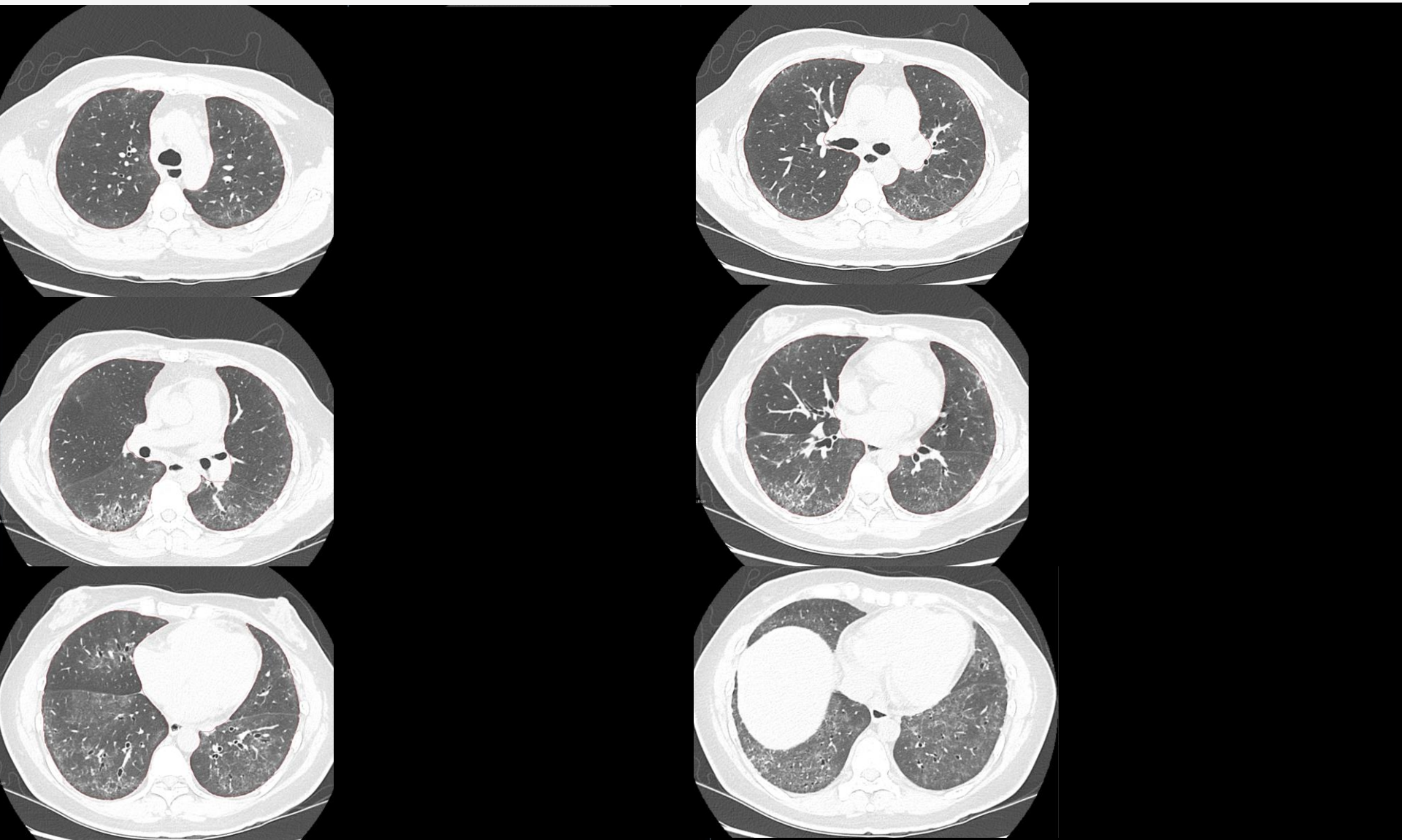
Spirometry-gated CT (PulmoCT)



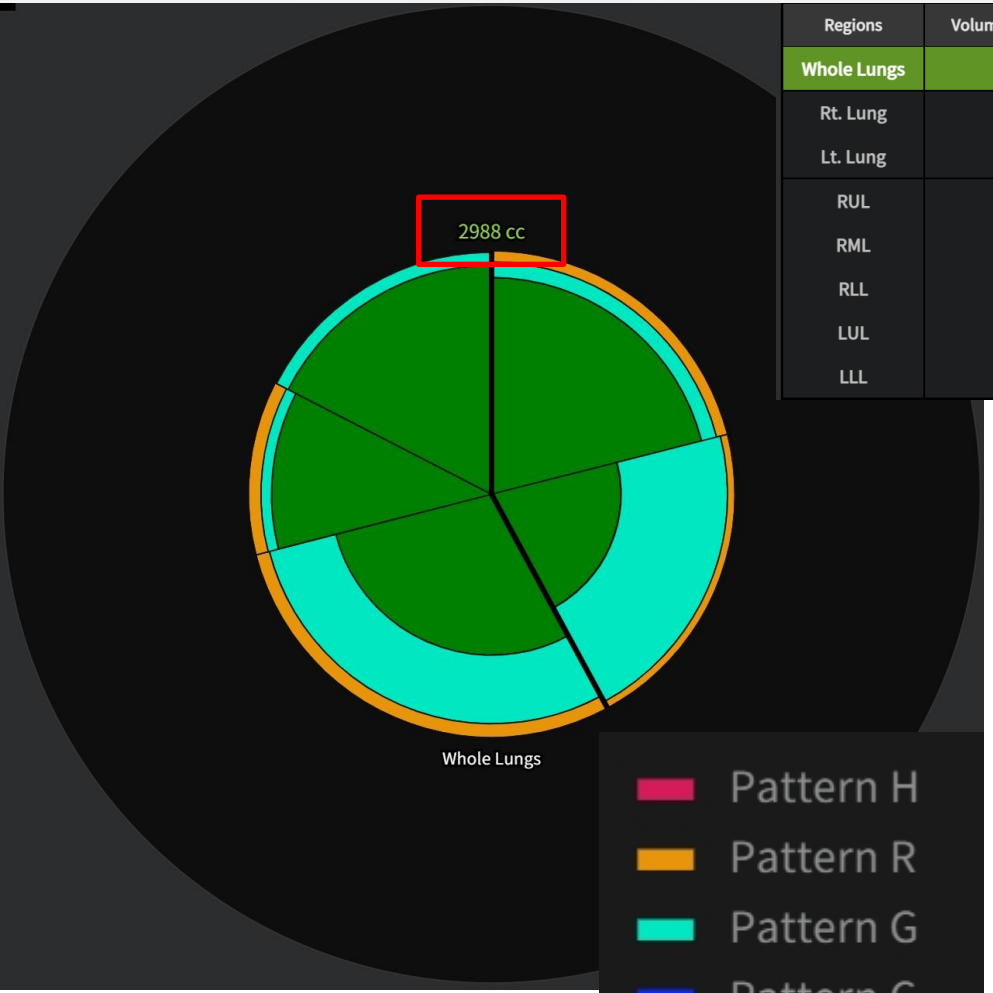
Siemens Somatom HQ, KSVGH, 1995

AI-3D Camera Method

Visual.semi- vs Auto.full-QCT



39 YOF PSS



Regions	Volume (cc)	Pattern H (%)	Pattern R (%)	Pattern G (%)	Pattern C	Pattern N (%)
Whole Lungs	2988	0	4	20		76
Rt. Lung	1730	0	4	17		79
Lt. Lung	1258	0	4	25		71
RUL	521	0	0	5		94
RML	346	0	5	4		90
RLL	863	0	6	28		66
LUL	629	0	5	6		89
LLL	629	0	3	44		53

		PRED	ACTUAL	%PRED
FVC	Liters	3.80	1.92 *	**050.5**
FEV1	Liters	3.30	1.74 *	052.7
FEV1/FVC	%		90.62	
LUNG VOLUMES	(BTPS)			
VC	Liters	3.89	1.92 *	049.4
TLC	Liters	5.69	**3.14** *	055.2
DLCO		09.5	03.2 *	33.6
DLCO/VA		01.7	01.2 *	68.7

Article

Radiomics for the Prediction of Response to Antifibrotic Treatment in Patients with Idiopathic Pulmonary Fibrosis: A Pilot Study

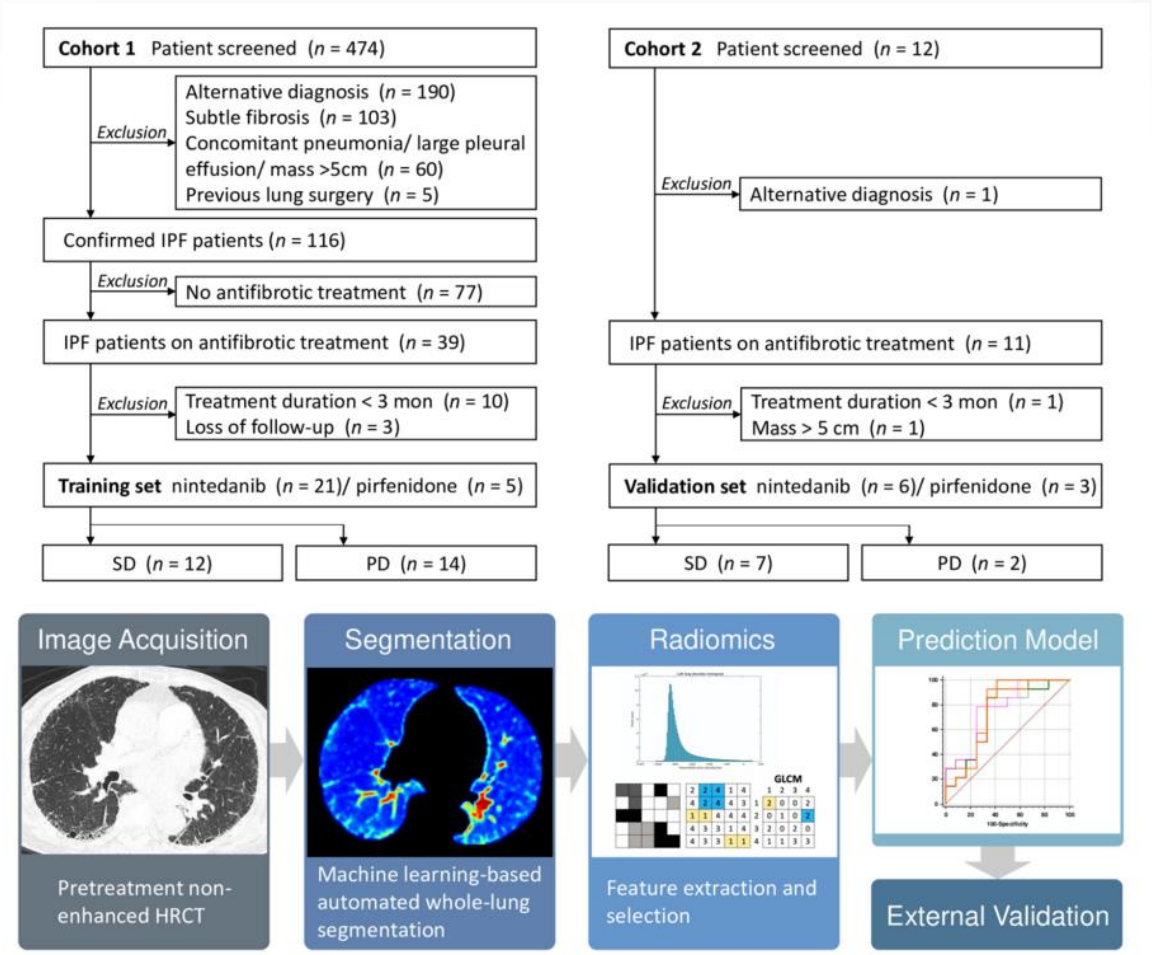


Figure 2. Flow diagrams of patient selection process and radiomics workflow.

Yang CC et al. (Chi-Mei, Mackay) Diagnostics 2022, 12, 1002.

Radiomics of the lungs

(QUIBIM Precision 2.8, QUIBIM SL, Valencia, Spain

Table 2. Comparison of Radiomic Features of Stable Disease (SD) and Progressive Disease (PD) Groups in the Training Set.

Metrics	Features	SD	PD	*p*-Value

Characteristics	Univariate Regression Analysis			Multivariate Regression Analysis		
	OR	95% CI	*p*-Value	OR	95% CI	*p*-Value
Entropy	4.37	1.05–18.30	0.04 *	3.42×10^{75}	0.02–5.94×10^{153}	0.06
Difference entropy	8.15	0.99–66.94	0.05 *	1.67×10^{16}	0.01–4.14×10^{40}	0.19
Sum entropy	3.93	1.01–15.32	0.05 *	0.01	0.01–0.22	0.04 *
Kurtosis	0.85	0.73–1.01	0.04 *	0.90	0.25–3.25	0.87
Skewness	0.40	0.16–0.95	0.04 *	0.01	0.01–63.14	0.29
Dissimilarity	2.30	0.97–5.48	0.06 *	0.01	0.01–525.21	0.16
Inverse difference	0.03	0.01–0.95	0.05 *	1.40×10^{61}	0.35–5.58×10^{122}	0.05
Maximum probability	0.02	0.01–0.47	0.04 *	0.01	0.01–2.21×10^{42}	0.58
GGO%	1.04	0.97–1.09	0.09 *	1.10	0.99–1.22	0.07
Honeycombing%	0.75	0.21–2.73	0.67			
Reticulation%	1.06	0.84–1.34	0.62			
Emphysema%	1.04	0.89–1.13	0.92			
Age	1.08	0.98–1.19	0.13			
Sex	4.29	0.65–28.26	0.13			
Smoking	1.40	0.30–6.62	0.67			

* Indicates statistical significance.

Yang CC et al. (Chi-Mei, Mackay) Diagnostics 2022, 12, 1002.

Article

Quantification of Cancer-Developing Idiopathic Pulmonary Fibrosis Using Whole-Lung Texture Analysis of HRCT Images

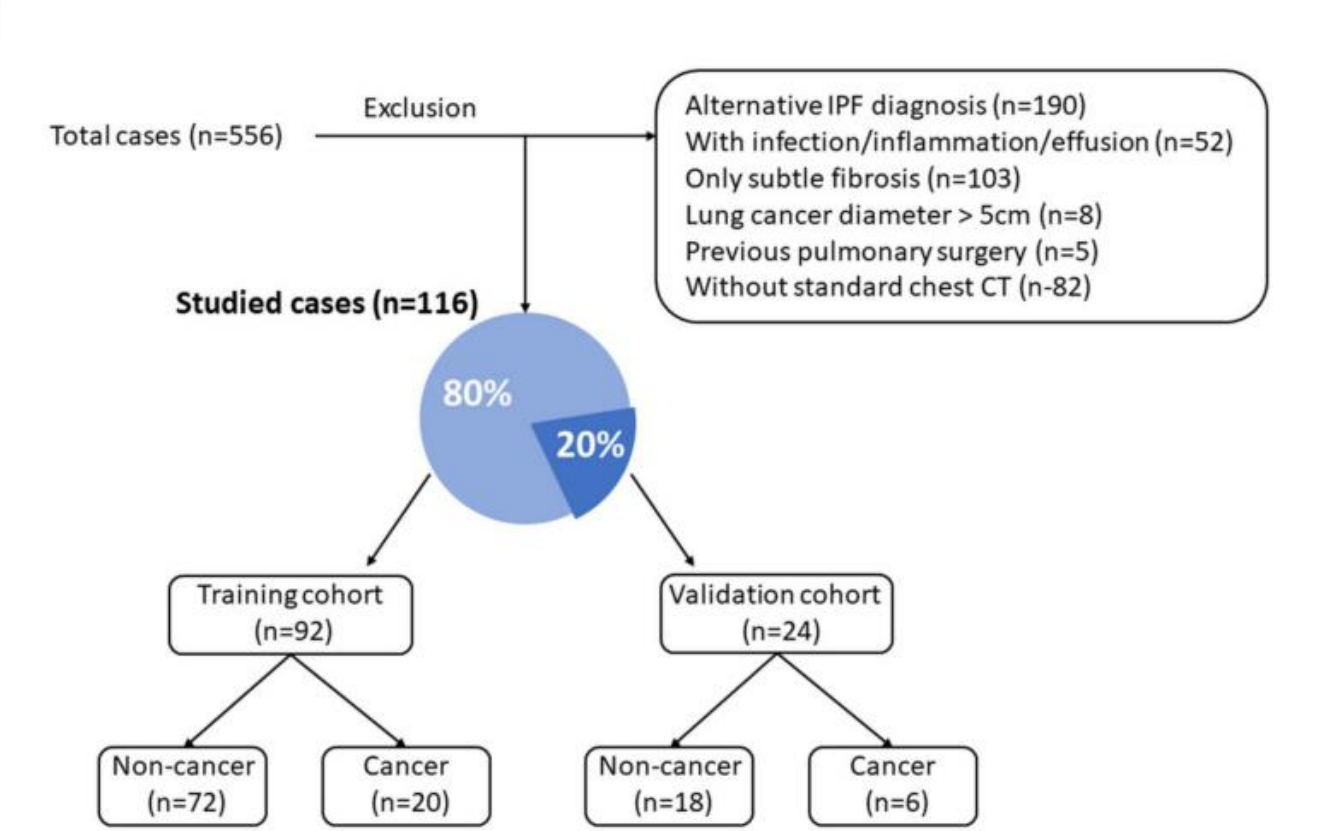


Figure 2. Patient selection flowchart for the training and validation cohorts.

Liang Chia-Hao et al. Cancers 2021,13,5600

Table 3. Univariate and multivariate logistic regression model to differentiate cancer-developing ILD from non-cancer ILD in the training cohort.

Characteristic	Univariate Regression Analysis			Multivariate Regression Analysis		
	OR	(95% CI)	*p* Value	OR	(95% CI)	*p* Value
Smoke	4.28	(1.51–12.12)	0.006	3.22	(1.05–9.87)	0.041 *
Energy	1.52	(1.14–2.05)	0.001	1.02	(0.93–1.11)	0.012 *
Kurtosis	1.08	(1.01–1.15)	0.034	1.03	(0.95–1.11)	0.508

OR: odd ratio; CI: confidence interval. * with significant difference.

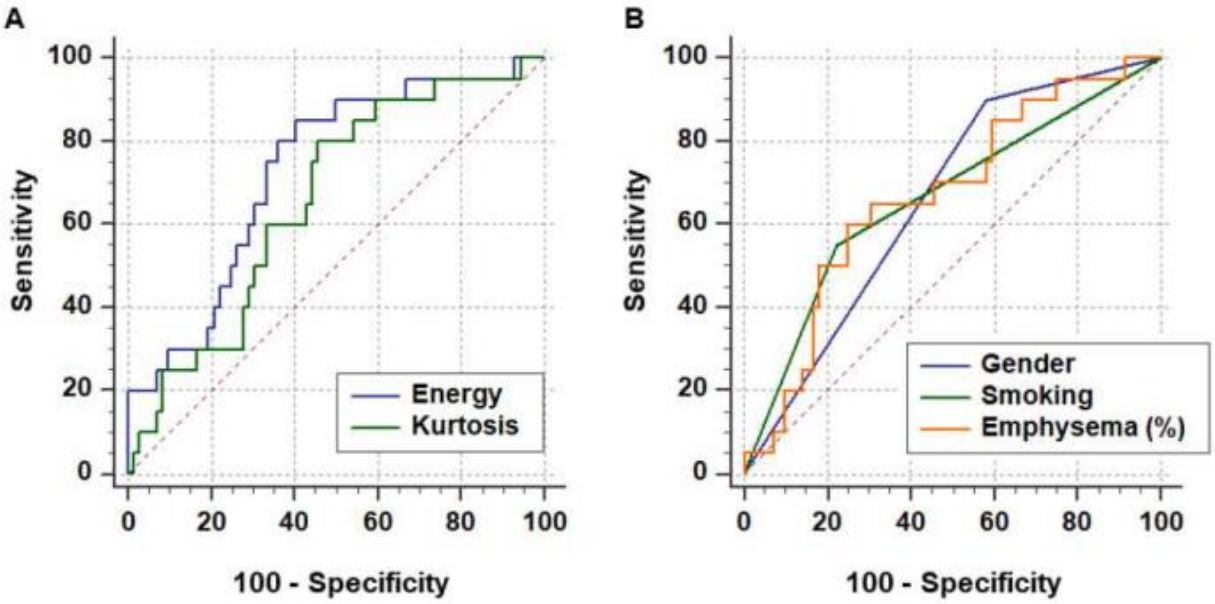
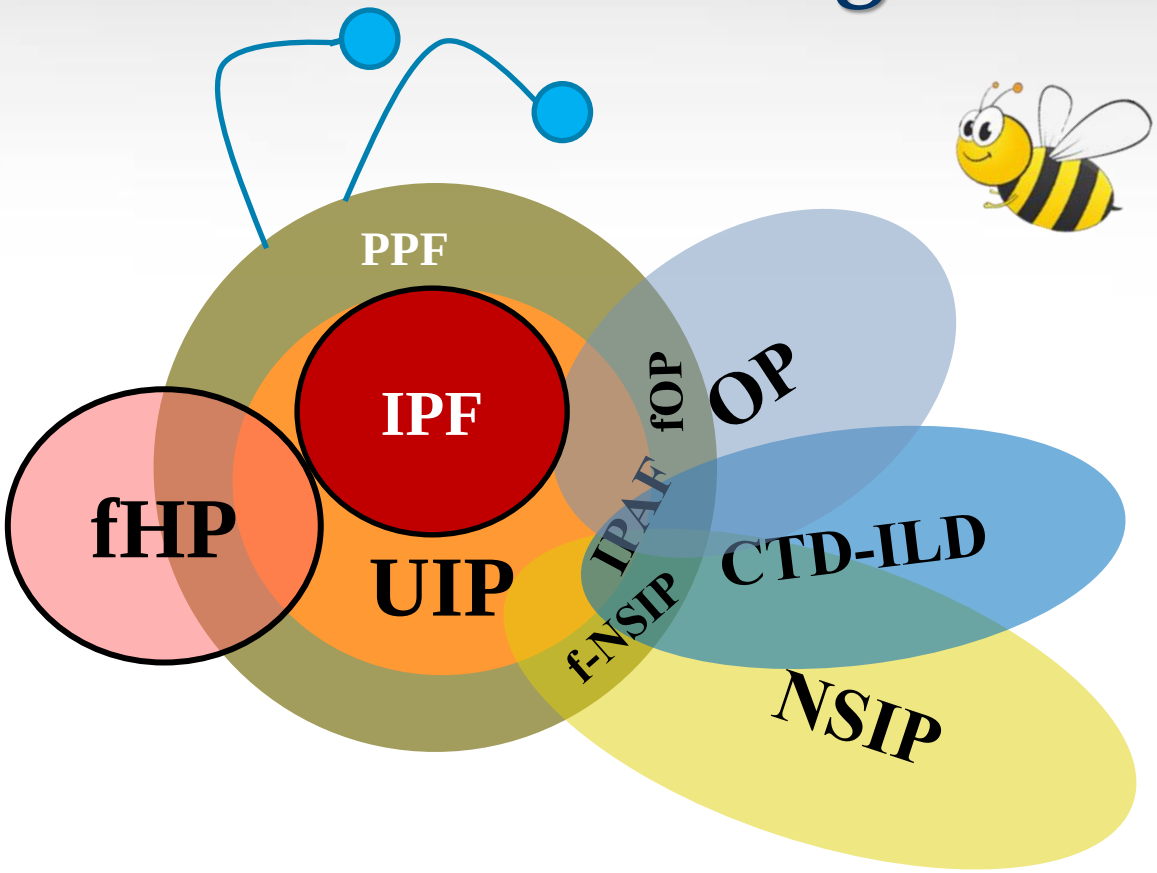


Figure 5. ROC curve for differentiating cancer-associated and non-cancer IPF. (**A**) Radiomics features (energy and kurtosis) demonstrated acceptable performance, with an AUC of 0.66–0.73, which was not inferior to (**B**) the performance of traditional risk factors (gender, smoke, and emphysema), with an AUC of 0.66–0.67.

The HRCT Diagram

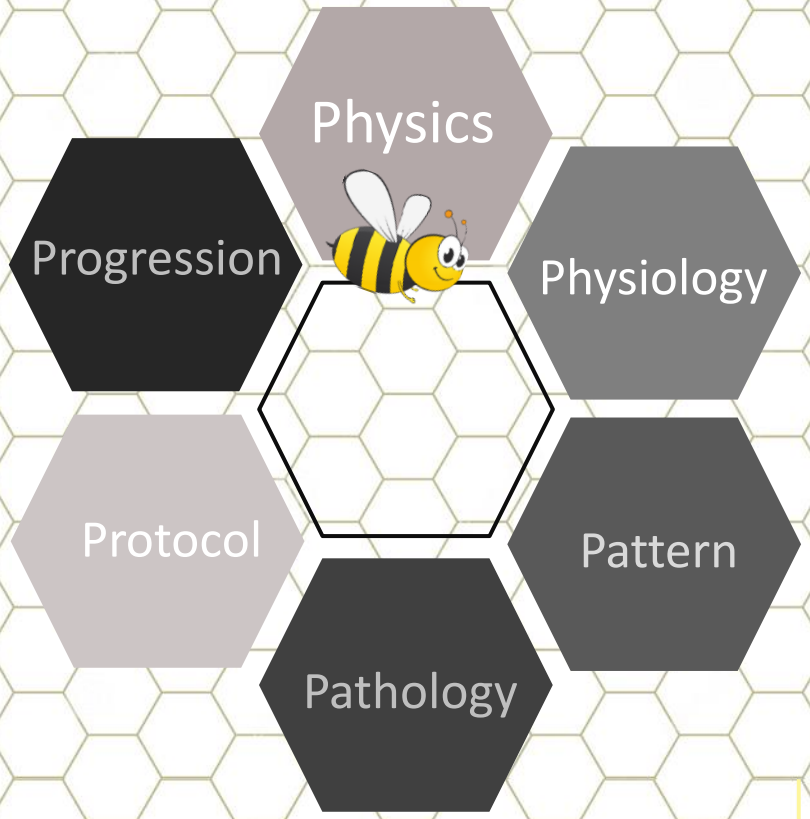


PF-ILD: Progressive fibrosis ILD
PFP-ILD: Progressive fibrosis phenotype ILD

Design by Wu Ming-Ting

**One-third of non-IPF ILD patients are at risk of developing a progressive fibrosing phenotype

Professionalism



6 Professionalists

- Pulmonologist
- Radiologist
- Rheumatologist
- Cardiologist
- Thoracic Surgeon
- Pathologist

6 P³-app®


Physics
Progression
Physiology
Professionalism
Protocol
Pattern
Pathology

謝謝聆聽 敬請指教

wu.mingting@gmail.com