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Multidisciplinary working group for interstitial lung disease in Thailand: Part 2 – a concise review of published visual scoring methods for interstitial lung disease

Juntima Euathrongchit, M.D.[(1)]
Phakphoom Thiravit, M.D.[(2)]
Wiwatana Tanomkiat, M.D.[(3)]
Chayanin Nitiwarangkul, M.D.[(4)]
Thanisa Tongbai, M.D.[(5)]
Yutthaphan Wannosopha, M.D.[(1)]
Thitiporn Suwatanapongched, M.D.[(4)]

From [(1)] Department of Radiology, Faculty of Medicine, Chiangmai University, Chiangmai, Thailand
[(2)] Department of Radiology, Siriraj Hospital, Mahidol University, Bangkok, Thailand
[(3)] Department of Radiology, Faculty of Medicine, Prince of Songkla University, Songkla, Thailand,
[(4)] Department of Diagnostic and Therapeutic Radiology, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand,
[(5)] Department of Radiology, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand.

Address correspondence to J.E. (e-mail: juntima.eua@cmu.ac.th)

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Introduction

Interstitial lung disease (ILD) comprises a large group of multiple disorders causing a variable degree of inflammatory and fibrotic changes predominantly in the interstitial parts of the lungs [1]. Two main histopathological changes of ILDs [2, 3] consist of usual interstitial pneumonia (UIP) and nonspecific interstitial pneumonia (NSIP). UIP representing advanced pulmonary fibrosis is typically found in idiopathic pulmonary fibrosis (IPF). Although NSIP is the most common histopathology in ILD associated with a connective tissue disease (CTD), other histopathological changes, including UIP, can also be found.

On HRCT, the presence of clustered subpleural cystic air spaces reflecting honeycombing and immediate subpleural sparing is considered the hallmark for UIP (Figure 1A) and NSIP (Figure 1B), respectively [3, 4]. However, differentiating bronchiectasis and bronchiolectasis seen in NSIP from subpleural honeycombing in UIP are sometimes crucially problematic. Due to clinical overlap and HRCT features of UIP and NSIP, the diagnosis and treatment of ILD are sometimes not straightforward. A correct diagnosis leading to a successful treatment requires a combination of clinical information (thorough clinical history taking and physical examination), laboratory data, HRCT findings, and sometimes lung biopsy for histopathological information through a multidisciplinary discussion (MDD).

HRCT is considered an essential part of MDD. An accurate interpretation of the disease pattern, the disease extent, and the presence and degree of lung fibrosis, could guide the disease etiology and diagnosis. Moreover, the degree of the disease extent and fibrotic severity could reflect treatment success and prognosis.

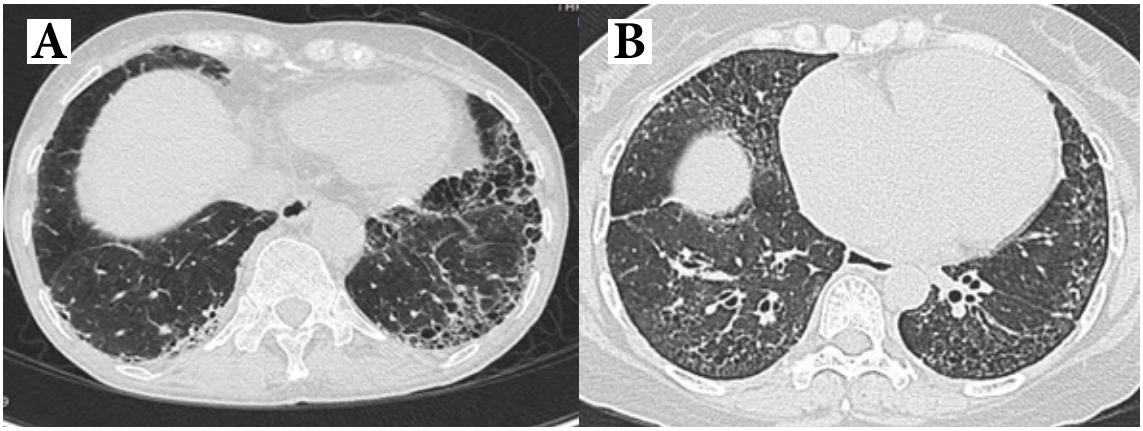

Figure 1. *Axial HRCT at basal lung (A) in UIP pattern showing subpleural honeycombing in bilateral basal lungs with slightly asymmetric involvement. Axial HRCT at the level of the right dome of diaphragm. (B) in the fibrotic NSIP pattern showing mixed ground-glass and reticular opacities with traction bronchiectasis, traction bronchiolectasis, architectural distortion, relative sparing of the immediate lungs, and symmetric involvement.*

Scoring system

Since the disease severity is essential for the current treatment guideline [1], HRCT has become the cornerstone CT for diagnosing and properly managing ILDs, particularly those associated with CTD and IPF. In addition, it helps select patients who will benefit from the antifibrotic therapy. An accurate estimation of the disease and fibrotic extents of ILD is therefore mandatory.

In the past two decades, many published scoring methods have been based on visual estimation of the disease severity and lung fibrosis on HRCT, especially those with IPF and CTD-ILD [5-12]. These methods can be categorized into comparative and semi-quantitative scoring methods. Noteworthly, there are substantial differences among these methods regarding the number of the sampling lung levels or lung zones, the percentage or grading for estimating the extent of involvement, and the weighting factors due to the concern of the unequal lung areas [11, 13]. Table 1 summarizes published visual scoring methods for ILDs commonly adopted in research and clinical practice.

As shown in Table 1, the sampling lung from the lung apex to the lung base ranged from three to five anatomical levels based on axial HRCT images, and the exact anatomical lung levels or zones used are also different (Figure 2). Nevertheless, the lung level was preferred in most previous studies since it is easy to localize without being accustomed to the anatomical boundary of the lung lobe on CT images. For the three-level method, Sánchez et al. [8] selected the anatomical level in each lung zone showing the most extensive involvement for estimating the disease extent.

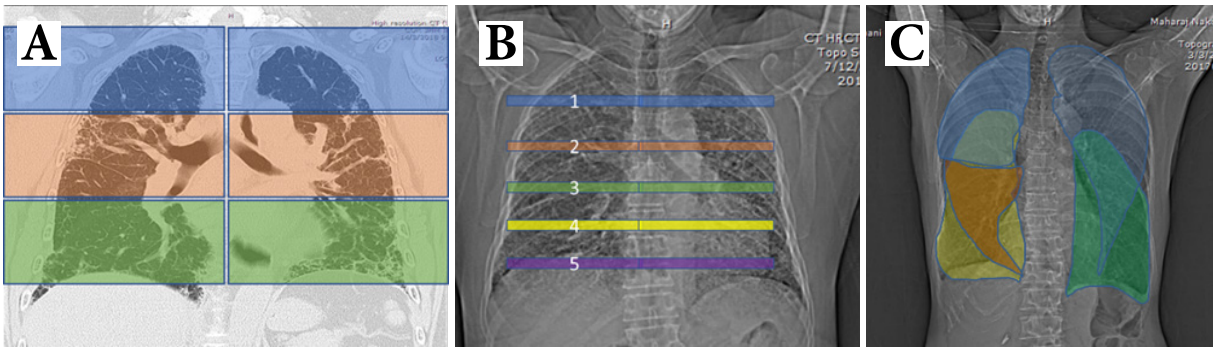

Figure 2. *Illustrations for the published visual CT scoring methods (A) three-level method (B) five-level method, and (C) five lung lobes.*

Table 1. *Summary of the published visual scoring methods for ILD.*

Authors (year), methods & keys	Abnormality and grading	Predefined anatomical levels or zones for evaluation	Adopted by	Advantages
Wells et al. [14] (1992) Comparative scoring Keys: - Score: Grade - Parenchymal disease extent on HRCT correlated with lung histology	Severity grading 1 = Parenchymal opacity alone 2 = Parenchymal opacity > reticulation pattern extent 3 = Parenchymal opacity = reticular pattern extent 4 = Reticular pattern extent > parenchymal opacity 5 = Reticular pattern alone Maximum score = 5 per lobe	Five lung lobes	Pignone et al. [15]; Davas et al. [16]; Shahin et al. [17]; Giacomelli et al. [18]; Shah et al. [19]; Gohari et al. [20]	- Correlation of high score and fibrotic specimen or low score and inflammatory specimen - Parenchymal disease extent on HRCT correlated with lung histology
Warrick et al. [11] (1991) Semi-quantitative scoring Keys: - Score: Grade - Combination of severity and extent of disease compared with clinical context	Severity grading based on HRCT features in each bronchopulmonary segment 1 = GGO 2 = Irregular pleural margin 3 = Septal or subpleural line 4 = Honeycombing 5 = Subpleural cyst Extent grading based on the number of bronchopulmonary segments involved - 1 to 3 segments = 1 - 4 to 9 segments = 2 - > 9 segments = 3	Bronchopulmonary segments	Bellia et al. [5]; Diot E et al. [21]; Orlandi I et al. [22]; Afeltra et al. [23]; Camiciottoli et al. [24]; Yiannopoulos et al.[25]; Savarino et al.[26]; Daoussis D et al.[27]	- Total score correlated inversely with total lung capacity, diffusion lung capacity for carbon monoxide, and forced expiratory volume in 1 second - Alveolitis and fibrosis, two keys from HRCT
Kazerooni EA et al. [7] (1997) and Ooi GC et al. [28] (2003) Semi-quantitative scoring Keys: - Score: Grade - Evaluation of extent and severity of disease	Abnormality - GGO alone - Mixed GGO and reticulation - Reticular fibrosis alone - Honeycombing Extent grade by area of disease involvement in one lobe 1 = involved 1 –25% 2 = involved 26 – 50% 3 = involved 51 – 75% 4 = involved > 75%	Lobes are scored independently Lingula is considered a separate lobe: 6 total lobes Anatomical landmark - Arch - Carina - 1 cm above diaphragm	Choi et al. [29]; Mok et al. [30]; Pandey et al. [31]; Tiev et al. [32]	Fibrosis score was high as 25 - Cellularity score and desquamation score was about 10 - Granulation score was about 9
Goldin et al. [33] (2009) Semi-quantitative scoring; Scleroderma Lung Study (SLS) Keys: - Score: Grade - Evaluation of extent and severity of disease	Abnormality in each each lung zone - GGO alone - Fibrosis (thick reticulation) - Bronchiectasis/ bronchiolectasis - Honeycombing Extent grade based on percentage of involvement in each zone 1 = involved 1– 25% 2 = involved 26 – 50% 3 = involved 51 – 75% 4 = involved > 75%	hree lung zones of each lung are scored for each abnormality - Zone 1: Apex to aortic arch - Zone 2: Aortic arch to inferior pulmonary veins - Zone 3: Inferior pulmonary veins to diaphragm	Scleroderma Lung Study (SLS)	- Lung fibrosis and GGO were commonest imaging findings in symptomatic systemic sclerosis (SSc) patients. - No relationship between progression and baseline lung fibrosis; or limited SSc vs. diffuse SSc.

Authors (year), methods & keys	Abnormality and grading	Predefined anatomical levels or zones for evaluation	Adopted by	Advantages
Well et al. [34] (1997) Quantitative and semi-quantitative scoring Keys: - Score: percentage - Evaluation 1. Global disease extent 2. Reticulation extent 3. Percentage of GGO	1. Global disease extent – estimated to the nearest 5 % 2. % of GGO: proportion of total disease extent 3. Extent of reticulation: proportion of toral disease extent 4. Coarseness of reticulation (fibrotic severity) 0 = Normal 1 = Fine intralobular fibrosis 2 = Microcystic honeycombing 3 = Macrocystic honeycombing The total disease extent is composed of the mean of the percentage of disease at each level	Anatomic landmark (multiplied with weight factor) 1) Origin of the great vessels 2) Main carina 3) Pulmonary venous confluence 4) Halfway between levels 3 and 5 5) Immediately above right hemidiaphragm	Goh et al. [6]; Desai et al. [35]; Hoyles et al. [36]	Goh et al. showed the global extent of disease > 20% → significantly increased mortality of SSc.
Euathrongchit et al. (2014) CMU scleroderma score [9, 10] Keys: - Score: Grade - Evaluation of extent and severity of disease 1. GGO 2. Reticulation 3.Traction bronchiectasis 4. Honeycombing	Determine the grade of each abnormality based on the percentage of lung involvement in each lobe 1 = involved 1 – 25% 2 = involved 26 – 50% 3 = involved 51 – 75% 4 = involved > 75%	Five lung lobes	Wangkaew et al. [9, 10]	- Thai patients - Sensitive method for monitoring disease

Despite the substantial difference in the scoring methods, all of them provided good interobserver agreements and inter-rater reliability, especially when performed by chest radiologists (interobserver agreement kappa 0.74 – 0.88 for overall grading and fibrosis grading, respectively [37]).

With modern CT technology and a simplified method for radiologists, rheumatologists and chest physicians to use a scoring system, we recommended evaluating the disease extent in the global disease and the amount of fibrosis. A semi-quantitative method estimated the amount of the global disease and the fibrotic extent in each reference image in percentage and calculate the average percentage. The reference images could be either 3 or 5 levels, Figure 3 and Table 2 are examples. Moreover, since IPF and the CTD-ILD disease mainly involved the basal lung, we encouraged the evaluation of the sulcal areas for weight as well (see detail in part 3 [38]) and more structural references that facilitated the usage by trainees, general radiologists and physicians.

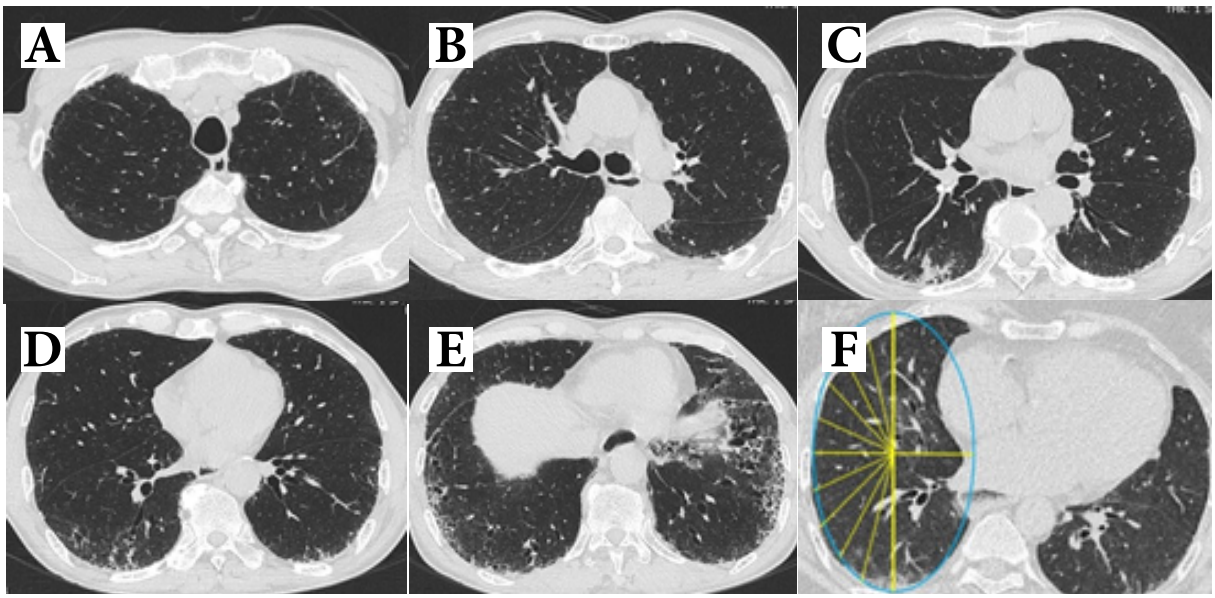

Figure 3. *Axial HRCT (A – E) 5 level from upper to lower lung fields. (A) the origin of great vessels, (B) the carina, (C) the pulmonary venous confluence, (D) between C and E and (E) the right hemidiaphargm level, respectively. Each right or left lung area is about 100% and divided uniformly into small pieces as small as about 5% area (F) that are used to estimate amount of disease findings. The estimated global disease extent and fibrotic extent are summarized in Table 2.*

Table 2. *Summary of the global disease extent and the fibrotic extent calculation by the previously published methods (three–level and five–level methods).*

Area reference	Global disease extent (%)		Fibrotic extent (%)		Average of the summed global disease extent	Average of the summed fibrotic extent
	Rt	Lt	Rt	Lt		
Three-level method by Kazerooni EA et al. [7]; Ooi GC et al. [28] and Goldin et al. [33]						
L1 above arch	5	5	5	5	20-25% [(140x100)/600 =23.3]	20-25% [(135x100)/600 =22.5]
L2 arch to vascular confluence	20	10	15	10		
L3 below vascular confluence	40	60	35	55		
Five–level method by Goh et al. [6] and Well et al. [34]						
L1 great vessel origin	5	5	5	5	20% [(195x100)/1000 =19.5]	15-20% [(170x100)/1000 =17]
L2 carina	0	5	0	5		
L3 vascular confluence	20	5	15	5		
L4 between L3&L5	25	10	20	10		
L5 diaphragm	50	70	45	60		

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