Original Article

DOI: 10.17354/ijss/2016/244

Role of High-resolution Computed Tomography Chest in Interstitial Lung Diseases

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Abstract

Introduction: Interstitial lung diseases (ILDs), also called as diffuse parenchymal lung diseases, are a diverse group of pulmonary disorders classified together because of similar clinical, roentgenographic, physiologic, or pathologic features.

Materials and Methods: The study was conducted in the Department of Radiodiagnosis and Imaging, Government Medical College, Srinagar, on 50 patients presented with suspected diagnosis of ILD referred by Chest Diseases Hospital and Medicine Department of Government Medical College, Srinagar.

Results: In this study, the age of the patients ranged from 22 to 85 years with mean age of 53.5 years, the majority of the patients were in age group 21-40 years (38%). There were 44% male patients and 56% female patients. The most common presenting clinical feature was dyspnea on exertion present in 64% of patients followed by a cough which was present in 60% of cases.

Conclusion: In conclusion, high-resolution computed tomography is a valuable technique for evaluating the extent of lung involvement in various ILDs even when chest X-rays are normal.

Key words: Computed tomography, Chest, Lung diseases

INTRODUCTION

Interstitial lung diseases (ILDs), also called as diffuse infiltrative lung diseases, are a heterogeneous group of disorders that predominantly affect the lung parenchyma and are characterized by alveolar, septal thickening, fibroblast proliferation, and pulmonary fibrosis. Although over 100 distinct entities of ILD are recognized, idiopathic pulmonary fibrosis (IPF), sarcoidosis, and connective tissue disease-related ILD account for most of ILD. Although ILDs are more commonly seen in adults, some forms such as hypersensitivity pneumonitis and idiopathic interstitial pneumonia are encountered in children as well.[1]

Access this article online

www.ijss-sn.com

Month of Submission : 03-2016
Month of Peer Review : 04-2016
Month of Acceptance : 05-2016
Month of Publishing : 05-2016

Patients with ILD most commonly present with shortness of breath with exertion, fatigue, weakness, loss of appetite, loss of weight, dry cough, and discomfort in the chest. These people have a diffuse infiltrative pattern on chest radiograph.[2]

ILDs are classified into those with known causes and with unknown causes. Those with known causes include connective tissue disease-associated ILD, pneumoconiosis, drug-induced, smoking-related ILD, radiation-induced, and toxic inhalation-induced ILD. Those with unknown causes include IPF, sarcoidosis, pulmonary lymphangioleiomyomatosis, and pulmonary alveolar proteinosis.[1]

ILDs are manifested radiographically as either reticular pattern, nodular pattern, or reticulonodular pattern. Interlobular septae contains lymphatics and veins along with connective tissue. Diseases that involve these structures will result in thickened interlobular septae and irregular appearances of the pleural surfaces such

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as in IPF, lymphangitic carcinomatosis, and pulmonary edema.[3]

CT only played minor role in the diagnosis of ILDs until the introduction of high-resolution computed tomography (HRCT). By eliminating superimposition of structures, CT allows for a better assessment of the type, distribution, and severity of parenchymal abnormalities.[4] HRCT has been found useful in the evaluation of ILDs in the following areas: Identification of the presence of disease (often being abnormal when other studies are normal or only mildly impaired), evaluation of the extent of disease, characterization of the patterns of the disease, narrowing the differential diagnosis, as a guide to the site of biopsy and assessing the clinical course of the disease and response to therapy.[5,6]

HRCT identifies a high prevalence of truly subclinical interstitial abnormalities which do not evolve into major disease in many cases. HRCT studies have revealed a similarly high prevalence of interstitial disease in other connective tissue diseases, despite normal chest radiograph in many patients.[10]

HRCT is superior to chest radiography in the diagnosis of ILD. It is highly accurate in the diagnosis of sarcoidosis, silicosis, and lymphangitis carcinomatosis. HRCT is indicated when clinical, radiological, and functional findings do not allow a specific diagnosis and should be done in patients before biopsy.[7]

Aim

The main aim of the study was to assess the role of HRCT in the evaluation of ILD with special attention:

i. To evaluate ILD in symptomatic patients with normal or equivocal chest radiograph findings
ii. To accurately assess the pattern, distribution, and severity of the disease process for the purpose of treatment and management
iii. To differentiate on HRCT reversible changes from those of irreversible which would determine the future prognosis in such patients
iv. To assess the role of HRCT in predicting response to treatment.

MATERIALS AND METHODS

The study was conducted in the Department of Radiodiagnosis and Imaging, Government Medical College, Srinagar, on 50 patients presented with suspected diagnosis of ILD referred by Chest Diseases Hospital and Medicine Department of Government Medical College, Srinagar. The study was done for the evaluation of ILDs discovered on chest radiographs, for the evaluation of lungs in patients with clinically suspected ILD with normal or equivocal radiographs and for quantification of the extent of ILD for the purpose of evaluating the effectiveness of treatment.

HRCT chest was performed using a helical CT scanner with imaging parameters chosen so as to maximize spatial resolution. Narrow slice thickness of 1 mm was taken from lung apices to lung bases with interslice distance of 1 cm resulting in images representative of the lungs. High spatial resolution image reconstruction algorithm will be used with minimal field of vision to minimize the size of the pixel. Window level of (–750 H U) and window width of (+1500 H U) was used for proper assessment of the patients. Scans were performed at full inspiration in supine position. Prone positioning helped in distinguishing gravity dependent atelectasis in the lung bases seen on supine images from early changes of idiopathic lung fibrosis. In patients with suspected airway disease, additional scans were obtained during expiration for detection of air trapping.

Serological testing was done for the presence of different serum markers such as erythrocyte sedimentation rate (ESR), rheumatoid factor (RF), antinuclear antibodies (ANA), and anticentromere antibody for the possibility of connective tissue disorders. HRCT findings of ILD were compared with those of histopathological findings wherever lung biopsy was done.

RESULTS

In this study, the age of the patients ranged from 22 to 85 years with mean age of 53.5 years, the majority of the patients were in age group 21-40 years (38%). There were 44% male patients and 56% female patients.

The most common presenting clinical feature was dyspnea on exertion present in 64% of patients followed by the cough which was present in 60% of cases. Fever was present in 24% patients while skin thickening and arthralgia were seen in 8% of patients each. Weight loss and Raynaud's phenomenon were seen in 6% of patients each. Chest pain was present in 2% cases, and hemoptysis was present in 8% patients.

So, the most common indication for which HRCT chest was performed was IPF present in 32% cases; rheumatoid arthritis (RA) was the next common indication seen in 26% of patients followed by scleroderma which was an indication in 20% cases. Systemic lupus erythematosus (SLE) was an indication in 18% of patients while occupational ILD and mycosis fungoides were an indication in 2% patients each. In our study, only 21 (42%) patients showed findings of

ILD on chest X-ray. There were only 35 (70%) patients in whom serum markers were present.

In our study, only 21 (42%) patients showed findings of ILD on chest X-ray. There were only 35 (70%) patients in whom serum markers were present. Out of 33 patients in whom serum markers were present, ESR was positive in 21 (42%) patients, ANA was raised in 14 (28%) cases, RF was positive in 11 (22%) patients, and Scl-70/anticentromere antibody was positive in 1 (2%) patient.

So, the most common finding in ILDs on HRCT was septal lines seen in 21 (42%) patients followed by bronchiectasis seen in 20 (40%) patients, ground glass haze was seen in 16 (32%) patients, and honeycombing was present in 10 (20%) cases, while subpleural nodules were seen in 9 (18%) patients. Consolidation was present in 2 (4%) patients and parenchymal bands were seen in 6 (12%) patients. Subpleural cyst and dilated esophagus were seen in 2 (4%) patients each while effusion and scar carcinoma were present in 1 (2%) patient each.

The most common HRCT finding in patients of RA was ground glass haze seen in 7 (53.8%) patients followed by bronchiectasis seen in 5 (38.4%) patients, reticulation was present in 3 (23%) cases, honeycombing was seen in 2 (15.4%) patients, and effusion was seen in 1 (7.6%) patient. Findings of RA were detected in 10 (76.9%) cases on HRCT Chest while only 6 (46.2%) patients showed positive findings on X-ray Chest.

Most common serum marker in RA was raised ESR present in 100% of patients, and RF was present in 10 (76.9%) patients while ANA was present in 1 (7.6%) patient.

The most common HRCT finding in patients of scleroderma was septal lines and parenchymal bands present in 5 (50%) cases each followed by subpleural nodules and bronchiectasis seen in 4 (40%) patients each. Honeycombing, ground glass haze, and dilated esophagus were seen in 2 (20%) patients each while scar carcinoma was present in 1 (10%) patient. Findings of scleroderma were detected in 8 (80%) cases on HRCT chest while only 5 (50%) patients showed positive findings on X-ray chest. Most common serum marker in scleroderma was ANA present in 6 (60%) patients while Scl-70 was present in 1 (10%) patient.

The most common HRCT finding in patients of SLE was septal lines seen in 4 (44.4%) patients followed by subpleural nodules and bronchiectasis seen in 3 (33.3%) patients each, ground glass haze was seen in 2 (22.2%) patients while irregular interface and consolidation was seen in 1 (11.1%) patient each. Findings of SLE were detected in 7 (77.8%) patients on HRCT chest while only 2 (22.2%) patients showed positive findings on X-ray chest. Most common serum marker in SLE was ANA present in 7 (77.8%) patients while RF was present in 1 (11.1%) patient.

The most common HRCT finding in patients of IPF was septal lines and honeycombing seen in 8 (50%) patients each followed by bronchiectasis seen in 7 (43.7%) cases, ground glass haze was seen in 4 (25%) patients, and subpleural cysts were seen in 2 (12.5%) cases. Findings of IPF were detected in 16 (100%) cases on HRCT chest while only 7 (43.7 %) patients showed positive findings on X-ray chest. Only serum marker seen in patients of IPF was raised ESR seen in 8 (50 %) of patients.

Diagnosis of IPF was made on the basis of clinico-radiological findings and by the exclusion of other possibilities. Lung biopsy was advised to the patients for confirmation. Out of 16 patients, only 3 (19%) cases underwent biopsy and HRCT findings were confirmed while in 13 (81%) cases who refused for the procedure, follow-up was done and clinico-radiological improvement was seen after getting the treatment for IPF.

HRCT findings in patient of mycosis fungoides were septal lines, ground glass haze, bronchiectasis, and miliary nodules. Findings of mycosis fungoides were present in both X-ray and HRCT chest. Associated findings in patient of mycosis fungoides were lytic bone lesions and liver cysts.

The HRCT findings in patient of pneumoconiosis were subpleural consolidation, centrilobular nodules, and parenchymal bands. Findings were present in both X-ray and HRCT chest. (Figures 1-4 and Tables 1, 2)

DISCUSSION

ILDs, also called as diffuse parenchymal lung diseases, are a diverse group of pulmonary disorders classified together because of similar clinical, roentgenographic, physiologic, or pathologic features. Patients with suspected diffuse

Table 1: Diseases studied with HRCT chest

Disease	Number of patients (%)
IPF	16 (32)
Rheumatoid arthritis	13 (26)
Scleroderma	10 (20)
SLE	9 (18)
Occupational disease	1 (2)
Mycosis fungoides	1 (2)

HRCT: High-resolution computed tomography, SLE: Systemic lupus erythematosus, IPF: Idiopathic pulmonary fibrosis

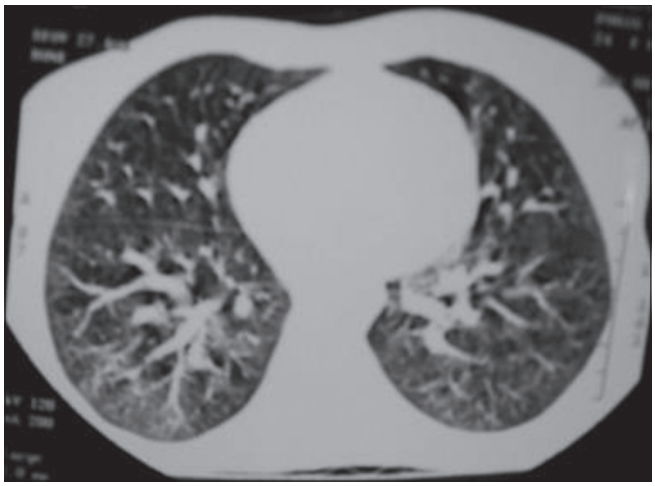

Figure 1: High-resolution computed tomography chest of case of rheumatoid arthritis showing thickening of central interstitium and intralobular septae resulting in reticular pattern of both lungs

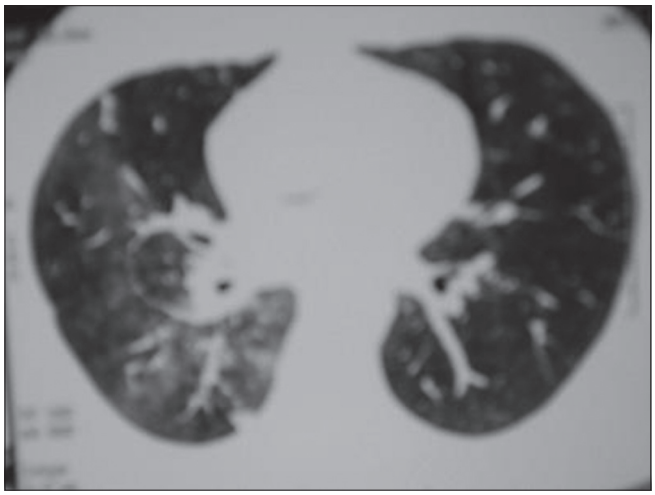

Figure 2: High-resolution computed tomography chest of the case of systemic lupus erythematosus showing ground glass haze with thickening of the central interstitium on right side

Table 2: HRCT features of ILD

HRCT findings	Number of patients (%)
Septal lines	21 (42)
Bronchiectasis	20 (40)
Ground glass haze	16 (32)
Honeycombing	10 (20)
Subpleural nodules	9 (18)
Parenchymal bands	6 (12)
Consolidation	2 (4)
Subpleural cyst	2 (4)
Dilated esophagus	2 (4)
Effusion	1 (2)
Scar carcinoma	1 (2)

HRCT: High-resolution computed tomography, ILDs: Interstitial lung diseases

ILD usually have a chest radiograph as the initial imaging investigation. In the majority of patients, this is abnormal.

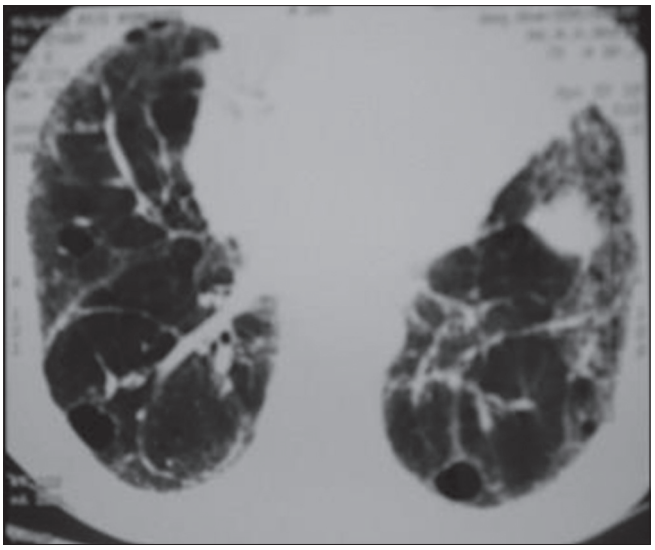

Figure 3: High-resolution computed tomography chest of case of idiopathic pulmonary fibrosis showing bilateral subpleural cysts and honeycombing with thickening of the central interstitium

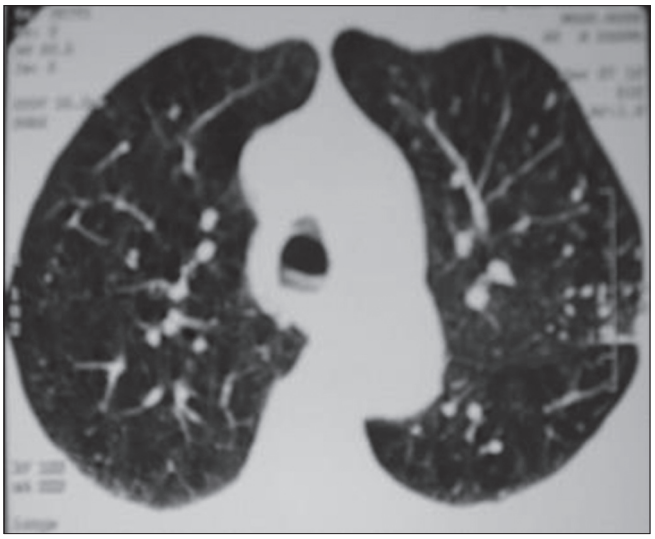

Figure 4: High-resolution computed tomography chest of case of mycosis fungoides with nodules in the bilateral lung fields involving upper lobe, more on the left side.

In most patients, the chest radiographic appearances are not specific while in small proportion of patients with diffuse ILD the chest radiograph is normal.[5]

The limitations of plain chest films in the assessment of lung diseases, especially diffuse ILDs and the difficulties of characterizing lung morphology precisely became even more evident when HRCT was introduced as a new tool in radiologic imaging.[8]

The components of the HRCT findings that are helpful in the diagnosis of ILD include the pattern of parenchymal abnormality (e.g., consolidation and reticular pattern),

the anatomic distribution (upper vs. lower and central vs. peripheral), and associated findings (e.g., mediastinal lymphadenopathy). The most common cause of ILD is IPF.[1] In this study, the maximum number of cases were seen in association with connective tissue diseases (32 cases) followed by IPF, which was present in (16 cases).

RA

RA is a connective tissue disease characterized by symmetrical inflammatory arthritis. It is the most common of the connective tissue diseases. The majority of patients have extra-articular disorders. RA is associated with a broad spectrum of pleural and pulmonary manifestations. Most, but not all patients with pleuropulmonary disease have other clinical evidence of RA.[9]

HRCT is the most sensitive parameter to detect the early interstitial changes in patients of RA. HRCT can show evidence of interstitial lung changes even when clinical and pulmonary function tests are normal. HRCT is superior to plain chest radiograph in the evaluation of early interstitial lung changes associated with RA.[10]

HRCT findings of RA associated with ILDs observed in the current study were ground glass haze present in 7 cases, bronchiectasis was seen in 5 cases, and reticulation was present in 3 cases. Honeycombing was seen in 2 cases and architectural distortion was present in 1 case. In none of the cases, nodules were seen but right sided pleural effusion was seen in 1 case. Similar findings were seen in previous studies.[11,12]

Scleroderma

Progressive systemic sclerosis (scleroderma) is a connective tissue disease of unknown pathogenesis that affects 30-50 years old women 3 times as often as it affects men. This type of sclerosis is characterized by overproduction of collagen which leads to fibrosis of the lungs, skin, vasculature, and visceral organs. Patients present with thickening and tightening of the skin, musculoskeletal manifestations, Raynaud's phenomenon and fibrosis of the lungs, kidneys, and gastrointestinal tract.[13]

HRCT is much more sensitive than chest radiography when assessing subtle pulmonary involvement in patients of scleroderma. It, therefore, seems to be the method of choice for evaluation of structural damage to lung parenchyma. 35% cases of scleroderma had normal X-rays while HRCT detected findings in 91% cases.[13] Similar observations were made in our study.

HRCT findings in this study revealed predominant lower lobe involvement in 3 cases. Septal lines and parenchymal bands were present in 5 cases each. Ill-defined subpleural nodules and bronchiectasis were present in 4 cases each while honeycombing was seen in 2 cases. Ground glass haze and dilated esophagus were seen in 2 cases each. 1 case had developed carcinoma over fibrotic changes. Findings were similar with the studies done by.[14,15]

SLE

SLE is a systemic autoimmune disease. SLE is an autoimmune disease of unknown pathogenesis characterized at histologic examination by deposition of autoantibodies and immune complexes that damage tissues and cells. The presentation is usually systemic and includes fatigue, malaise, anorexia, fever, and weight loss. The disease predominantly affects women (F: M, 10:1) aged 20-50 years.[16]

In this study, there were 9 cases of SLE. HRCT findings were interlobular septal thickening present in 4 cases and irregular interfaces in 1 case. Subpleural nodules and bronchiectasis were seen in 3 cases each, and ground glass haze was seen in 2 cases while consolidation was seen in 1 case. No pleural thickening or effusion was seen. In 7 cases where X-rays were normal, HRCT was able to detect the lung involvement. HRCT is superior to X-ray in evaluating the involvement of lung in ILDs and helps detect changes with greater accuracy and confidence than chest radiography. In addition, thin-section CT is able to define the extent of disease and to identify abnormalities when chest radiographs appeared to have normal finding.[17,18]

IPF

IPF is defined as a specific form of chronic fibrosing interstitial pneumonia of unknown cause, limited to the lungs, and associated with a histologic pattern of usual interstitial pneumonia. It is slightly more common in men and occurs mainly in patients over 50 years old. Clinically, IPF is characterized by the insidious onset of a non-productive cough and dyspnea. The prognosis is poor; the median survival from the time of diagnosis is 2.5-3.5 years.[5]

In this study, there were 16 cases of IPF. Bilateral parenchymal abnormalities were seen in fifteen cases. Basal and subpleural distribution was seen in 13 cases. Honeycombing and septal lines were seen in eight cases each. Bronchiectasis was seen in seven cases, and ground glass haze was seen in four cases while subpleural cysts were present in two cases. HRCT findings were present in all the 16 cases while X-ray findings were present in only 7 cases. Similar findings were observed in study conducted by Müller *et al.*[19]

Out of 16 cases, only 3 cases (18.75%) underwent lung biopsy, and histopathological findings were found to be consistent with those of HRCT findings while 13 (81%) cases showed clinico-radiological improvement after

receiving treatment. A clinical diagnosis in conjunction with distinct distribution patterns on HRCT is an effective tool for making the diagnosis of IPF.[20]

Mycosis Fungoides

Mycosis fungoides, a malignant skin condition with the microscopic appearance of lymphoma, is easily confused with the skin manifestations of leukemia and Hodgkin's disease. It may remain localized to the skin for long periods, but in some cases, it may progress to a systemic stage. The organs most commonly affected are lymph nodes, spleen, liver, lungs, gastrointestinal tract, bones, and adrenal glands.[21]

In mycosis fungoides, HRCT lung reveals areas of ground glass haze with bronchiectasis, septal lines, and small nodules.[22] Similar observations were made in our study.

Occupational Diseases

Numerous occupations expose workers to chemicals, gases, dust, and toxins that can damage the lungs. Silicosis, asbestosis, and coal workers' pneumoconiosis all belong to a group called pneumoconiosis. Of these pneumoconioses, silicosis most often occurs in people working in fields involving high exposure to dust. Such people include miners, construction workers, ceramics workers, tunnel drillers, sandblaster, and stone carvers. In this study, HRCT lung revealed multiple confluent areas of subpleural consolidation, centrilobular nodules, and interlobular septal thickening as parenchymal bands. Involvement was bilateral and there was upper lobe predominance. Similar results were also found in the medical literature.[23,24]

In a subset of patients with ILD, who undergo lung biopsy, accurate diagnosis can be made with HRCT findings alone. Transbronchial and open lung biopsies are commonly avoided because CT helps to form a specific diagnosis with a high level of confidence. HRCT made accurate diagnosis in most of the cases.[25]

HRCT can play a major role in the assessment of patients who have diffuse lung disease. By eliminating superimposition of structures, CT allows for a better assessment of the type, distribution, and severity of parenchymal abnormalities than is possible with chest radiographs. HRCT currently has the best sensitivity and specificity of any imaging method for the assessment of focal and diffuse lung diseases. By demonstrating the pattern and distribution of these abnormalities, HRCT often allows for a confident diagnosis to be made. Thus, HRCT is indicated in patients with suspected diffuse infiltrative lung disease who have normal or questionable radiographic findings.[4]

CONCLUSION

In conclusion, HRCT is a valuable technique for evaluating the extent of lung involvement in various ILDs even when chest X-rays are normal. It is capable of imaging the lung with excellent spatial resolution and provides good anatomic detail. Specific diagnosis can be made and is useful in planning patients' management. In conjunction with clinical diagnosis, it can obviate the need for lung biopsy.

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How to cite this article: Bhat IM, Bhat JA, Shamshad M, Malik AA, Mir S. Role of High-resolution Computed Tomography Chest in Interstitial Lung Diseases. Int J Sci Stud 2016;4(2):20-26.

Source of Support: Nil, **Conflict of Interest:** None declared.