Induced sputum is a useful non-invasive method for the assessment of airway and parenchymal lung diseases. This study aimed to compare induced sputum and bronchoalveolar lavage fluid (BALF) cellular composition and T-lymphocyte subpopulations in patients with interstitial lung disease. We evaluated 33 patients: 15 with sarcoidosis, 11 with hypersensitivity pneumonitis, and 7 with idiopathic pulmonary fibrosis. The percentage of macrophages was significantly lower in induced sputum than in BALF in sarcoidosis (P=0.005), and the percentage of neutrophils was higher in induced sputum than in BALF in sarcoidosis (P=0.001) and hypersensitivity pneumonitis (P=0.006). A significant correlation was found between the BALF and induced sputum CD4+ and CD8+ subsets and the CD4+/CD8+ ratio in both the whole patient group (r_s=0.80, r_s=0.88, r_s=0.88, P<0.001, respectively) and in the 3 subgroups. A strong correlation of the T-lymphocyte subsets in induced sputum and BALF in patients with interstitial lung disease shows that induced sputum may be a non-invasive surrogate for certain parameters in BALF in these patients.

Key words: bronchoalveolar lavage, hypersensitivity pneumonitis, idiopathic pulmonary fibrosis, induced sputum, sarcoidosis
INTRODUCTION

Bronchoalveolar lavage (BAL) is a standard procedure in the diagnostic work-up of patients with interstitial lung diseases, as it is recommended in European Respiratory Society and American Thoracic Society statements (1-3). Results of BAL cell differentials with lymphocytic, neutrophilic, eosinophilic, or mixed cellular pattern can be used as an adjunct to diagnosis. If a BAL finding is compatible with the suspected diagnosis in the context of an appropriate disease history and clinical and radiologic findings, this can then be sufficient for disease confirmation obviating the need for lung biopsy (3). Although BAL imposes minimal risk to the patient when applied under proper selection guidelines, it is an invasive procedure and patient compliance is a commonly encountered problem. Moreover, it cannot be performed on patients who suffer from other diseases, and in whom bronchoscopy may be contraindicated. At present, the only non-invasive method to directly study inflammatory processes in the lung is the examination of induced sputum (IS) (4).

Induced sputum has been widely used in the investigation of airway inflammation in patients with asthma, chronic obstructive pulmonary disease (COPD), and prolonged cough (5-7). Recently, induced sputum has been proposed in the assessment of interstitial lung disease (ILD), such as more specifically sarcoidosis, pneumoconiosis, idiopathic pulmonary fibrosis, or hypersensitivity pneumonitis (8-14).

ILD is a heterogeneous group of disorders with different grades of pulmonary parenchyma disruption. Therefore, the feasibility and reliability of induced sputum analysis might vary among ILD. Today, only about 30 articles refer to ILD, from more than 1000 papers having been published on the application of induced sputum in the diagnosis and management of various diseases. Induced sputum findings were compared with bronchoalveolar lavage fluid (BALF) in patients with ILD, mainly in sarcoidosis, only in a few reports (8, 9, 11, 12, 14). Induced sputum appears a promising technique in assessing ILD, but its exact role in the diagnosis and evaluation of disease activity in these disorders has not been clearly defined. Thus, further studies are needed to explore the role of induced sputum as compared with BAL in patients with ILD.

The aim of the present study was to evaluate induced sputum cellular composition and T-lymphocyte subpopulations and to compare them with those of BALF in patients with newly diagnosed sarcoidosis, hypersensitivity pneumonitis and idiopathic pulmonary fibrosis.

MATERIAL AND METHODS

Subjects

Study protocol was approved by the Ethics Committee of the National Tuberculosis and Lung Diseases Research Institute. Each subject gave written informed consent.
Fifty nine consecutive patients (26 women, 33 men) with newly diagnosed sarcoidosis, hypersensitivity pneumonitis, and idiopathic pulmonary fibrosis who had undergone bronchoscopy with bronchoalveolar lavage during diagnostic work-up in the First Department of Lung Diseases of National Tuberculosis and Lung Diseases Research Institute in Warsaw, Poland, were enrolled into the study.

There were 36 patients with sarcoidosis in the study group (18 women, 18 men; mean age 35.3 ±8.9SD years; 8 smokers, 4 ex-smokers, 24 non-smokers). The ATS/ERS/WASOG statement (2) on sarcoidosis was followed by the diagnosis, which was based on medical history, clinical symptoms, standard chest radiography findings, and computed tomography scan findings. Twenty five of them had biopsy with histopathological evidence of non-caseating epithelioid cell granulomas. According to the chest radiography classification of sarcoidosis (15), fourteen patients had stage I disease (i.e., lymphadenopathy alone), twenty patients had stage II disease (i.e., lymphadenopathy and parenchymal opacities), and two patients had stage III disease (i.e., only parenchymal opacities).

Hypersensitivity pneumonitis was diagnosed in 16 patients (5 women, 11 men; mean age 48.5 ±13.2 years; 1 smoker, 3 ex-smokers, 12 non-smokers) basing on the American Thoracic Society criteria (16). According to high-resolution computed tomography (HRCT) patterns, 11 patients had subacute hypersensitivity pneumonitis, and 5 had chronic hypersensitivity pneumonitis (17).

The diagnosis of idiopathic pulmonary fibrosis (3 women, 4 men; mean age, 65.3 ±7.6 years; 1 smoker, 4 ex-smokers, 2 non-smokers) was established according to the ATS/ERS consensus report (1). The diagnosis was confirmed by open lung biopsy specimen in one patient.

None of the patients received oral or inhaled corticosteroids or antibiotics during the 3 months preceding the study.

**Bronchoscopy and BAL processing**

Fiberoptic bronchoscopy with BAL was performed as a part of routine clinical management, according to the guidelines recommended by ERS (18). After administration of topical xylocaine, the bronchoscope (Pentax EB-1830T3, Japan) was inserted and wedged in the right middle lobe. Boluses of 20 ml of sterile 0.9% saline previously warmed to 37°C, and up to a total volume of 150-200 ml, were instilled into the subsegmental bronchus. The fluid was gently aspirated immediately after each aliquot was introduced and collected in a sterile container. Supplemental oxygen was administered during and immediately after the procedure. During the bronchoscopy, oxygen saturation and pulse rate (Pulsoxymetr 400HS, TRIDENT MED, Poland) were continuously monitored.

The recovered fluid was filtered through sterile gauze and centrifuged at 400 x g for 15 min at 4°C. The pellet was washed twice with cold phosphate-buffered saline (PBS), and the cells were counted. Cells were >90% viable, as assessed by trypan blue exclusion. Slide preparations for differential percentage counting of cells were made in a cytocentrifuge (MPW 341, Warsaw, Poland) using 50 µl aliquots of the lavage cell suspension. Two slides were stained by the May-Grünwald-Giemsa method. The differential cell count of macrophages, neutrophils, lymphocytes, and eosinophils was made under a light microscope (magnification x 100) by counting at least 400 cells. Additionally, 300 µl of BALF were processed for flow cytometric analysis.

**Sputum induction and processing**

Sputum was induced at least 7 days after BAL by inhalation of hypertonic saline solution as described by D’Ippolito et al (11). All subjects inhaled 5% saline solution four times for 5 min using a jet nebulizer (PARI MASTER, PARI GmbH, Germany), with a mean volume output 0.5 ml/min and producing particles with a mass median diameter of 3.6 µm. Throughout the procedure, subjects were
encouraged to cough and to expectorate into a plastic container. Three flow volume curves were performed before and after each inhalation, and the best FEV$_1$ was recorded. Induction of sputum was stopped if the FEV$_1$ value fell by at least 20% from baseline or if troublesome symptoms occurred.

Sputum was processed as soon as possible within 2 h. The method of sputum examination described by Popov et al (19) was used with some modifications. Sputum was poured onto a Petri dish. All viscid portions of the expectorated sample were separated from the whole sputum and placed in pre-weighed polypropylene centrifuge tubes. The weight of the plugs was measured, and dithiothreitol (DDT; Sputolysin® Reagent; Calbiochem, Germany), was freshly prepared in a dilution of 1:10 with distilled water according to the manufacturer’s instructions. The specimen was treated with DDT in order to break up the mucus and disperse the cells. The volume added was four times the weight of the plugs, and was mixed mechanically with the sputum by aspiration in and out of a pipette about 20 times to ensure mixing. The samples were rocked for 15 min on a bench rocker at 22°C. The samples were then filtered through a 40 µm nylon cell strainer (Becton Dickinson, USA). A total cell count (TCC) was performed on the filtered sample, and the viability was checked using the trypan blue exclusion method. Thereafter, the suspension was centrifuged at 500 x g, and the pellet was diluted with PBS to achieve a concentration of 10$^6$ cells/ml.

Slide preparations for differential percentage counting of cells were made in cytocentrifuge (MPW 341, Warsaw, Poland) using 60 µl of the cell suspension. Two slides were stained with May-Grünewald-Giemsa. Four hundred non-squamous cells were counted, and the results were expressed as a percentage of the total non-squamous cell count. Countable cytospins were defined by low salivary contamination (<20% squamous epithelial cells) and cell viability > 70% (14). Additionally, 300 µl of sputum suspension was processed for flow cytometric analysis.

**Flow cytometric analysis of induced sputum and BALF**

Samples (sputum and BALF cells) prepared as described above were analyzed on an FACSCalibur (Becton Dickinson, San Diego, CA) fluorescence activated flow cytometer using monoclonal antibodies TriTEST CD4/CD8/CD3 (Becton Dickinson, San Jose, CA) according to the manufacturer’s instructions. Data were collected and analyzed using the CellQuest 3.3 program (Becton-Dickinson, San Diego, CA). Gating of lymphocytes was performed on the basis of image-measuring granulation and size of cells (FSC, forward scatter cell; SSC, side scatter cell). All cytofluorometric tests were performed within 4 h after collecting samples. The following mouse anti-human monoclonal antibodies were used for labelling sputum and BALF cells: piridinin chlorophyll protein (PerCP)-conjugated anti-CD3+, fluorescein isothiocyanate (FITC)-conjugated anti-CD4+ and phycoerythrin (PE)-conjugated anti-CD8+. Mouse anti-mouse isotype-matched PerCP-, FITC-, PE-conjugated immunoglobulin was used as control antibodies.

**Statistical analysis**

Data were expressed as means ±SD. Since the data were not normally distributed, a nonparametric Wilcoxon test was used to compare the differences in differential cell counts and cell subsets. Correlations between different cells from different samples (induced sputum and BALF) were examined by Spearman’s rank correlation coefficient. A P value of <0.05 was considered as statistically significant.

**RESULTS**

All subjects tolerated well both induced sputum and bronchoscopy procedure, without experiencing any adverse events. Sputum samples were adequate in 33
Out of 59 patients enrolled into the study. Induced sputum was assessed in all patients with idiopathic pulmonary fibrosis, in 15 patients with sarcoidosis, and in 11 patients with hypersensitivity pneumonitis.

Differential cell counts in induced sputum and BALF are shown in Table 1. The percentage of macrophages was significantly lower in induced sputum than in BALF in the sarcoidosis group (45.8 ±24.8% vs. 72.1 ±12.0%; P=0.005); in the remaining two groups the differences were not statistically significant. The percentage of neutrophils was significantly higher in induced sputum than in BALF in the sarcoidosis (36.2 ±28.2% vs. 1.1 ±1.9%, P=0.001) and hypersensitivity pneumonitis groups (38.8 ±33.1% vs. 5.2 ±6.7%, P=0.006); for the patients with idiopathic pulmonary fibrosis the difference was not statistically significant (30.4 ±4.0% vs. 11.6 ±11.6%, P=0.398). There were no significant differences between the percentages of lymphocytes in induced sputum and BALF in sarcoidosis and idiopathic pulmonary fibrosis group, but the percentage of lymphocytes was significantly lower in induced sputum compared to BALF in patients with hypersensitivity pneumonitis (20.7 ±15.4% vs. 49.9 ±22.6%, P=0.004). Finally, the percentage of eosinophils was significantly higher in sputum compared to BALF in sarcoidosis (2.2 ±2.4% vs. 0.5 ±1.1%, P=0.023).

A significant correlation was found between the BALF and induced sputum CD4+, CD8+ subsets and CD4+/CD8+ ratio both in the whole group (r_s=0.80, r_s=0.88, r_s=0.88, P<0.001, respectively) (Fig. 1) and in the 3 subgroups: in patients with sarcoidosis (Fig. 2), with hypersensitivity pneumonitis (Fig. 3), and with idiopathic pulmonary fibrosis (Fig. 4). Moreover, the percentage of lymphocytes and eosinophils in induced sputum correlated strongly with that in BALF in the hypersensitivity pneumonitis group (lymphocytes: r_s=0.64; P=0.035; eosinophils: r_s=0.63; P=0.039) (Fig. 5). No significant correlation between induced sputum and BALF was found for differential cell counts in the

<table>
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<th>HP</th>
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<td>IS</td>
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<tr>
<td>Macrophages (%)</td>
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<td>Neutrophils (%)</td>
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<td>Lymphocytes (%)</td>
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<td>0.156</td>
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<tr>
<td>Eosinophils (%)</td>
<td>2.2±2.4</td>
<td>0.5±1.1</td>
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Values are means ±SD; IS - induced sputum, HP - hypersensitivity pneumonitis, IPF - idiopathic pulmonary fibrosis, BALF - bronchoalveolar lavage fluid. Statistical analysis by Wilcoxon test.

Table 1. Comparison of differential cell count in induced sputum (IS) and bronchoalveolar lavage fluid (BALF) in the study subgroups.
Fig. 1. Correlation of T CD4+, CD8+ lymphocyte subpopulations, and CD4+/CD8+ ratio between induced sputum (IS) and bronchoalveolar lavage fluid (BALF) in the whole study group.

Fig. 2. Correlation of CD4+, CD8+ lymphocyte subpopulations, and CD4+/CD8+ ratio between induced sputum (IS) and bronchoalveolar lavage fluid (BALF) in the sarcoidosis group.
Fig. 3. Correlation of CD4+, CD8+ lymphocyte subpopulations, and CD4+/CD8+ ratio between induced sputum (IS) and bronchoalveolar lavage fluid (BALF) in patients with hypersensitivity pneumonitis (HP).

Fig. 4. Correlation of CD4+, CD8+ lymphocyte subpopulations, and CD4+/CD8+ ratio between induced sputum (IS) and bronchoalveolar lavage fluid (BALF) in patients with idiopathic pulmonary fibrosis (IPF).
DISCUSSION

In this study we compared induced sputum cellular composition and T-lymphocyte subpopulations with those of BALF in patients with different newly diagnosed ILD, i.e., sarcoidosis, hypersensitivity pneumonitis and idiopathic pulmonary fibrosis. We aimed to explore the possible correlation of the differential cell counts and T-lymphocyte subsets, and CD4+/CD8+ ratio between induced sputum and BALF in these patients. The main finding of this study was a significantly positive correlation between the BALF and induced sputum CD4+, CD8+ T-lymphocyte subpopulations and CD4+/CD8+ ratio both in the whole group ($r_s=0.80$, $r_s=0.88$, $r_s=0.88$, $P<0.001$, respectively) and in the 3 subgroups (sarcoidosis, hypersensitivity pneumonitis, idiopathic pulmonary fibrosis).

Another important finding was that the percentage of lymphocytes in induced sputum correlate strongly with that in BALF in patients with hypersensitivity pneumonitis ($r_s=0.64; P=0.035$).

Thus, our data support the view that the T cell subpopulations present in the samples recovered by induced sputum correlate well with those recovered by BAL. This findings are in agreement with those reported for normal subjects, asthmatics, and various ILD (8, 12, 14, 20). The strong correlation of the CD4+, CD8+ subsets and CD4+/CD8+ ratio in induced sputum and BAL fluid in patients with sarcoidosis, hypersensitivity pneumonitis, and idiopathic pulmonary fibrosis may reflect inflammation in both the proximal and distal parts of the lung. There is some evidence that in patients with ILD the immune inflammatory process is not compartmentalized within the alveolar walls, but it can also involve bronchial...
airways. In patients with sarcoidosis and hypersensitivity pneumonitis, the bronchial epithelium may be extensively damaged during the active phase of disease and bronchial hyperreactivity to methacholine may be found (15, 21). In addition, the computed tomography can show a variety of bronchial wall abnormalities in these patients (15, 17).

The lack of correlation between macrophages and neutrophils percentage in induced sputum and BALF in our patients is probably due to the fact that these two samples were taken from different compartments of the lung. Studies which performed segmental lavages at different depths within the airways demonstrated that the proportion of neutrophils decreased from central (20-30%) to peripheral (<2%) airways, with a corresponding increase in the proportion of macrophages. Based on these observations it seems likely the sputum is derived from large airways which are rich in neutrophils, whereas BAL samples the more distal airways and alveolar spaces (22).

Our first objective in the current study was to directly compare the induced sputum cellular composition with those of BALF in patients with the most often encountered ILD. We found that the induced sputum samples contained a significantly higher percentage of neutrophils and lower percentage of macrophages compared to those recovered by BALF in patients with sarcoidosis. These findings are in agreement with those found by other authors (9, 12, 20). In our hypersensitivity pneumonitis patients, the percentage of neutrophils was significantly higher in induced sputum then BALF, while the difference in the percentage of macrophages in two samples did not achieve statistical significance probably due to a small number of the patients in this group.

In contrast to the results of other authors, who found a significantly lower percentage of lymphocytes in induced sputum than in BALF (9, 11), the percentage of lymphocytes was similar in two recovered samples in our sarcoidosis patients. Similar results have been obtained by Tsiligianni et al (14). However, the percentage of lymphocytes in BALF in our population seems to be in accordance with those in other studies (11-14). It is known that sarcoidosis is a chronic inflammatory disorder that is characterized by the accumulation of lymphocyte populations in air spaces and interstitium. The equivalent of $25 \times 10^6$ T-cells can be recovered from the BALF of patients with active pulmonary sarcoidosis, most probably in response to unknown exogenous or endogenous antigen(s) (23). Lack of significant difference in the percentage of lymphocytes in induced sputum and BALF in our sarcoidosis patients supports Tsiligianni et al (14) observations that lymphocytosis can be found not only in BALF, but also in induced sputum. A higher percentage of lymphocytes in induced sputum in our patients in relation to the results of other authors (9, 11, 13) and similar (12), or somewhat lower one as compared to the others (14) could be explained by variations in activity state of disease in patients having been assessed in the above mentioned studies.
In addition, a high percentage of lymphocytes in induced sputum can permit assessments of T-lymphocyte subpopulations and CD4+/CD8+ ratio calculations in patients with sarcoidosis. Some reports have shown the CD4+/CD8+ ratio can be helpful in distinguishing sarcoidosis from other ILD (9, 14). There is evidence that a CD4+/CD8+ ratio of >3.5 in BALF has a sensitivity of about 50% for sarcoidosis compared with lung biopsies, obviating the need for surgery in this portion of patients (2, 9, 14). The CD4+/CD8+ ratio in induced sputum also helps distinguish sarcoidosis from other lung diseases, and a CD4+/CD8+ ratio of ≥2.5 has a high positive predictive value for distinguishing sarcoidosis from non-granulomatous interstitial lung disease (9). In induced sputum of our sarcoidosis patients a CD4+/CD8+ ratio of ≥2.5 was found in all subjects (100%), while a CD4+/CD8+ ratio of >3.5 was found in 13 (87%) cases. As we found a good correlation of CD4+, CD8+ T-lymphocytes and of CD4+/CD8+ ratio between induced sputum and BALF, we suggest that induced sputum could be used instead of BALF in distinguishing sarcoidosis from idiopathic pulmonary fibrosis and hypersensitivity pneumonitis.

Hypersensitivity pneumonitis is characterized by a diffuse and predominantly mononuclear cell inflammation of small airways and pulmonary parenchyma and the main pathophysiologic process in this disease is a T-lymphocytes alveolitis (10, 16). An analysis of cells recovered in BALF has been extensively used as diagnostic tool, since it shows an increased number of activated polyclonal or oligoclonal T-lymphocytes (3, 16). In addition, most studies report a strong predominance of CD8+ T-lymphocytes, with a decreased CD4+/CD8+ ratio (16). In our hypersensitivity pneumonitis patients, we found that the percentage of lymphocytes was significantly lower in induced sputum, as compared with BALF, which is in close agreement with a report by D'Ippolito et al (10). These authors also demonstrated that not only BAL, but also induced sputum samples from newly diagnosed untreated patients with hypersensitivity pneumonitis contain significantly more lymphocytes, than those from healthy subjects. In the present study, a control group of healthy subjects was not considered, because the main objective was to directly compare the induced sputum cellular composition with those of BALF in ILD patients. However, the mean percentage of lymphocytes in induced sputum in patients with hypersensitivity pneumonitis in a report by D'Ippolito et al (10) is considerably lower than that in our hypersensitivity pneumonitis patients (4 ±3% vs. 21 ±15%, respectively). Previous studies have reported that the percentage of lymphocytes in induced sputum from healthy subjects and from non-selected patients with asthma or COPD is low, and its mean value, in general, is <3.3% (6, 20, 24). A range of normal values for induced sputum cells in a group of healthy Polish people living in the Silesia region has recently been published (25). Smokers were not excluded from this study, similar to our present report. The percentage of lymphocytes in this population does not exceed 4.5% for smokers and 7% for non-smokers. The percentage of lymphocytes in induced sputum from our patients with newly
diagnosed hypersensitivity pneumonitis ranged from 1.8 to 42.0% (mean 20.7 ±15.4%). Increased percentage of lymphocytes in induced sputum is of interest, because of potential use of this safe and non-invasive method as a complementary tool to bronchoscopy in research and clinical monitoring of patients with hypersensitivity pneumonitis. As far as we know, induced sputum as an investigative tool in hypersensitivity pneumonitis patients has been used only by D’Ippolito (10) and Mroz et al. (13). The authors of the latter report have found a higher lymphocyte count in induced sputum from hypersensitivity pneumonitis and sarcoidosis patients, as compared with that from COPD patients (13). A control group of healthy volunteers was not considered, similarly as in our present study. In contrast to the results of D’Ippolito et al (10), who did not find a correlation among lymphocyte percentages in samples recovered with two different techniques (induced sputum and BALF), the correlation in our hypersensitivity pneumonitis population was significant. A plausible explanation for this discrepancy might be some variations in patient population or in the technique of sputum induction and processing. High percentage of lymphocytes in induced sputum, several times higher then reported by Sozanska et al (25) for healthy subjects and significant correlation between the percentages of those cells in induced sputum and BALF in our patients with hypersensitivity pneumonitis may reflect inflammation in both proximal and distal parts of the lung. Thus, it supports the potential use of induced sputum as a non-invasive and safe surrogate for certain parameters in BAL fluid in these patients.

We did not find significant differences in differential cell counts between induced sputum and BALF in patients with idiopathic pulmonary fibrosis, unlike our sarcoidosis and hypersensitivity pneumonitis patients’ results. The percentage of macrophages was lower, and that of neutrophils was higher in induced sputum as compared with those in BALF, but the differences did not achieve the statistical significance. The idiopathic pulmonary fibrosis group consisted of the smallest number of patients and the lack of a statistically significant difference was likely due to a small number of subjects, even though the mean percentage of neutrophils in induced sputum was almost three-fold higher, as compared with that in BALF. Nevertheless, the differential cell count in induced sputum in our idiopathic pulmonary fibrosis patients was in close agreement with that found by Antoniou et al (8).

In contrast to the results of Antoniou et al (8), who demonstrated a strong correlation of the percentage of eosinophils between induced sputum and BALF in patients with idiopathic pulmonary fibrosis, we did not find such a correlation in our population. These contradictory findings underline the need for further studies evaluating the full potential of induced sputum in idiopathic pulmonary fibrosis in prospective multicentre studies, owing to low incidence of this disease.

In conclusion, the present study showed that the analysis of T-lymphocyte subpopulations by means of induced sputum might be as helpful as BALF analysis in the diagnosis of sarcoidosis. The strong correlation of the T-
lymphocyte subsets and CD4+/CD8+ ratio in induced sputum and BALF in patients with different ILD may reflect inflammation in both proximal and distal parts of the lung. Induced sputum may become a non-invasive surrogate for certain parameters in BALF in these patients.

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REFERENCES


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