Outcome of patients with interstitial lung diseases admitted to the Respiratory Intensive Care Unit

Nehad M. Osman, Samar H. Sharkawy, Ashraf A. Gomaa

Introduction Clinicians may face unique challenges while managing critically ill patients with interstitial lung diseases (ILD) admitted to respiratory intensive care units (RICUs).

Objectives The aim of the present study was to determine the outcome of ILD patients admitted to RICU as regards mortality rate and risk factors associated with mortality.

Patients and methods Ninety-one patients with ILD admitted to RICU were prospectively recruited. We analyzed demographic data, pulmonary function test results, arterial blood gas values, therapeutic strategies, mechanical ventilation (MV) use, RICU and hospital duration, and mortality rates.

Results The RICU morality rate was 9.9%. Presence of hemophilia, renal impairment, low-diffusion lung capacity for carbon monoxide, and low arterial oxygen saturation were significantly more frequent among nonsurvivor compared with survivor patients. All nonsurvivor patients had pulmonary hypertension compared with 69% of the survivors, but without a significant difference. Fifteen percent of our patients received invasive MV. There were no significant differences between nonsurvivors and survivors as regards need for MV and duration of MV. Whereas patients with a positive history of previous MV had a significant survival time that was less than those with a negative history of previous MV. The duration of hospital and RICU stay were significantly longer in the survivors group compared with the nonsurvivors group (12.65±9.06 vs. 5.55±4.12 and 10.51±7.51 vs. 4.88±2.31, respectively).

Conclusion Our study population showed very low RICU morality rate when compared with previous studies. Nonsurvivors had a shorter hospital and RICU stay, positive history of previous MV, lower diffusion lung capacity for carbon monoxide, and lower arterial oxygen saturation.
Egypt J Bronchol 2017 11:134–140

Egyptian Journal of Bronchology 2017 11:134–140

Keywords: interstitial lung diseases patients, mortality rate, risk factors

Department of Chest Diseases, Ain Shams University, Cairo, Egypt

Correspondence to Nehad M. Osman, MD, PhD, 7, Kadry ST., Hamamat El Kobba, Cairo 2111, Egypt; Tel: +20 122 354 9008;
e-mail: osman_nehad@yahoo.com

Received 31 December 2016 **Accepted** 7 January 2017

Introduction

Interstitial lung diseases (ILDs) are a heterogeneous group of diseases that afflict the lung parenchyma and share many clinical, radiologic, and physiological features. It occurs either in association with identifiable causes (chiefly connective tissue disease, environmental exposures, and drugs) or as idiopathic conditions, that is, idiopathic interstitial pneumonias (IIPs) [1,2]. Idiopathic pulmonary fibrosis (IPF) is a subtype of IIPs and is considered as the most lethal among the ILDs [3].

Some ILD patients may need hospitalization or ICU admission during the course of their illness and clinicians may face unique challenges while managing critically ill ILD patients [4–6].

One complication of ILD is acute respiratory failure (ARF), which may develop as the inaugural manifestation or as an acute exacerbation of chronic ILD. ILD-associated ARF may require even ventilatory support. Little is known about the outcomes of ILD in ICU, especially in those presenting with ARF [4,7].

This study aimed to describe and determine the outcome of patients with ILD admitted to the respiratory intensive care unit (RICU) as regards mortality rate and risk factors associated with mortality.

Patients and methods

This prospective study included consecutive patients with ILD admitted to the RICU for more than 24 h in Ain Shams University Hospitals between January 2013 and July 2015.

Patients were diagnosed with ILD and included in the study if they had previous clinical features, documented high-resolution computed tomography (HRCT) scan findings and pulmonary function test (PFT) results that included evidence of restriction and/or decreased diffusion lung capacity for carbon monoxide (DL_{CO}) of ILD, and who met the American Thoracic Society/European Respiratory Society consensus classification of IIPs and the British Thoracic Society ILD guidelines [2,8,9]. Diagnosis of ILDs of known cause (e.g. connective tissue disease related) and other forms of ILD (e.g. sarcoidosis, eosinophilic pneumonia, lymphangioleiomyomatosis) were further based on appropriate diagnostic criteria in the literature [9–13].

 DOI: 10.4103/ejb.ejb_92_16

The diagnosis of IPF was based on characteristic clinical and PFT setting, presence of usual interstitial pneumonia (UIP) pattern on HRCT images of the lung, and exclusion of causes known to cause and/or associated with ILD [2,9].

ARF was defined as an acute and rapid deterioration in respiratory function and exacerbation of dyspnea within a few days, associated with a deterioration of hypoxemia with a PaO_2/FiO_2 less than 250 mmHg [14].

Acute exacerbations of ILD diagnosis were based on the following criteria: previous diagnosis of an ILD, deterioration of dyspnea lasting less than 1 month, hypoxemia (decreased PaO_2 or PaO_2/FiO_2 ratio), new ground-glass opacities or consolidation on chest radiograph or HRCT, and exclusion of infection (negative respiratory culture) and other diagnoses (pulmonary embolism, congestive heart failure, or pneumothorax) [15–18].

Diagnosis of pulmonary infections was made on the clinical bases of lower respiratory tract infection presentation, with radiographic presence of new or progressive radiological infiltrates (pneumonia) or without new radiological infiltrates (tracheobronchitis), and microbiological bases of isolation of cultured organisms according to the national and international standers of practice [19,20].

Data collection

We collected data including demographics, associated comorbidities, reasons for RICU admission, duration of illness, previous HRCT scan chest findings, former PFT measurements (spirometry, DL_{CO}, and total lung capacity), arterial blood gas values, RICU and hospital lengths of stay and mortality rates, use and duration of mechanical ventilation (MV) and immunosuppressive, and the concomitant therapy used. We reviewed the available reports of the histological findings of lung tissues obtained previously.

The study was approved by the Institutional Review Board and ethical committee.

Statistical analysis

Data were collected, tabulated, and statistically analyzed using SPSS (version 15; SPSS Inc, Chicago, IL). Parametric data were expressed as minimum, maximum, mean, and SD. Nonparametric data were expressed as number and percentage. Comparison between two groups was done using the χ^2-test and the unpaired *t*-test. Results were considered statistically significant for *P*-values less than or equal to 0.05. A survival study was carried out by linear regression analysis. The Kaplan–Meier survival curves and the log rank test were used to compare mortality.

Table 1 Comparison between survivors and nonsurvivors as regards demographic characteristics

	Patients (*N*=91)	Nonsurvivors (*N*=9)	Survivors (*N*=82)	*P*
Age (mean±SD) (years)	51.72±15.59	58.77±7.39	50.95±16.08	*0.1*
Sex				
Female	72 (79.1)	9 (100)	63 (76.8)	0.1
Male	19 (20.9)	0	19 (23.2)	
Smoking (*N*)				0.3
Smoker	14 (15.4)	0	14 (17.1)	
Exsmoker	6 (6.6)	1 (11.1)	5 (6.1)	
Nonsmoker	71 (78)	8 (88.9)	63 (76.8)	
Duration of illness (months)	32.37±30.18	17.11±10.25	34.04±31.19	0.1
Comorbidities				
Any comorbidity	47	7 (77.8)	40 (48.8)	0.09
CLD	4 (8.5)	1 (14.3)	3 (7.5)	0.5
HCV	8 (17)	2 (28.6)	6 (15)	0.3
IHD	5 (10.6)	1 (14.3)	4 (10)	0.7
NIDDM	24 (51.1)	4 (57.1)	20 (50)	0.7
HTN	24 (51.1)	3 (42.9)	21 (52.5)	0.6
RI	3 (6.4)	2 (28.6)	1 (2.5)	0.009*
Hemophilia	1 (2.1)	1 (14.3)	0	0.01*
RHD	1 (2.1)	0	1 (2.5)	0.6
DCM	2 (4.3)	0	2 (5)	0.5
DVT	1 (2.1)	0	1 (2.5)	0.6
CVS	1 (2.1)	0	1 (2.5)	0.6

CLD, chronic liver diseases; CVS, cerebrovascular stroke; DCM, dilated cardiomyopathy; DVT, deep venous thrombosis; HCV, hepatitis c virus; HTN, hypertension; IHD, ischemic heart diseases; NIDDM, noninsulin diabetes mellitus; RHD, rheumatic heart diseases; RI, renal illness. Just to enumerate the patients in each group.

Results

Ninety-one patients with ILD who were admitted to the RICU during the study period fulfilled the inclusion criteria and were included in the study analysis. Twenty patients were excluded from the study because of incomplete data.

The main demographic characteristics data of the 91 study patients [82 (90.15%) survivors and nine (9.95%) nonsurvivors] are shown in Table 1. Comparison between survivors and nonsurvivors were done as regards age, sex, smoking history, duration of illness, and comorbidities. There were significant differences between the two groups as regards presence of hemophilia (only one of nonsurvivors) and the presence of renal impairment [two (28.6%) nonsurvivors vs one (2.5%) survivor] (Table 1).

Sixty-eight (74.73%) patients had IPF, 12 (13.19%) patients had connective tissue disease-related ILD (seven systemic lupus erythematosus, four rheumatoid arthritis, and one scleroderma), four (4.40%) patients had histological documentation (bronchoscopic or surgical) of sarcoidosis, three (3.2%) patients had non-IPF–IIPs, one (1.09%) patient had lymphangioleiomyomatosis, one (1.09%) patient had silicosis, one (1.09%) patient had chronic eosinophilic pneumonia, and one (1.09%) patient had radiation pneumonitis. Comparison between survivors and nonsurvivors as regards the cause of admission showed no significant differences (Table 2).

The duration of the illness from the time of ILD diagnosis to RICU admission was very variable, ranging from 1 to 120 months, with a mean±SD duration of 32.37±30.18 days.

As regards chest radiographic findings on admission, five (5.49%) patients had pneumothorax and seven (7.69%) had pneumonia. Whereas, all patients had bilateral infiltration with or without some area of consolidation, reticulonodular infiltration, and/or honey combing.

Comparisons between survivors and nonsurvivors were done regarding former PFT measurements, current arterial blood gas, and echocardiography findings, as shown in Table 3. DL_{CO}% of predicted was significantly higher among the survivors group (52.87±12.19) compared with the nonsurvivors group (42.11±11.8). Furthermore, arterial oxygen saturation (SaO_2%) was significantly higher in the survivors group (80.57±10.72) compared with the nonsurvivors group (71.57±17.84).

Comparisons between the two groups were done concerning current and previous treatment polices (previous long-term oxygen therapy, MV, and

Table 2 Comparison between survivors and nonsurvivors as regards the cause of admission

	Patients (*N*=91)	Non-survivors (*N*=9)	Survivors (*N*=82)	*P*
ARF	80	9 (100)	71 (86.6)	0.2
AIE	66	6 (66.7)	60 (73.2)	0.6
AE	20	1 (11.1)	19 (20.88)	0.4
HF	2	1 (11.1)	1 (1.2)	0.054
PE	13	2 (22.2)	11 (13.4)	0.4
Cerebritis	1	0	1 (1.3)	0.7
Tracheal stenosis[a]	1	0	1 (1.3)	0.7
Pneumothorax	5	1 (11.1)	4 (4.9)	0.4

AE, acute exacerbations; AIE, acute infective exacerbations; ARF, acute respiratory failure; CHF, congestive heart failure; HF, heart failure; PE, pulmonary embolism. [a]Patients presented by stridor caused by tracheal stenosis post previous mechanical ventilation.

Table 3 Comparison between survivors and nonsurvivors as regards pulmonary functions, arterial blood gases, and echocardiography results

	Patients (*N*=91)	Nonsurvivors (*N*=9)	Survivors (*N*=82)	*P*
PFTs (predicted FEV1%)	61.64±11.87	59.44±12.81	62±11.8	0.5
FVC%	45±10.83	38.77±5.89	46±11.14	0.06
D_{LCO}%	51.33±12.63	42.11±11.8	52.87±12.19	0.01*
TLC%	96.26±15.6	102.77±14.16	95.18±15.69	0.1
ABG on admission PH	7.41±0.06	7.37±0.07	7.41±0.06	0.06
PaO_2	48.76±13.14	45.33±10.75	49.13±13.38	0.4
$PaCO_2$	47.18±12.81	53.04±11.96	46.54±12.81	0.1
HCO_3	30.36±7.01	30.28±3.9	30.37±7.29	0.9
SaO_2%	79.68±11.79	71.57±17.84	80.57±10.72	0.02*
Echocardiography				
LVF EF%	63.75±6.14	62±6.46	64.01±6.11	0.3
PH	66 (72.5)	9 (100)	57 (69.5)	0.051

ABG, arterial blood gases; D_{LCO}%, diffusion lung capacity for carbon monoxide; FEV1%, forced expired value in first second; FVC, forced vital capacity; LVF EF%, left ventricular ejection fraction; PFTs, pulmonary functions test; PH, pulmonary hypertension; SaO_2%, arterial oxygen saturation; TLC%, total lung capacity.

treatment), and showed no significant differences except for history of previous MV. There were significant increases in the percentages of nonsurvivors (44.44%) when compared with survivors (6.1%) as regards the history of previous MV (Table 4). Patients with a positive history of previous MV had a significant survival time that was less than that of those with a negative history of previous MV (Fig. 1).

Out of 91 patients with ILD admitted to RICU, nine (9.9%) patients died and 82 (90.1%) survived, in which 45 (49.4%) were discharged with a long-term oxygen therapy, 34 (37.3%) patients discharged without long-term oxygen therapy, and three (3.2%) patients transferred to other hospital. The cause of death was due to ventilatory and hemodynamic failure in seven (77.8%) patients and due to ventilator-associated pneumonia and septic shock in two (22.2%) patients.

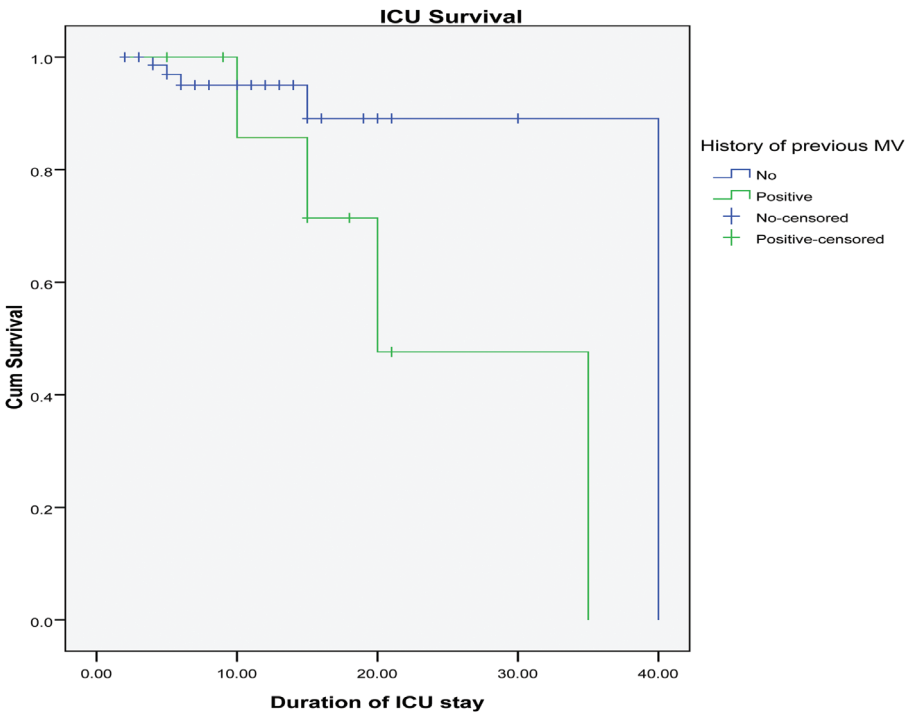
The mean±SD hospital stay was 11.95±8.94 days (range: 2–49 days), whereas the mean±SD duration of RICU stay was 9.95±7.36 days (range: 2–40 days).

The duration of hospital stay and duration of ICU stay was significantly longer among survivors compared with nonsurvivors (12.65±9.06 vs. 5.55±4.12 and 10.51±7.51 vs. 4.88±2.31, respectively). Meanwhile, there were no significant differences between the two groups as regards need for MV and duration of MV (Table 5).

Table 4 Differences in current and previous treatment polices between nonsurvivors and survivors

	Patients (*N*=91)	Nonsurvivors (*N*=9)	Survivors (*N*=82)	*P*
Previous long-term oxygen therapy	48 (52.8)	5 (55.6)	43 (52.4)	0.8
Previous mechanical ventilation	9 (9.9)	4 (44.5)	5 (6.1)	0.0002
Previous corticosteroids therapy	91 (100)	9 (100)	82 (100)	1
Previous immunosuppressant	11 (12.1)	1 (11.1)	10 (12.2)	0.9
Increase dose of corticosteroids	72 (79.1)	8 (88.9)	64 (78)	0.4
Oxygen therapy	91 (100)	9 (100)	82 (100)	1
Mechanical ventilation	14	4 (44.4)	10 (12.2)	0.2
Antibiotics use	91 (100)	9 (100)	82 (100)	1
Added immunosuppressant	17 (18.7)	2 (22.2)	15 (18.3)	0.7

Figure 1



Kaplan–Meier survival curves of survival in interstitial lung disease patients in ICU. Blue line (*n*=82) denotes patients that were not previously mechanical ventilation (MV) (including five patients that died). Green line (*n*=9) denotes patients with history of previous MV (including four patients who died). Global log-rank test (*P*>0.05).

Table 5 Respiratory intensive care units outcomes for patients with interstitial lung disease

	Patients (*N*=91)	Nonsurvivors (*N*=9)	Survivors (*N*=82)	*P*
Duration of hospital stay (day)	11.95±8.94	5.55±4.12	(12.65±9.06)	0.02*
Duration of RICU stay (day)	9.95±7.36	4.88±2.31	(10.51±7.51)	0.02*
Need for mechanical ventilation [*n* (%)]	14 (15.39)	4 (44.44)	10 (12.20)	0.2
Duration of ventilation (day)	(8.78±5.35)	(11.25±7.5)	(7.8±4.34)	0.2

RICU, respiratory intensive care unit.

Discussion

The current study describes the outcome of 91 patients with ILD admitted to a RICU. The RICU morality rate among ILD patients was 9.9%. Presence of hemophilia, renal impairment, low DL_{CO}, and low SaO_2% were risk factors associated with mortality. Duration of hospital and RICU stay was significantly longer among survivors compared with nonsurvivors. Patients with a positive history of previous MV had a significant survival time that was less than that of those with a negative history of previous MV.

ILD are a heterogeneous group of pulmonary diseases. The majority of ILD cases studied were IPF (74.73%), followed by connective tissue disease-related ILD, encountered in 13.19% of the admitted patients to the RICU. Similar experiences were reported in other studies [6,21]. Whereas several other studies focused on other subgroups of critically ill ILD, as toxic-related ILD (e.g. drug induced, radiation) and acute ILD [7,22].

The mortality rate for ICU patients with ILD is difficult to compare. First, only few studies have been conducted on this issue [6,7]. Second, there was a great heterogeneity in the subgroups of patients included in ILD studies [6,7]. The majority of previously conducted studies focused on the outcome of IPF in ICU [23–25]. Whereas other studies focused on the outcomes of respiratory failure and MV, in particular among ICU-admitted ILD patients [6,21]. Third, different definitions of estimation were used (ICU morality, hospital morality, 6-month morality, 1-year mortality) in previous studies [7].

In the current study, RICU morality rate was 9.9%, which is very low when compared with other previous studies [6,7]. Several factors may have contributed in this outcome, including low mean age (51.72±15.59 years) of our study population, early interstitial lung affection among the studied patients (moderately impaired DL_{CO} and preserved total lung capacity), low mean duration of illness (32.37±30.18 months) before RICU admission, and only 15% of our patients receiving invasive MV. In contrast, Güngör *et al.* [6] studied 120 ILD patients with ARF and found the total ICU mortality rate was 60%. The mortality rates differ with the method of ventilation used (61.7% for continuous noninvasive ventilation vs 89.7% for invasive ventilation). The study by Güngör *et al.* [6] was different from the current study mainly in that all the recruited patients had significant ARF that necessitates whether invasive or noninvasive ventilation. Another study by Zafrani *et al.* [7] found a hospital and 1-year mortality rates of 41 and 54%, respectively, in 83 patients with ILD-associated ARF. The difference in mortality rates from the current study could be attributed to that all recruited patients had ARF, among whom 73% met the criteria for ARDS and 60% received invasive MV.

The current study could identify that presence of hemophilia, renal impairment, low DL_{CO}, and low SaO_2% as risk factors associated with mortality. All nonsurvivor patients (100%) had pulmonary hypertension compared with 69% of survivor patients, but it did not reach the significant value. Zafrani *et al.* [7] reported three factors independently associated with hospital mortality in critically ill patients with ILD, including pulmonary hypertension, traction bronchiectasies, and/or honeycombing on computed tomography scan and acute kidney injury.

Pulmonary fibrosis is associated with an increased incidence of pulmonary infections. The presence of traction bronchiectasis, the decrease in mucociliary clearance, and treatment with corticosteroids and immunosuppressive drugs in these patients predispose them to infections [1,4]. Acute infective exacerbations in this study were recorded in 72.5% of the patients. Rangappa and Moran [26] reported that the acute deterioration that led to ICU admission was attributed to pneumonia in 42% of cases.

The challenge in differentiating lung infection from an acute exacerbation of pre-existing ILD includes that negative culture results cannot completely rule out the possibility of infection and that radiological changes are difficult to distinguish disease progression and pneumonic infiltration, and thus treatment with broad-spectrum antibiotics should be considered in all patients [5,10,27].

In present study, the length of hospital and ICU stay was nearly comparable to a previous study on critically ill patients with ILD [7]. In addition, similar to another study, the duration of hospital stay was significantly longer among survivors compared with nonsurvivors [7].

DL_{CO} and arterial oxygen saturation was significantly higher among survivors compared with nonsurvivors. The degree of abnormality in pulmonary function values has not been uniformly shown to influence long-term survival in patients with IPF. An earlier study had shown a shorter survival period in patients with lower DL_{CO} [13]. However, a more recent study using multivariate analysis has not confirmed this finding [14].

Although 44% of the nonsurvivors received MV compared with 12% of the survivors, no significant statistical difference could be detected. In contrast, patients with a positive history of previous MV had a significant survival time that was less than that of those with a negative history of previous MV. The literature suggests poor outcomes from MV in patients with pulmonary fibrosis and ARF [4]. Patients with chronic ILD have profound alterations in mechanical lung properties and may be potentially susceptible to ventilator induced lung injury [21,28].

Our study had several limitations. Our results represent the experience of a single center in which the number of patients was too small for the proper evaluation of risk factors associated with mortality. ILD diagnosis was not confirmed histologically in all participants. This source of bias was minimized in our study by a detailed review of all cases and our diagnosis was based on the international standard of practice. We did not follow up our patients after the RICU discharge to determine the actual mortality rate.

In conclusion, the outcome of patients with ILD referred to RICU showed very low morality rate when compared with previous studies. Nonsurvivors had shorter hospital and RICU stay and lower DL_{CO} and arterial oxygen saturation. Patients with a positive history of previous MV had a significant survival time that was less than that of those with a negative history of previous MV.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1 Schwarz M, King T. *Interstitial lung diseases*. Hamilton: B.C. Decker; 1998.

2 American Thoracic Society/European Respiratory Society. International multidisciplinary consensus classification of the idiopathic interstitial pneumonias. *Am J Respir Crit Care Med* 2002; **165**:277–304.

3 Antoniou K, Margaritopoulos G, Tomassetti S, Bonella F, Costabel U, Poletti V. Interstitial lung disease. *Eur Respir Rev* 2014; **23**:40–54.

4 Xaubet A, Molina-Molina M, Badia J, Torres A. Outcome of patients with Interstitial lung diseases requiring mechanical ventilation. *Clin Pulm Med* 2005; **12**:26–31.

5 Disayabutr S, Calfee C, Collard H, Wolters P. Interstitial lung diseases in the hospitalized patient. *BMC Medicine* 2015; **13**:245.

6 Güngör G, Tatar D, Saltürk C, Çimen P, Karakurt Z, Kirakli C. Why do patients with interstitial lung diseases fail in the ICU? A 2-center cohort study. *Respir Care* 2013; **58**:525–531.

7 Zafrani L, Lemiale V, Lapidus N, Lorillon G, Schlemmer B, Azoulay E. Acute respiratory failure in critically ill patients with interstitial lung disease. *PLoS One* 2014; **9**:e104897.

8 Raghu G, Collard H, Egan J, Martinez F, Behr J, Brown K. An official ATS/ERS/JRS/ALAT statement: idiopathic pulmonary fibrosis: evidence-based guidelines for diagnosis and management. *Am J Respir Crit Care Med* 2011; **183**:788–824.

9 Wells A, Hirani N. Interstitial lung disease guideline: the British Thoracic Society in collaboration with the Thoracic Society of Australia and New Zealand and the Irish Thoracic Society. *Thorax* 2008; **63**(Suppl V): v1–v58.

10 Statement on Sarcoidosis. Joint statement of the American Thoracic Society (ATS), the European Respiratory Society (ERS) and the World Association of Sarcoidosis and other Granulomatous Disorders (WASOG). *Am J Respir Crit Care Med* 1999; **160**:736–755.

11 Fischer A, du Bois R. Interstitial lung disease in connective tissue disorders. *Lancet* 2012; **380**:689–698.

12 Bhatt N, Allen J. Update on eosinophilic lung diseases. *Semin Respir Crit Care Med* 2012? **33**:555–571.

13 Johnson S, Cordier J, Lazor R, Cottin V, Costabel U, Harari S. European Respiratory Society guidelines for the diagnosis and management of lymphangioleiomyomatosis. *Eur Respir J* 2010; **35**:14–26.

14 American Thoracic Society, European Respiratory Society. Idiopathic pulmonary fibrosis: diagnosis and treatment. International Consensus Statement. *Am J Respir Crit Care Med* 2000; **161**(Part 1):646–664.

15 Kondoh Y, Taniguchi H, Kawabata Y. Acute exacerbation in idiopathic pulmonary fibrosis: analysis of clinical and pathologic findings in three cases. *Chest* 1993; **103**:1808–1812.

16 Akira M, Hamada H, Sakatani M. CT findings during phase of accelerated deterioration in patients with idiopathic pulmonary fibrosis. *Am J Roentgenol* 1997; **168**:79–83.

17 Collard H, Moore B, Flaherty K, Brown K, Kaner R, King T. Acute exacerbations of idiopathic pulmonary fibrosis. *Am J Respir Crit Care Med* 2007; **176**:636–643.

18 Papanikolaou I, Drakopanagiotakis F, Polychronopoulos V. Acute exacerbations of interstitial lung diseases. *Curr Opin Pulm Med* 2010; **16**: 480–486.

19 Mandell LA, Wunderink RG, Anzueto A, Bartlett JG, Campbell GD, Dean N. Infectious Diseases Society of America; American Thoracic Society. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis* 2007; **44**(Suppl 2):S27–S72.

20 American Thoracic Society; Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *Am J Respir Crit Care Med* 2005; **171**:388–416.

21 Fernández-Pérez E, Yilmaz M, Jenad H, Daniels C, Ryu JH, Hubma R, Gajic O. Ventilator settings and outcome of respiratory failure in chronic interstitial lung disease. *Chest* 2008; **133**:1113–1119.

22 Vial-Dupuy A, Sanchez O, Douvry B, Guetta L, Juvin K, Wermert D. Outcome of patients with interstitial lung disease admitted to the intensive care unit. *Sarcoidosis Vasc Diffuse Lung Dis* 2013; **30**:134–142.

23 Park N, Kim D, Shim T, Lim C, Lee S, Koh Y. Acute exacerbation of interstitial pneumonia other than idiopathicpulmonary fibrosis. *Chest* 2007; **132**:214–220.

24 Saydain G, Islam A, Afessa B, Ryu J, Scott J, Peters S. Outcome of patients with idiopathic pulmonary fibrosis admitted to the intensive care unit. *Am J Respir Crit Care Med* 2002; **166**:839–842.

25 Blivet S, Philit F, Sab J, Langevin B, Paret M, Guérin C. Outcome of patients with idiopathic pulmonary fibrosis admitted to the ICU for respiratory failure. *Chest* 2001; **120**:209–212.

26 Rangappa P, Moran JL. Outcomes of patients admitted to the intensive care unit with idiopathic pulmonary fibrosis. *Crit Care Resusc* 2009; **11**:102–109.

27 Song J, Hong S, Lim C-M, Koh Y, Kim D. Acute exacerbation of idiopathicpulmonary fibrosis: incidence, risk factors and outcome. *Eur Respir J* 2011; **37**:356–363.

28 Nava S, Rubini F. Lung and chest wall mechanics in ventilated patients with end stage idiopathic pulmonary fibrosis. *Thorax* 1999; **54**:390–395.