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VARIABLE PREVALENCE OF PULMONARY HYPERTENSION IN PATIENTS WITH ADVANCED INTERSTITIAL PNEUMONIA

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Abstract

Background—Pulmonary hypertension may occur in patients with interstitial pneumonia and is associated with increased mortality. We sought to determine the prevalence of pulmonary hypertension in subgroups of patients with interstitial pneumonia, and to investigate possible associations between pulmonary vascular hemodynamics and pulmonary function.

Methods—The presence or absence of pulmonary hypertension was assessed in 70 patients with advanced interstitial pneumonia who underwent right heart catheterization. The associations of pulmonary hypertension with clinical characteristics and pulmonary function tests were analyzed.

Results—The prevalence of pulmonary hypertension in patients with idiopathic interstitial pneumonia was 29% versus 64% in patients with connective tissue disease-interstitial pneumonia ($p = 0.013$). African American patients had a significantly higher prevalence of pulmonary hypertension in the entire study population (81% vs. 22%, $p < 0.001$) and in the idiopathic interstitial pneumonia group (70% vs. 19%, $p < 0.01$). Regression analyses revealed no association between mPAP and FVC or mPAP and D_LCO in the entire cohort or in subgroups of patients.

Conclusions—African American patients and patients with connective tissue disease-interstitial pneumonia had a high prevalence of PH. Non-African American patients with advanced idiopathic interstitial pneumonia (including idiopathic pulmonary fibrosis) had a low prevalence of pulmonary hypertension.

Introduction

Pulmonary hypertension (PH) is a progressive disease marked by vasoconstriction and vascular remodeling within the pulmonary vasculature, and may occur as a primary vascular disorder or in association with a variety of pulmonary diseases including interstitial pneumonia (1).

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Right heart catheterization remains the standard by which the diagnosis of pulmonary hypertension is confirmed (1).

Idiopathic interstitial pneumonia (IIP) refers to a group of idiopathic parenchymal lung diseases which are characterized by a combination of lung inflammation and/or fibrosis (2), and the most common and severe form of IIP is idiopathic pulmonary fibrosis (IPF) (3). The reported frequency of pulmonary hypertension in patients with IPF has ranged from 30–85% (4–7). The presence of pulmonary hypertension in patients with IPF is associated with increased overall mortality (4,5) and increased mortality following lung transplantation (8).

Pulmonary hypertension may also occur in patients with systemic connective tissue diseases, and reported frequencies have ranged from 8–20% (9–11). In these patients, pulmonary hypertension may occur as a primary pulmonary vascular disorder without significant abnormalities of the lung parenchyma, or may occur in patients with systemic connective tissue disease and interstitial pneumonia (CTD-IP) (12–14). The prevalence of pulmonary hypertension in patients with CTD-IP has been reported to be 20–30% (12,15).

The risk factors for the development of pulmonary hypertension in IPF or other forms of IIP have not been completely characterized. Our goal was to determine the prevalence of pulmonary hypertension in subgroups of patients with interstitial pneumonia, and to analyze the association of pulmonary hypertension with clinical characteristics and pulmonary function tests.

Patients and Methods

Patients

The study was reviewed and approved by the University of Maryland Institutional Review Board. Patients with one of the forms of IIP or CTD-IP were identified at the University of Maryland Medical Center through either patient care visits or through ICD-9 code review for “interstitial lung disease”. Patients with sarcoidosis were excluded since the clinical course, pulmonary physiology, and lung pathology of sarcoidosis differs significantly from patients with IIP or CTD-IP. Clinical information and patient demographics were recorded. Pulmonary function tests (PFTs), computed tomography (CT) of the chest, and lung pathology were reviewed and findings recorded. From our initial cohort, 70 patients were identified in whom right heart catheterization was performed, and in most instances, this was performed as part of the evaluation for lung transplantation.

Based upon the review of the clinical history, PFTs, chest CT, and lung pathology, all patients were assigned a final clinical diagnosis. The specific diagnoses of IPF, non-specific interstitial pneumonia (NSIP), cryptogenic organizing pneumonia (COP), or unclassified idiopathic interstitial pneumonia were made based on the joint ATS/ERS consensus statement for IIP (2). Patients who had interstitial pneumonia in association with a systemic connective tissue disease were classified as having CTD-IP, and lung biopsies were reviewed in these patients if previously obtained.

Computed Tomography of the Chest

All 70 patients had a CT of the chest performed, and in 64 patients, the CT images were reviewed by two thoracic radiologists (JRG, JJ) specifically for the purpose of this study. The lung parenchyma was reviewed and evaluated for reticular opacities, traction bronchiectasis, cysts, honeycomb change, emphysema, consolidation, and ground glass opacities.

Lung Pathology

A surgical lung biopsy (defined as a lung biopsy obtained from video assisted thoracoscopy (VATS), from an explanted native lung obtained at the time of lung transplantation, or from an autopsy specimen) was obtained in 48 of the 70 patients. A pulmonary pathologist (TJF) reviewed biopsies from 38 patients specifically for the purposes of this study. A primary pathologic pattern was assigned to each sample, and secondary features of the biopsy were recorded when appropriate. Criteria for the pathologic pattern were used according to the consensus statement on IIP (2).

Pulmonary Function Testing

All PFT data available was recorded for each patient, including forced expiratory volume in one second, forced vital capacity, FEV₁/FVC ratio, total lung capacity, functional residual capacity, residual volume, and diffusing capacity for carbon monoxide. PFTs which were performed on the date closest to the date of right heart catheterization were used for data analysis. Median time between PFTs and right heart catheterization was 0.8 months.

Pulmonary Artery Pressures

Pulmonary hemodynamics were evaluated using right heart catheterization and transthoracic echocardiography. Data obtained at the time of right heart catheterization included heart rate, systolic and diastolic systemic blood pressure, systolic and diastolic pulmonary artery pressure, pulmonary capillary wedge pressure, and mixed venous oxygen saturation. Mean systemic arterial pressure and mean pulmonary artery pressure were calculated as the diastolic pressure plus one-third of the pulse pressure. Cardiac output was measured by thermodilution or calculated from the Fick equation. Pulmonary vascular resistance was calculated as mean pulmonary artery pressure minus wedge pressure, divided by cardiac output.

All patients underwent transthoracic echocardiography, and estimates of right ventricular systolic pressure (pulmonary artery systolic pressure) were obtainable in 56 of 70 patients. Right ventricular systolic pressure was estimated by the formula $4v^2 + \text{RAP}$, where v is the tricuspid flow velocity and RAP is right atrial pressure. RAP was estimated as 5, 10, or 15 mm Hg based on clinical assessment of the inferior vena cava size. Additional echocardiographic data obtained included right atrial size, right ventricular function, left ventricular ejection fraction, presence of diastolic dysfunction, and mitral valve function. The date of the echocardiogram was compared with the date of right heart catheterization to calculate the time interval between the two studies.

Statistical Analyses

Data were analyzed using Statistica software (StatSoft, Tulsa, OK). Differences between groups were analyzed by ANOVA (with post-hoc [Scheffe]) testing or chi-squared test as indicated. Differences at $p < 0.05$ were considered significant.

Results

Characteristics of the Patient Population

Initially, 142 patients were identified at the University of Maryland Medical Center through either patient care visits or through ICD-9 code review for “interstitial lung disease”. From this initial group, 70 patients were evaluable and enrolled in the current study since all of the following criteria were met: 1) right heart catheterization was performed; 2) computerized tomography scans of the chest were obtained; and 3) review of the clinical history, PFTs, chest CT, and lung pathology allowed a consensus final clinical diagnosis. All 70 patients had a combination of reticular opacities, ground glass opacities, traction bronchiectasis, or cysts

indicating advanced interstitial pneumonia radiographically. The majority of patients (Figure 1, Table 1) had moderate to severe reductions in FVC and D_LCO , almost all required home oxygen use, and 67/70 were eligible and were evaluated for lung transplantation due to the severity of their lung disease. This combination of findings indicates severe, advanced interstitial pneumonia in almost all patients.

There were 56 patients with IIP, and within this group, 41 patients had IPF, 7 had non-specific interstitial pneumonia, 2 had cryptogenic organizing pneumonia, and 6 had unclassified IIP. There were 14 patients with CTD-IP, and the most common underlying connective tissue disease responsible for interstitial pneumonia was systemic sclerosis (5 patients), whereas other patients had rheumatoid arthritis, dermatomyositis, systemic lupus erythematosus, overlap syndrome, and undifferentiated CTD.

Table 2 shows clinical, physiologic, and hemodynamic characteristics of patients based on their final clinical diagnoses of IPF, non-IPF IIP, or CTD-IP. Survival was shorter in patients with IPF when compared to the other two groups ($p < 0.01$). In patients with IIP, 27 of 56 patients (48%) underwent lung transplantation, compared with 3 of 14 patients in the CTD-IP group. No significant differences were noted in the median values for FVC, D_LCO , mean systemic arterial pressure, or left ventricular ejection fraction between the three groups.

Measured mPAP by right heart catheterization (RHC) was indicative of PH in 25 out of 70 patients (Figure 1C). All of the patients had oxygen saturations greater than 90% during the RHC procedure itself, measured either by finger pulse oximetry or by measured arterial oxygen saturation from arterial blood. Thus, it is unlikely that the underlying mechanism leading to PH in patients with interstitial pneumonia is solely due to hypoxic vasoconstriction. Therefore, we proceeded to analyze other possible correlates for PH.

Effects of Diagnosis and Race on the Prevalence of Pulmonary Hypertension

Table 3 indicates the presence or absence of pulmonary hypertension (PH) in diagnostic groups of patients, with PH defined as measured mPAP by RHC > 25 mmHg. Patients with CTD-IP had a higher prevalence of PH when compared to patients with IPF or non-IPF IIP (top panel, $p < 0.05$), and a higher prevalence of PH when compared to the IPF and non-IPF IIP patients when combined into an IIP group as a whole (bottom panel, $p = 0.013$). The prevalence of PH in the IPF subgroup ($n = 41$), the combined IIP group ($n = 56$), and the CTD-IP group ($n = 14$) was 29%, 29%, and 64%, respectively.

We separately analyzed the prevalence of PH in patients with a clinical diagnosis of IPF and pathologically confirmed UIP on a surgical lung biopsy. There were 32 patients who met these criteria. The prevalence of PH in these patients was 28% (9/32), very similar to the 29% prevalence of PH in the idiopathic interstitial pneumonia (IIP) group when taken as a whole.

In the entire study population, African American patients had a higher prevalence of PH when compared with Caucasians and with other racial groups, and likewise had a higher prevalence of PH when compared to all non-African American patients (Table 4). In patients with IIP, African American patients had a higher prevalence of PH when compared to Caucasian patients or patients of other racial groups, and likewise had a higher prevalence of PH when compared to all non-African American patients with IIP. In the entire study population, the prevalence of PH in African American patients was 81% and the prevalence of PH in non-African American patients was 22%. In the IIP group, the prevalence of PH in African American patients was 70% and the prevalence of PH in non-African American patients was 19%. There were no differences in mean systemic arterial blood pressure, left ventricular ejection fraction, FVC, TLC, FRC, or D_LCO between African American patients and non-African American patients in the IIP group ($p > 0.05$ for all comparisons).

There was no association between the presence of PH and age, gender, smoking history, or medication use (corticosteroids or other immunosuppressive agents, statins, ACE inhibitors) in the study population ($p > 0.05$ for all comparisons).

Accuracy of Echocardiography for Pulmonary Hypertension

There was a fair correlation between estimated sPAP by echocardiography and measured mPAP by RHC ($r^2=0.543$). By chi-square analysis, PH was associated with elevated echocardiographic sPAP (defined as sPAP > 40 mm Hg) in the entire cohort of patients in whom pulmonary artery systolic pressure could be estimated ($p < 0.001$). The sensitivity, specificity, positive predictive value, and negative predictive value of echocardiography for the diagnosis of PH in this cohort was 78%, 79%, 72%, and 84%, respectively. PH was similarly associated with elevated echocardiographic sPAP in the group of non-African American patients with IIP ($p < 0.001$, chi-square test). The sensitivity, specificity, positive predictive value, and negative predictive value of echocardiography for the diagnosis of PH in this group of patients was 75%, 78%, 50%, and 91%, respectively.

Relationship between PFT Parameters and Pulmonary Hypertension

Figure 3A shows a poor correlation between FVC percent predicted and mPAP ($r^2 = 0.054$), and 3B a poor correlation between D_LCO percent predicted and mPAP ($r^2 = 0.156$). Additional regression analyses performed in the subgroup of patients with IPF ($n = 41$) showed similarly poor correlations between FVC and mPAP ($r^2 = 0.06$), as well as between D_LCO and mPAP ($r^2 = 0.09$).

Discussion

In this study, we addressed the hypothesis that the prevalence of pulmonary hypertension may vary among patients with interstitial pneumonia depending on their underlying diagnosis, their race, or other clinical characteristics. The prevalence of pulmonary hypertension in patients with IIP was 29%, and the prevalence of pulmonary hypertension in the subgroup of these patients with IPF was also 29%. This observed prevalence is comparable with the reports of other groups (4,6,7). We found a significantly higher pulmonary hypertension prevalence of 64% in patients with CTD-IP.

It is commonly accepted that pulmonary hypertension increases mortality in patients with interstitial pneumonia. Though our patients with CTD-IP had a significantly higher prevalence of pulmonary hypertension, their overall survival was longer than patients with IPF (see Table 2), and this is consistent with previous reports indicating a better prognosis for patients with CTD-IP than IPF (16,17). This observation suggests that pulmonary hypertension by itself may not be the major prognostic indicator of survival, but should be considered in combination with the etiology of the interstitial pneumonia.

Consistent with a recent report (6), African American patients had a significantly higher prevalence of pulmonary hypertension in our study, both in the entire study population and in patients with IIP. Non-African American patients with advanced IIP (including IPF) had a prevalence of pulmonary hypertension of only 19%. Thus, non-African American race is a better prognostic indicator for the absence of pulmonary hypertension. An association with the African American race was noticed in other forms of pulmonary hypertension. In idiopathic pulmonary hypertension, African Americans demonstrated a substantially increased mortality compared with Caucasians (18). African Americans patients with systemic sclerosis developed pulmonary hypertension at an earlier age, were more likely to have ILD-associated pulmonary hypertension, and tended to have poorer survival compared with white patients (14,19).

We took these observations further by assessing the correlation between estimated sPAP by echocardiography and measured mPAP by RHC in non-African American patients with IIP. Normal echocardiographic sPAP values ($\text{sPAP} \leq 40 \text{ mm Hg}$) were a very strong predictor for the absence of PH in this group. Therefore, a combination of non-African American race, IIP, and a normal estimated sPAP by echocardiography is a very strong predictor for the absence of pulmonary hypertension. This observation provides a practical and simple clinical approach for practicing clinicians. Right heart catheterization will most likely still be required in patients undergoing evaluation for lung transplantation, since more complete hemodynamic data (mPAP, pulmonary capillary wedge pressure, cardiac output, PVR) can be obtained by RHC but not by echocardiogram. However, in patients with mild to moderate disease who are being evaluated for the presence or absence of PH, echocardiography alone in combination with race and diagnosis may be sufficient to confirm or exclude PH.

We demonstrated a poor correlation between FVC and mPAP, as well as between D_{LCO} and mPAP. This is consistent with other reports indicating poor correlations between FVC and mPAP in patients with IPF (4,5,7,20,21). The lack of correlation between the severity of parenchymal lung disease and PH strongly suggests that it is not just the severity of parenchymal lung disease which subsequently leads to PH (21).

There are limitations to this study. One, only patients with advanced interstitial pneumonia in a tertiary care center were enrolled, and the results are not necessarily applicable to patients with mild or moderate ILD. Two, these observations will need to be expanded to a larger patient population. Three, there is an obvious need for molecular studies explaining the mechanisms of the association between pulmonary hypertension and African Americans race.

In summary, we have demonstrated a low prevalence of PH in patients with advanced IIP who are of non-African American race. The prevalence of PH was much higher in patients with CTD-IP and in patients of African American race. The biochemical basis for the differences in PH prevalence in these patient groups warrants further study at the molecular level.

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References

1. Galiè N, Torbicki A, Barst R, et al. Guidelines on diagnosis and treatment of pulmonary arterial hypertension. *Eur Heart J* 2004;25:2243–2278. [PubMed: 15589643]
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. [PubMed: 11790668]
3. Idiopathic pulmonary fibrosis: diagnosis and treatment. International Consensus Statement. *Am J Respir Crit Care Med* 2000;161:646–664. [PubMed: 10673212]
4. Lettieri CJ, Nathan SD, Barnett SD, Ahmad S, Shorr AF. Prevalence and outcomes of pulmonary arterial hypertension in advanced idiopathic pulmonary fibrosis. *Chest* 2006;129:746–752. [PubMed: 16537877]
5. Nadrous HF, Pellicka PA, Krowka MJ, et al. Pulmonary hypertension in patients with idiopathic pulmonary fibrosis. *Chest* 2005;128:2393–2399. [PubMed: 16236900]
6. Shorr AF, Wainright JL, Cors CS, Lettieri CJ, Nathan SD. Pulmonary hypertension in patients with pulmonary fibrosis awaiting lung transplant. *Eur Respir J* 2007;30:715–721. [PubMed: 17626111]
7. Nathan SD, Shlobin OA, Ahmad S, Urbanek S, Barnett SD. Pulmonary hypertension and pulmonary function testing in idiopathic pulmonary fibrosis. *Chest* 2007;131:657–663. [PubMed: 17356077]

8. Whelan TP, Dunitz JM, Kelly RF, et al. Effect of preoperative pulmonary artery pressure on early survival after lung transplantation for idiopathic pulmonary fibrosis. *J Heart Lung Transplant* 2005;24:1269–1274. [PubMed: 16143244]
9. Hachulla E, Gressin V, Guillemin L, et al. Early detection of pulmonary arterial hypertension in systemic sclerosis: a French nationwide prospective multicenter study. *Arthritis Rheum* 2005;52:3792–3800. [PubMed: 16320330]
10. Galiè N, Manes A, Farahani KV, et al. Pulmonary arterial hypertension associated to connective tissue diseases. *Lupus* 2005;14:713–717. [PubMed: 16218473]
11. Mukerjee D, St George D, Coleiro B, et al. Prevalence and outcome in systemic sclerosis associated pulmonary arterial hypertension: application of a registry approach. *Ann Rheum Dis* 2003;62:1088–1093. [PubMed: 14583573]
12. Chang B, Wigley FM, White B, Wise RA. Scleroderma patients with combined pulmonary hypertension and interstitial lung disease. *J Rheumatol* 2003;30:2398–2405. [PubMed: 14677184]
13. Condliffe R, Kiely DG, Peacock AJ, et al. Connective tissue disease-associated pulmonary arterial hypertension in the modern treatment era. *Am J Respir Crit Care Med* 2009;179:151–157. [PubMed: 18931333]
14. Mathai SC, Hummers LK, Champion HC, et al. Survival in pulmonary hypertension associated with the scleroderma spectrum of diseases: impact of interstitial lung disease. *Arthritis Rheum* 2009;60:569–577. [PubMed: 19180517]
15. Hesselstrand R, Ekman R, Eskilsson J, et al. Screening for pulmonary hypertension in systemic sclerosis: the longitudinal development of tricuspid gradient in 227 consecutive patients, 1992–2001. *Rheumatology* 2005;44:366–371. [PubMed: 15561735]
16. Park JH, Kim DS, Park IN, Jang SJ, Kitaichi M, Nicholson AG, Colby TV. Prognosis of fibrotic interstitial pneumonia: idiopathic versus collagen vascular disease-related subtypes. *Am J Respir Crit Care Med* 2007;175:705–711. [PubMed: 17218621]
17. Flaherty KR, Colby TV, Travis WD, et al. Fibroblastic foci in usual interstitial pneumonia: idiopathic versus collagen vascular disease. *Am J Respir Crit Care Med* 2003;167:1410–1415. [PubMed: 12615630]
18. Davis KK, Lilienfeld DE, Doyle RL. Increased mortality in African Americans with idiopathic pulmonary arterial hypertension. *J Natl Med Assoc* 2008;100:69–72. [PubMed: 18277811]
19. Beall AD, Nietert PJ, Taylor MH, et al. Ethnic disparities among patients with pulmonary hypertension associated with systemic sclerosis. *J Rheumatol* 2007;34:1277–1282. [PubMed: 17516621]
20. Patel NM, Lederer DJ, Borczuk AC, Kawut SM. Pulmonary hypertension in idiopathic pulmonary fibrosis. *Chest* 2007;132:998–1006. [PubMed: 17873194]
21. Nathan SD, Noble PW, Tudor RM. Idiopathic pulmonary fibrosis and pulmonary hypertension: connecting the dots. *Am J Respir Crit Care Med* 2007;175:875–880. [PubMed: 17255562]

Figure 1.

Frequency distributions for the study population ($n=70$). FVC percent predicted, D_LCO percent predicted, mean pulmonary artery pressure (Mean PAP), pulmonary vascular resistance (PVR), transpulmonary gradient (TPG), and cardiac output (CO) are included.

Figure 2.

Regression analyses for the study population ($n=70$) between FVC and mean pulmonary arterial pressure (mPAP) in A ($r^2 = 0.054$), and between DLCO and mPAP in B ($r^2 = 0.156$).

TABLE 1

Characteristics of the study population ($n=70$)

Variable	<i>n</i> or median
Age, years	60 (53, 64)
Gender	
Male, <i>n</i>	44
Female, <i>n</i>	26
Race	
Caucasian, <i>n</i>	47
African-American, <i>n</i>	16
Other, <i>n</i>	7
Diagnostic Tests	
Right Heart Catheterization, <i>n</i>	70
Chest CT, <i>n</i>	70
PFTs, <i>n</i>	69
Echocardiogram, <i>n</i>	51
Surgical biopsy, <i>n</i>	48
Smoking	
Never, <i>n</i>	27
Ever, <i>n</i>	43
Current, <i>n</i>	2
Past, <i>n</i>	41
Home O ₂ Use	
Yes, <i>n</i>	63
No, <i>n</i>	7
Medications*	
Prednisone, <i>n</i>	56
Azathioprine, <i>n</i>	32
Mycophenolate, <i>n</i>	20
N-Acetylcysteine, <i>n</i>	25
ACE Inhibitor, <i>n</i>	15
Statin, <i>n</i>	24
PFT parameters	
FVC, % predicted	53 (38, 60)
TLC, % predicted	50 (40, 60)
FRC, % predicted	52 (42, 66)
D _L CO, % predicted	29 (21, 37)
Hemodynamics	
mPAP, mm Hg	21.8 (17.7, 31.9)
PVR, Wood units	2.1 (1.5, 3.4)
Survival, months [†]	37 (21, 58)

Definition of abbreviations: mPAP = mean pulmonary artery pressure; PVR = pulmonary vascular resistance.

* Other medications included cyclophosphamide ($n=6$), colchicine ($n=13$), and vitamin E ($n=8$).

[†] Survival was defined from date of diagnosis to death, lung transplant, or date of review if patient was alive and not transplanted. Values reported for age, FVC, TLC, FRC, DLCO, mPAP, PVR, and survival are median and 1st, 3rd quartiles.

TABLE 2

Characteristics of the study population by diagnostic groups

Variable	IPF (n=41)	Non-IPF IIP (n=15)	CTD-IP (n=14)	P value
Age	63 (58,67)	58 (54,60)	52 (39,60)	< 0.05
Gender				
Male, <i>n</i>	28	12	4	< 0.01
Female, <i>n</i>	13	3	10	
Race				
African-American, <i>n</i>	7	3	6	ns
Caucasian, <i>n</i>	30	11	6	
Other, <i>n</i>	4	1	2	
FVC, % predicted	50 (37,58)	57 (46,66)	56 (38,60)	ns
DLCO, % predicted	29 (22,37)	29 (22,33)	28 (19,38)	ns
Systemic MAP, mm Hg	94 (82,101)	87 (80,91)	89 (82,95)	ns
mPAP, mm Hg	22 (18,29)	20 (17,25)	31 (21,36)	ns
PVR, Wood units	2.2 (1.6,3.6)	1.7 (1.2,2.0)	2.7 (1.5,5.5)	ns
TPG, mm Hg	12.2 (8.7,16.8)	9.3 (4.5,12.0)	15.3 (9.0,27.4)	< 0.05
CO, L/min	5.1 (4.3,5.7)	6.4 (5.5,6.5)	4.9 (4.4,5.2)	< 0.01
LVEF, %	60 (60,65)	60 (60,64)	60 (60,65)	ns
Survival, months	26 (17,46)	41 (24,92)	62 (45,83)	< 0.01

Definition of abbreviations: IPF = idiopathic pulmonary fibrosis; IIP = idiopathic interstitial pneumonia; CTD-IP = connective tissue disease-interstitial pneumonia; MAP = mean arterial pressure; PVR = pulmonary vascular resistance; TPG = transpulmonary gradient; CO = cardiac output; LVEF = left ventricular ejection fraction. Values reported for FVC, DLCO, systemic MAP, mPAP, PVR, TPG, CO, LVEF, and survival are median and 1st, 3rd quartiles.

Differences between groups were analyzed by ANOVA and chi-squared analysis.

TABLE 3

Presence of pulmonary hypertension (PH) in diagnostic groups

	No PH	PH	Total
IPF	29	12	41
non-IPF IIP	11	4	15
CTD-IP	5	9	14
<hr/>			
Total	45	25	70
	No PH	PH	Total
IIP	40	16	56
CTD-IP	5	9	14
<hr/>			
Total	45	25	70

Definition of abbreviations: IPF = idiopathic pulmonary fibrosis; IIP = idiopathic interstitial pneumonia; CTD-IP = connective tissue disease-interstitial pneumonia. PH defined as mean pulmonary artery pressure by RHC > 25 mm Hg.

Chi-square analysis: $p < 0.05$ in 3×2 table, $p = 0.013$ in 2×2 table.

Presence of pulmonary hypertension (PH) in racial groups

All Patients <i>(n=70)</i>				IIP only <i>(n=56)</i>			
	No PH	PH	Total	No PH	PH	Total	
African-American	3	13	16	African-American	3	7	10
Caucasian	36	11	47	Caucasian	32	9	41
Other	6	1	7	Other	5	0	5
Total	45	25	70	Total	40	16	56
African-American	No PH 3	PH 13	Total 16	No PH 3	PH 7	Total 10	
Non-African-American	42	12	54	37	9	46	
Total	45	25	70	40	16	56	

Definition of Abbreviations: IIP = idiopathic interstitial pneumonia. PH defined as mean pulmonary artery pressure by RHC > 25 mm Hg.

Chi-square analysis in all patients ($n=70$): $p < 0.001$ in both 3×2 and 2×2 table.

Chi-square analysis in IIP patients ($n=56$): $p < 0.01$ in both 3×2 and 2×2 table.