

# Direct medical costs of hospitalized patients with idiopathic pulmonary fibrosis in a tertiary hospital in China

Xiao-Fen Zheng<sup>1,2,3</sup>, Bing-Bing Xie<sup>1</sup>, Yan Liu<sup>3</sup>, Ming Zhu<sup>3</sup>, Shu Zhang<sup>1</sup>, Cheng-Jun Ban<sup>4</sup>, Jing Geng<sup>1</sup>, Ding-Yuan Jiang<sup>1</sup>, Yan-Hong Ren<sup>1</sup>, Hua-Ping Dai<sup>1</sup>, Chen Wang<sup>1</sup>

<sup>1</sup>Department of Pulmonary and Critical Care Medicine, Center of Respiratory Medicine, China-Japan Friendship Hospital; National Clinical Research Center for Respiratory Diseases; Institute of Respiratory Medicine, Chinese Academy of Medical Sciences, Peking Union Medical College, Beijing 100029, China;

<sup>2</sup>The Second Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou, Zhejiang 310000, China;

<sup>3</sup>Department of Pulmonary and Critical Care Medicine, Beijing Chao-Yang Hospital, Capital Medical University, Beijing 100012, China;

<sup>4</sup>Department of Respiratory Medicine, Dongzhimen Hospital, Beijing University of Chinese Medicine, Beijing 100700, China.

Idiopathic pulmonary fibrosis (IPF) incidence shows wide variations in different countries, ranging from 3 to 9 per 100,000 inhabitants per year in North America and Europe, while in South America and Asia, incidence is lower, ranging from 1.2 to 4.16 per 100,000 inhabitants per year.<sup>[1]</sup> With the increase of the incidence of IPF, the economic burden caused by IPF is becoming heavier. A US study on the burden of illness in patients with IPF found that total direct medical costs (including inpatient services, outpatient services, and medication claims) were found to be 26,378 USD.<sup>[2]</sup> In Spain, the estimated annual cost per IPF patient was € 26,435.<sup>[3]</sup> However, few data concerning the economic burden of patients with IPF are available in China. This study aimed to examine the direct medical costs of hospitalized patients with IPF and to determine the contributing factors.

This was a retrospective cross-sectional analysis. We undertook pre-study investigations into the total hospitalization costs of 47 IPF patients in 2015. According to the sample size estimation formula  $n = (Z\alpha/2 * V/\epsilon)^2$  ( $Z\alpha/2 = 1.96$ ,  $\epsilon = 0.1$ ,  $V = \sigma/\mu$ ), the sample size of this study was required to be at least 202. This retrospective study was conducted in accordance with the *Declaration of Helsinki* and data analysis was performed anonymously. Data were obtained from the IPF cohort and the database of patients discharged from the Beijing Chao-Yang Hospital between 2012 and 2015 (219 cases). Data were retrieved from the hospital case statistics management system, including data on patient characteristics, comorbid conditions, and treatment cost. IPF was diagnosed according to the American Thoracic Society/European Respiratory Society/Japanese Respiratory Society/Asociación Latinoamericana de Tórax Statement.<sup>[4]</sup>

This study examined the direct medical costs of patients hospitalized for IPF; direct medical costs cover three categories with a total of 18 cost items, including auxiliary testing fees (laboratory diagnosis, radiography, ultrasonic imaging, pathological diagnosis, and clinical diagnosis fees), drug fees (antibiotics, western medicine, Chinese patent medicine, Chinese herbal medicine, and blood products fees), and other fees (such as treatment, anesthetic, rehabilitation, general medical expenses, nurse fees, monitoring and auxiliary equipment, oxygen, and accommodation). Cost estimates were reported in CNY (1 USD  $\approx$  6.2 CNY, 2015).

Continuous data were presented as median ( $Q_1$ ,  $Q_3$ ), while categorical data were presented as numbers and proportions. Distribution of continuous variables was tested for normality using the Kolmogorov-Smirnov test. The Mann-Whitney  $U$  test was used to compare the differences in continuous variables. Univariate linear regression and multivariate stepwise linear regression were performed to estimate the impact of different variables on costs. Statistical analysis was performed using SPSS version 22.0 (IBM Corporation, Armonk, NY, USA).  $P < 0.05$  was considered statistically significant.

This study included 219 hospitalized patients diagnosed with IPF in the Beijing Chao-Yang Hospital from 2012 to 2015. Patients with IPF were on average 65 years old; 200 (91.3%) were male. The youngest patient was 41 years old, while the oldest was 88 years old. Almost half of the patients (107) were Beijing residents. The mean (standard deviation) length of hospital stay was 10.1 (8.0) days. Moreover, 13 (5.9%) cases were treated with invasive or non-invasive ventilation and 3 (1.4%) in the intensive care unit [Table 1].

## Access this article online

Quick Response Code:



Website:  
www.cmj.org

DOI:  
10.1097/CM9.0000000000001089

**Correspondence to:** Prof. Hua-Ping Dai, Department of Pulmonary and Critical Care Medicine, Center of Respiratory Medicine, China-Japan Friendship Hospital, Beijing 100029, China  
E-Mail: daihuaping@ccmu.edu.cn

Copyright © 2020 The Chinese Medical Association, produced by Wolters Kluwer, Inc. under the CC-BY-NC-ND license. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

Chinese Medical Journal 2020;133(20)

Received: 23-07-2020 Edited by: Pei-Fang Wei

For hospitalized patients with IPF, the median ( $Q_1$ ,  $Q_3$ ) direct medical costs were 9378.3 (7366.9, 12,122.8) CNY per capita per admission. Testing fees (5745.8 [4105.4, 7043.7] CNY) constituted the largest proportion of direct medical costs, of which, laboratory costs were 3687.5 (2525.5, 4556.5) CNY. Drug costs amounted to only 1347.0 (624.9, 3809.9) CNY.

We found that direct medical costs were significantly different according to whether or not the patients received intensive care ( $P = 0.004$ ), ventilator use ( $P = 0.001$ ) and whether or not the patient was a resident of Beijing ( $P = 0.047$ ) [Table 1]. Comorbid conditions that had a significant impact on direct medical costs included pulmonary infection ( $P < 0.001$ ), respiratory failure ( $P < 0.001$ ), and PAH ( $P = 0.002$ ). Details are shown in Table 1.

The following independent variables were entered into the regression model: gender, age, place of birth, reimbursement, length of stay in hospital, ventilator use, intensive care, and the aforementioned comorbid conditions. Univariate linear regression showed that the length of hospital

stay ( $B = 0.064$ ,  $P < 0.001$ ), place of birth ( $B = 0.245$ ,  $P = 0.007$ ), reimbursement ( $B = 0.169$ ,  $P < 0.001$ ), ventilator use ( $B = 0.982$ ,  $P < 0.001$ ), intensive care ( $B = 2.036$ ,  $P < 0.001$ ), pulmonary infection ( $B = 0.480$ ,  $P < 0.001$ ), respiratory failure ( $B = 0.655$ ,  $P < 0.001$ ) and PAH ( $B = 0.483$ ,  $P < 0.001$ ) were significantly associated with the direct medical costs. After conducting multivariate linear regression analysis, we found that the length of hospital stay ( $B = 0.057$ ,  $P < 0.001$ ), intensive care ( $B = 1.260$ ,  $P < 0.001$ ), pulmonary infection ( $B = 0.186$ ,  $P = 0.002$ ), and respiratory failure ( $B = 0.213$ ,  $P = 0.003$ ) were significantly associated with high direct medical costs. Having intensive care had the greatest impact on costs.

This study investigated the direct medical costs of patients with IPF based on a single-center database. We found that the median direct medical cost of IPF inpatients was 9378.3 CNY per patient per admission. As most patients were first diagnosed with IPF based on presumptive interstitial lung disease during hospitalization, testing fees ranked first, followed by drug costs. Treatment options for IPF today are limited to the internationally recommended

**Table 1: Analysis of the direct medical costs in hospitalized patients with idiopathic pulmonary fibrosis.**

Factors	n (%)	Cost (CNY)	Z values	P
Gender			-0.303	0.762
Male	200 (91.3)	9378.3 (7467.5, 12,223.5)		
Female	19 (8.7)	8634.5 (6715.2, 12,473.5)		
Age (years)			-0.552	0.581
<65	91 (41.6)	9396.3 (7519.7, 11,528.1)		
≥65	128 (58.4)	9301.1 (7219.6, 12,569.4)		
Place of birth			-1.988	0.047
Beijing native	107 (48.9)	9516.5 (7544.0, 14,527.0)		
Non-native	112 (51.1)	9171.9 (7023.9, 11,479.0)		
Reimbursement			-1.343	0.179
Yes	181 (82.6)	9420.2 (7484.2, 12,247.2)		
No	38 (17.4)	8638.4 (6165.9, 11,864.4)		
Ventilator use			-3.191	0.001
Yes	13 (5.9)	29,869.7 (10,121.8, 72,415.4)		
No	206 (94.1)	9242.5 (7322.8, 11,897.7)		
Critical care			8.299	0.004
Yes	3 (1.4)	81,452.5 (63,117.9, 100,048.5)		
No	216 (98.6)	9294.9 (7344.2, 12,057.8)		
Pulmonary infection			-4.478	<0.001
Yes	70 (32.0)	11,023.4 (8347.4, 19,849.6)		
No	149 (68.0)	8789.3 (6810.5, 11,209.4)		
Respiratory failure			-5.018	<0.001
Yes	43 (19.6)	16,456.9 (9265.8, 29,350.6)		
No	176 (80.4)	8806.8 (6938.3, 11,147.5)		
PAH			-3.070	0.002
Yes	39 (17.8)	12,122.7 (8123.3, 19,011.5)		
No	180 (82.2)	9212.6 (7046.1, 11,626.3)		
Heart failure			-0.118	0.906
Yes	9 (4.1)	8419.1 (6865.2, 16,938.4)		
No	210 (95.9)	9400.4 (7428.2, 12,095.1)		
Lung cancer			-0.868	0.385
Yes	4 (1.8)	7612.6 (6041.8, 12,764.0)		
No	215 (98.2)	9396.3 (7366.9, 12,122.7)		
Emphysema			-0.626	0.532

(continued)

Table 1

(continued).

Factors	n (%)	Cost (CNY)	Z values	P
Yes	35 (16.0)	8824.2 (7012.8, 12,122.7)		
No	184 (84.0)	9424.8 (7387.3, 12,171.6)		
Asthma			-0.907	0.365
Yes	5 (2.3)	8634.5 (5727.1, 10,673.4)		
No	214 (97.7)	9400.4 (7428.2, 12,182.9)		
Bronchiectasis			-1.578	0.115
Yes	3 (1.4)	15,222.1 (10,092.1, 16,826.4)		
No	216 (98.6)	9294.9 (7344.2, 12,079.8)	-0.674	0.500
GERD*				
Yes	16 (7.3)	8487.5 (6573.2, 13,420.8)		
No	203 (92.7)	9387.3 (7502.0, 12,079.8)		
HBP			-0.672	0.501
Yes	56 (25.6)	9487.2 (7552.1, 12,365.4)		
No	163 (74.4)	9265.8 (7057.3, 12,046.4)		
Diabetes			-0.377	0.706
Yes	34 (15.5)	9227.8 (7487.4, 11,867.8)		
No	185 (84.5)	9396.3 (7351.7, 12,188.7)		
CHD			-0.150	0.880
Yes	41 (18.7)	9404.6 (6800.1, 12,275.4)		
No	178 (81.3)	9351.2 (7523.2, 12,108.7)		

Data are presented as median (Q<sub>1</sub>, Q<sub>3</sub>). \*Eight cases were diagnosed with 24-h ambulatory esophageal pH and pressure recording; eight cases were diagnosed by gastroscopy and upper gastrography. CNY: Chinese yuan; PAH: Pulmonary arterial hypertension; GERD: Gastroesophageal reflux disease; HBP: High blood pressure; CHD: Coronary heart disease.

anti-fibrotic drugs pirfenidone and nintedanib. However, the costs of these drugs were not included in this study, as anti-fibrotic drugs were not available in China at that time.

After conducting a regression analysis, we found that length of stay, admittance into intensive care, pulmonary infection and respiratory failure, were significantly positively correlated with higher total hospitalization costs. A Spanish study also found that a significant increase in the annual cost per patient was due to the treatment of acute exacerbations of the disease.<sup>[3]</sup> Patients with IPF often have complications and other comorbidities, which require substantial health care resources, leading to increased overall burden. As our study showed, the costs of IPF patients with pulmonary infection, respiratory failure, and PAH were found to be higher than those of other patients. This result was similar to a previous study.<sup>[5]</sup>

The results of this study highlight the importance of controlling the progression of IPF and following clinical guidelines for inpatients. The study of European and American countries has investigated the economic burden of IPF on patients, but no such study exists in China. Bridging this gap is important because it is the first step for the follow-up research to reduce the clinical and economic burden of this illness in China.

### Funding

This study was supported by the grants from the National Key Technologies R & D Program Precision Medicine

Research (No. 2016YFC0901101), CAMS Innovation Fund for Medical Sciences (CIFMS, No. 2018-12M-1-001), and Non-profit Central Research Institute Fund of Chinese Academy of Medical Sciences (No. 2019PT320021).

### Conflicts of interest

None.

### References

- Hutchinson J, Fogarty A, Hubbard R, McKeever T. Global incidence and mortality of idiopathic pulmonary fibrosis: a systematic review. *Eur Respir J* 2015;46:795-806. doi: 10.1183/09031936.00185114.
- Collard HR, Ward AJ, Lanes S, Cortney Hayflinger D, Rosenberg DM, Hunsche E. Burden of illness in idiopathic pulmonary fibrosis. *J Med Econ* 2012;15:829-835. doi: 10.3111/13696998.2012.680553.
- Morell F, Esser D, Lim J, Stowasser S, Villacampa A, Nieves D, *et al.* Treatment patterns, resource use and costs of idiopathic pulmonary fibrosis in Spain—results of a Delphi Panel. *BMC Pulm Med* 2016;16:7. doi: 10.1186/s12890-016-0168-6.
- Raghu G, Collard HR, Egan JJ, Martinez FJ, Behr J, Brown KK, *et al.* 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. doi: 10.1164/rccm.2009-040GL.
- Frank AL, Kreuter M, Schwarzkopf L. Economic burden of incident interstitial lung disease (ILD) and the impact of comorbidity on costs of care. *Respir Med* 2019;152:25-31. doi: 10.1016/j.rmed.2019.04.009.

**How to cite this article:** Zheng XF, Xie BB, Liu Y, Zhu M, Zhang S, Ban CJ, Geng J, Jiang DY, Ren YH, Dai HP, Wang C. Direct medical costs of hospitalized patients with idiopathic pulmonary fibrosis in a tertiary hospital in China. *Chin Med J* 2020;133:2498-2500. doi: 10.1097/CM9.0000000000001089